A SYNOPSIS OF DISTRIBUTION PATTERNS AND THE CONSERVATION OF MAMMAL SPECIES

F. RUSSELL COLE, DEEANN M. REEDER, AND DON E. WILSON

Department of Biology, Colby College, Waterville, ME 04901 (FRC)
National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560 (DMR, DEW)

The 26 orders of living mammals occur in a variety of habitats; 97.5% of the species occupy terrestrial while only 2.5% inhabit marine environments. The most recent complete compilation lists 136 families, 1,135 genera, and 4,629 living and recently extinct species. The Ethiopian region possesses the most diverse fauna (52 families, 17 endemic) and 23% of all described species. This region has the highest generic and species endemism; almost 80% of the genera and >90% of the species are endemic. Fauna of the Oriental region also is rich (50 families, three endemic), including >20% of the world's species. The Palearctic region possesses 42 families (none endemic) and 18% of the world's species. The Australian region includes 10% of the world's species in 28 families (12 endemic); >60% of the genera and almost 90% of the species are endemic. The richest diversity of mammals in the New World occurs in the Neotropical region with 50 families (19 endemic) and 24% of the world's species (>80% endemic). The Nearctic region (37 families, two endemic) is home to 14% of all described species. Three terrestrial orders (Primates, Perissodactyla, and Proboscidea) and two marine orders (Cetacea and Sirenia) require immediate conservation efforts. Within the remaining 21 orders, ca. 30% of Old World and 15% of New World families are at risk. Additionally, almost 15% of the world's species are rated as endangered or vulnerable, and another ca. 10% are categorized as potentially vulnerable; these species warrant conservation strategies. The areas of the world with the greatest mammalian diversity are also the most poorly known, so conservation needs may be underrepresented in those regions.

Key words: mammals, families, genera, species, distribution, endemic, conservation

The 26 orders of living mammals occur in a variety of habitats. Species of mammals are found on all continents, occurring from above the Arctic Circle in the northern hemisphere to the southern tips of the continents and large islands in the southern hemisphere (Nowak, 1991; Vaughan, 1972). Mammal species also inhabit all oceans. There are 136 families, 1,135 genera, and 4,629 living and recently extinct species recognized in the most recent complete compilation (Wilson and Reeder, 1993), although at least five new species have been described from South America alone since that work. The great majority of mammal species (97.5%) occupy terrestrial habitats; only 2.5% inhabit marine habitats. The purposes of this synopsis were to investigate the taxonomic affinities among regions, determine regional distribution patterns, and assess the conservation status of the world's mammal species. Because the most diverse areas also are poorly understood, conservation needs may be underestimated in the areas where potential problems are the greatest.

METHODS

Taxonomic treatment and geographic distribution patterns of mammal species follow Wilson and Reeder (1993). The mammal-inhabited, large land masses of the world were divided into six regions. Generally, these regions correspond to traditional zoogeographical realms, but some

TABLE 1.—*Distribution of mammal families and genera among the six regions studied. The number of families and genera represented in the mammal fauna of each region, the percent of these families and genera endemic to that region, and the affinities among regions are shown. Taxonomy and range distributions follow Wilson and Reeder (1993).*

Region	No. of families (genera)	Percent endemic	Number of families (genera) in common					
			Nearctic	Neotropical	Palearctic	Ethiopian	Oriental	Australian
Nearctic	37	5.4		30	17	13	15	5
	(184)	(26.6)		(113)	(32)	(13)	(20)	(6)
Neotropical	50	38.0	30		12	11	12	5
	(309)	(63.1)	(113)		(10)	(8)	(11)	(7)
Palearctic	42	0	17	12		28	38	9
	(262)	(26.7)	(32)	(10)		(61)	(158)	(17)
Ethiopian	52	32.7	13	11	28		33	9
	(298)	(77.5)	(13)	(8)	(61)		(61)	(17)
Oriental	50	6.0	15	12	38	33		16
	(312)	(35.9)	(20)	(11)	(158)	(61)		(46)
Australian	28	42.9	5	5	9	9	16	
	(135)	(63.0)	(6)	(7)	(17)	(17)	(46)	

additional grouping and partitioning was done. The Nearctic region includes the land from the Canadian Arctic south to the Mexican border with Guatemala and the Neotropical region includes Middle America, the West Indies, and South America. These two regions comprise the New World. The Old World encompasses the Palearctic, Ethiopian, Oriental, and Australian regions. The Palearctic was divided into four subregions for some analyses: Europe; West Asia; North Asia; East Asia. Europe encompasses the British Isles and the area bounded by the Atlantic Ocean in the west, the Arctic Ocean in the north, the Mediterranean Sea in the south, and the Ural Mountains in the east. West Asia comprises Mediterranean Africa and the Middle East including the Arabian Peninsula. North Asia includes Asia west of the Ural Mountains and north of the Mongolia and China borders. The remainder of the Palearctic region is East Asia. The Ethiopian region includes sub-Saharan Africa and Madagascar. The Indo-Malayan region and the Philippines comprise the Oriental region. New Guinea, Australia, Tasmania, and adjacent islands make up the Australian region. The Oceanic region includes the isolated islands of the world. Species inhabiting islands found close to a large land mass were included in the fauna for that continental region. The marine environment includes coastal New and Old World, Atlantic, Pacific, and Indian oceans, Arctic and Antarctic regions.

Most categories of conservation status used in this compilation roughly approximate those used by the International Union for the Conservation of Nature and Natural Resources (1990): extinct (EX)—species not definitely located in the wild during the past 50 years; endangered (EN)—taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating; vulnerable (V)—taxa likely to move into the endangered category in the near future if causal factors do not change; potentially vulnerable (PV)—taxa with small world populations, taxa that occupy only a small percentage of their preferred habitat, or taxa that occupy a very specific, limited habitat, and faced with present or foreseeable pressures that could lead to their becoming vulnerable (we consider potentially vulnerable to be a subset of the stable category); stable (ST)—taxa that are characterized by stable or apparently stable populations and usually are found in small to large numbers within appropriate habitat; no assessment (NA)—taxa for which too little data are available for a status assessment. Status determinations used in this analysis were based on the International Union for the Conservation of Nature and Natural Resources specialist group reports, a review of the relevant literature, and responses to a survey distributed to specialists on certain taxa or geographical regions. Assessing conservation status by asking relevant experts assures timely input, but carries an inherent bias as well. Our knowl-

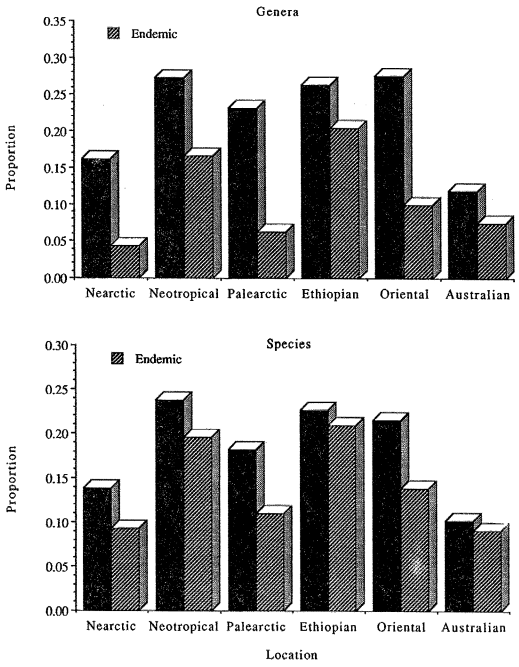

FIG. 1.—Distribution of terrestrial mammal genera and species among the six geographical regions. The proportion of endemic genera and species within each region is indicated.

edge is highly skewed in that we know a great deal about the Nearctic, Australian, and part of the Palearctic (Europe) regions, less about the Neotropical region, and still less about the remainder of the Palearctic (West Asia, North Asia, and East Asia), the Ethiopian, and the Oriental regions. This means that the parts of the world where conservation faces its greatest problems (i.e., where the largest number of species are actually endangered) are probably under represented in the compilation.

RESULTS

The Ethiopian region possesses the most diverse mammalian fauna with 52 families (17 endemic). More than 50% of the families and 20% of the genera found in the Ethiopian region extend to the Palearctic; 63% and 20%, respectively, extend to the Oriental region. Fauna of the Oriental region also is diverse with 50 families (three endemic). The Palearctic region possesses 42 families (none endemic). This region shares 67% of its families and 23% of its genera with the Ethiopian region and 90% and 60%, respectively, with the Oriental region. The Australian region includes 28 families (including 16 marsupial and two monotreme families) and 135 genera; 57% of the families and 34% of the genera found in this region also occur in the Oriental region.

The richest diversity of mammals in the New World occurs in the Neotropical region with 50 families (19 endemic) and 309 genera (Table 1). This region shares 60% of its families and 37% of its genera with the Nearctic region. The Nearctic (37 families, two endemic) shares >80% of its families and >60% of its genera with the Neotropical region. About 50% of the Nearctic families and almost 20% of the genera occur in the Palearctic region.

The Ethiopian region is diverse and possesses 26% of all genera and 23% of all described species. This region has the highest proportion of endemic genera and species, 78% and 93%, respectively (Fig. 1, Table 2). One order (Tubulidentata) is unique to this region. The Oriental fauna also is diverse and includes the greatest proportion of the world's genera (27%) and >20% of the world's species; 36% of the genera and 65% of this region's species are endemic. One order (Dermoptera) is unique to the Oriental region. The Australian region includes 12% of the world's genera and 10% of all species. This region is second only to the Ethiopian region in generic (63%) and species (89%) endemism. The Notoryctemorphia are endemic to this region. Four additional orders (Monotremata, Dasyuromorphia, Peramelemorphia, and Diprotodontia) inhabit only the Oriental and Australian regions.

The Palearctic region has the lowest generic endemism of all Old World regions (27%) and the lowest proportion of endemic species in all regions (60%; Fig. 1). When this region is divided into four subregions, Europe, West Asia, and North Asia possess similar numbers of genera and spe-

TABLE 2.—*Distribution of mammalian taxa among the six regions studied. The number of families (Fam), genera (Gen), and species (Sp) found in each region is indicated for each order of mammals. The taxonomy and geographical distributions follow Wilson and Reeder (1993).*

	Nearctic			Neotropical			Palearctic			Ethiopian			Oriental			Australian		
Taxon	Fam	Gen	Sp	Fam	Gen	Sp	Fam	Gen	Sp	Fam	Gen	Sp	Fam	Gen	Sp	Fam	Gen	Sp
Monotremata													1	1	1	2	3	3
Didelphimorphia	1	5	6	1	15	62												
Paucituberculata				1	3	5												
Microbiotheria				1	1	1												
Dasyuromorphia													1	3	3	3	17	63
Peramelemorphia													1	2	4	2	7	19
Notoryctemorphia																1	1	2
Diprotodontia													4	11	16	10	37	112
Xenarthra	2	4	4	4	13	29												
Insectivora	2	10	55	3	4	25	3	27	125	4	28	179	3	18	78			
Scandentia							1	1	1				1	5	19			
Dermoptera													1	1	2			
Chiroptera	8	58	134	9	80	248	7	37	134	9	45	193	9	67	278	7	36	132
Primates	2	3	4	3	16	85	4	7	22	9	34	88	5	12	54	1	1	1
Carnivora	5	24	51	5	26	47	7	44	74	6	46	77	7	41	81	1	1	1
Proboscidea							1	1	1	1	1	1	1	1	1			
Perissodactyla	1	1	1	1	1	3	1	1	4	2	3	7	3	4	6			
Hyracoidea							1	2	2	1	3	5						
Tubulidentata										1	1	1						
Artiodactyla	4	12	13	3	11	20	6	29	68	5	36	90	5	23	64			
Pholidota							1	1	2	1	1	4	1	1	3			
Rodentia	10	61	350	18	138	568	7	106	367	11	92	374	5	118	368	1	32	139
Lagomorpha	2	5	25	1	1	3	2	5	42	1	4	10	2	4	17			
Macroscelidea							1	1	1	1	4	14						
Total	37	184	643	50	309	1,096	42	262	843	52	298	1,045	50	312	995	28	135	472

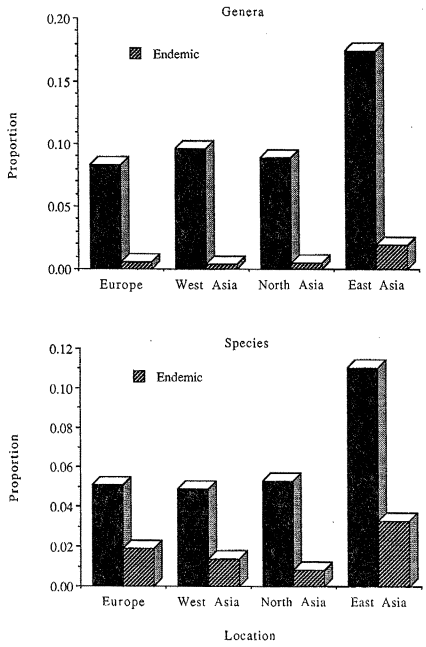

FIG. 2.—Distribution of mammal genera and species among four subregions of the Palearctic; Europe, West Asia, North Asia, and East Asia. The proportion of endemic genera and species within each region is indicated.

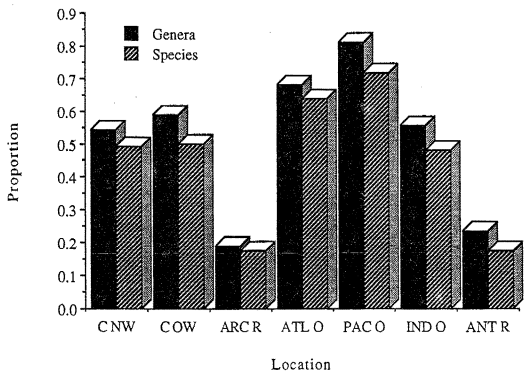

FIG. 3.—Distribution of marine mammal species among coastal New World (C NW) and Old World (C OW), Atlantic (ATL O), Pacific (PAC O), and Indian (IND O) oceans, and Arctic (ARC R) and Antarctic (ANT R) regions.

cies (Fig. 2). North Asia has almost one-half the proportion of endemic species present when compared to the three remaining subregions. East Asia possesses the most diverse fauna within the Palearctic region. This subregion has almost double the number of genera (11% endemic) and more than twice as many species (30% endemic) as the remaining subregions.

The Neotropical region possesses more species than any other region and ranks second in the number of genera (Table 2). About one-quarter of the world's genera and species are found in this region; 38% of the genera and 82% of the species are endemic (Fig. 1). Two orders of marsupials (Paucituberculata and Microbiotheria) are unique to this region (Table 2). The Nearctic is home to 16% of the world's genera and 14% of all described species. This New World region equals the Palearctic for the lowest proportion of endemic genera (27%).

Three areas of high endemism also were studied. Renowned for its unique mammalian fauna, Madagascar has six endemic families (14 families total); 61% of the genera and 82% of the species are endemic. New Guinea (18 families) and the Philippines (26 families) have no endemic families, but ca. 30% of the genera and 60% of the species in these areas are endemic.

Only 2.5% of the world's mammal species inhabit marine environments. About 50% of the marine mammal genera and species occur in coastal waters of the New World and Old World (Fig. 3). Only ca. 20% of the genera and species are found in the Arctic or Antarctic regions. The order Cetacea includes the largest number of marine mammal species (Table 3). Some cetacean species are pelagic and inhabit the open ocean; other species may be found in both coastal and deep-water environments. River dolphins, dugongs and manatees (Sirenia), and many species of seals (Carnivora) inhabit rivers and coastal areas of the New World and Old World. Three additional species of Carnivora (*Enhydra lutris, Lontra felina,* and *Ursus maritimus*) also are included in this group.

About 2% (82) of all described mammal species have gone extinct in the past 500 years; 24 of these species inhabited the

TABLE 3.—*Distribution of mammal species among the coastal areas and oceans of the world. Species of marine mammals occurring in coastal environments are listed under the appropriate region while species occurring in deep-water environments or in coastal areas of isolated islands are listed under the appropriate ocean or region. The taxonomy follows Wilson and Reeder (1993). Fam = families, Gen = genera, and Sp = species.*

	Coastal New World			Coastal Old World			Arctic Region			Atlantic Ocean			Pacific Ocean			Indian Ocean			Antarctic Region		
Taxon	Fam	Gen	Sp	Fam	Gen	Sp	Fam	Gen	Sp	Fam	Gen	Sp	Fam	Gen	Sp	Fam	Gen	Sp	Fam	Gen	Sp
Carnivora	4	16	23	4	15	22	3	5	9	3	11	13	4	14	16	2	4	5	2	6	7
Cetacea	8	18	29	8	19	29	6	8	11	8	32	56	9	35	58	7	30	46	5	9	12
Sirenia	1	1	2	2	3	3							1	2	2	1	1	1			
Total	13	35	54	14	37	54	8	12	19	11	43	69	14	51	76	10	35	52	7	15	19

Australian region, and 32 were found in the West Indies (Fig. 4; Appendix I). Only species not definitely located in the wild during the past 50 years are included in this list. Within the past 50 years, at least four additional species probably have gone extinct.

Thirteen percent of the world's species are rated as endangered or vulnerable and warrant conservation strategies. Additionally, 50% of all mammal species are categorized as having stable population levels; 10% of these species are potentially vulnerable, but more information is needed for an accurate status determination. Three terrestrial orders (Primates, Perissodactyla, and Proboscidea) and two marine orders (Cetacea and Sirenia) require immediate conservation efforts (Fig. 4). Many large ungulates with extensive home ranges or seasonal migratory routes are susceptible to population declines. Conservation plans are needed for almost 60% of the Artiodactyla and >80% of the Perissodactyla. In addition, 57% of the Pholidota appear to be at risk. These species have been rated as endangered, vulnerable, or potentially vulnerable in our review. Although smaller and less mobile, 57% of the Peramelemorphia, 26% of the Lagomorpha, and 20% of the Macroscelidea are rated in these categories and deserve conservation strategies.

Populations of large predators also are likely to be affected by environmental perturbation; ca. 46% of the Carnivora are endangered, vulnerable, or potentially vulnerable. Additionally, at least 50% of the Diprotodontia, 57% of the Peramelemorphia, and 27% of the Dasyuromorphia are at risk. Both species in the Notoryctemorphia are rare and potentially vulnerable. Our estimates are that almost 5% of the Chiroptera, 15% of the Rodentia, and 20% of the Insectivora warrant conservation strategies; however, more data are needed to assess accurately the status of species in these orders.

The mammalian fauna of the New World may be generally less threatened than the fauna inhabiting the Old World or Oceanic islands. Less than 5% of the New World species are endangered and ca. 15% more are vulnerable or potentially vulnerable based on our survey (Fig. 5). The 6% for Neotropical species in the extinct or endangered category reflects a number of extinct West Indian rodents as well as endangered taxa on the mainland. Conversely, almost 30% of the Old World species are rated as endangered, vulnerable, or potentially vulnerable, although no assessment was made for almost 45% of the mammal species inhabiting the Palearctic, Ethiopian, and Oriental regions. About 45% of species known from isolated Oceanic islands are extinct or endangered, probably due to habitat disruption.

About 5% of the mammal species in New Guinea and the Philippines are endangered; 11% of the species in Madagascar are rated in this category. The proportions of vulner-

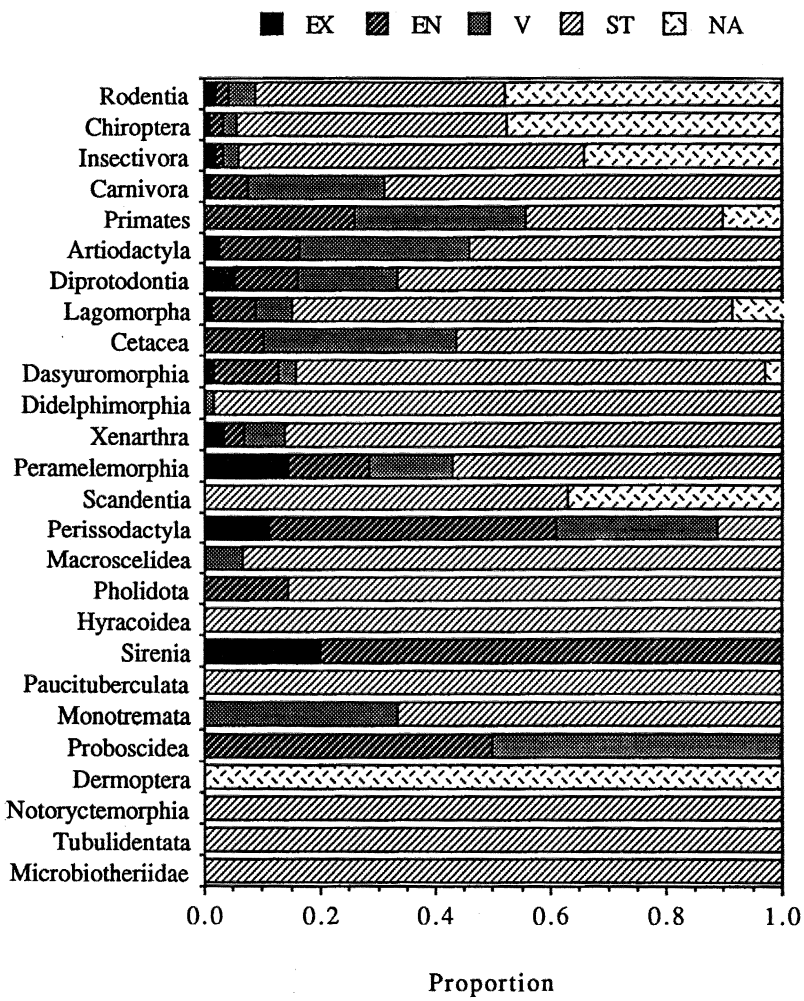

FIG. 4.—Conservation status of the species within each mammalian order. Status categories include extinct (EX), endangered (EN), vulnerable (V), stable (ST), and no assessment (NA).

able and potentially vulnerable species for these three areas are 19, 28, and 37%, respectively.

About 70% of the marine mammal species in each region are thought to be either endangered, vulnerable, or potentially vulnerable (Fig. 6). Species inhabiting coastal waters are twice as likely to be endangered as open ocean species. Pollution, habitat degradation, disturbance, boat accidents, and other human activities threaten these species (Klinowska, 1991). The primary threats to deep-water cetaceans are commercial whaling and incidental takes (e.g., by-catches in gillnet fisheries).

DISCUSSION

Although verifying extinction is a difficult process, and we welcome comments on those species listed in Appendix I, we count 82 species of mammals that probably have gone extinct in the past 500 years. We have listed only species that have not been definitely located in the wild during the past 50 years. Additionally, we have identified 234 species that we rank as endangered. Determining the causes of extinctions or the endangered status of selected species is beyond the scope of this report, but it is possible to list some characteristics of spe-

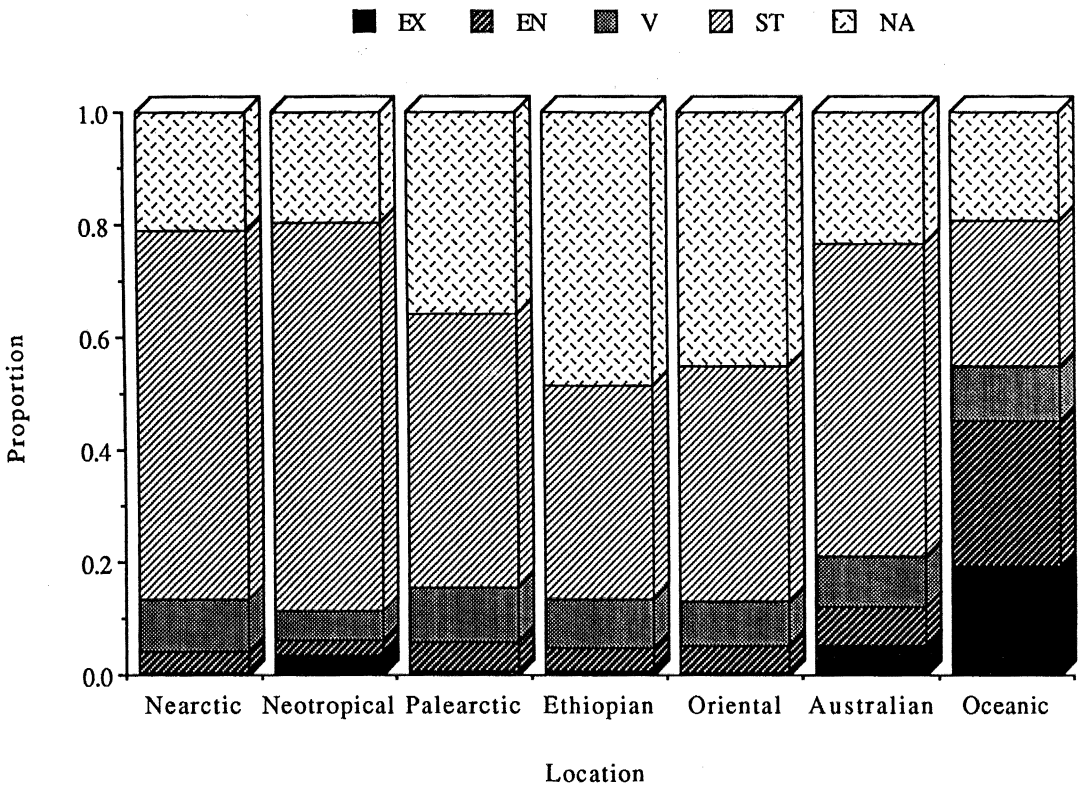

FIG. 5.—Conservation status of terrestrial mammal species that inhabit each of the six geographical regions and islands of the Oceanic region. Status categories include extinct (EX), endangered (EN), vulnerable (V), stable (ST), and no assessment (NA).

cies prone to extinction (Hoage, 1985; Miller, 1992). These include low reproductive rate, long gestation and parental care time, limited or specialized habitat requirements, specialized diet, feeding at high trophic levels, large body size, restricted distribution, small population size, fixed migratory routes, competitor-predator of humans, and behavior patterns that increase exposure to mortality risks.

It also is possible to suggest factors that may increase the risk of extinction (Hoage, 1985; Miller, 1992; Ryan, 1992; Soule, 1986; Soule and Wilcox, 1980; Wilson, 1988, 1992). These include: rapid growth of human populations in areas of high diversity; habitat destruction, degradation, and fragmentation; commercial, sport, and subsistence hunting; pollution of terrestrial and marine habitats; introduction of exotic species; pest and predator control; collection for the pet trade.

There are several problems in determining the conservation status of mammal species. Assignment to categories may depend on information that is difficult to obtain, and a high level of knowledge is needed to classify species accurately. Categories may not be precisely defined or may be defined differently for different taxa. The critical level for each species may vary. New criteria for categorizing the conservation status of different animal taxa have been proposed recently and their use may reduce the ambiguity found in the current system (Mace et al., 1993).

How rare should a species be before being listed as a conservation risk? Some species may simply be rare, but not experiencing a decline in numbers. The status of

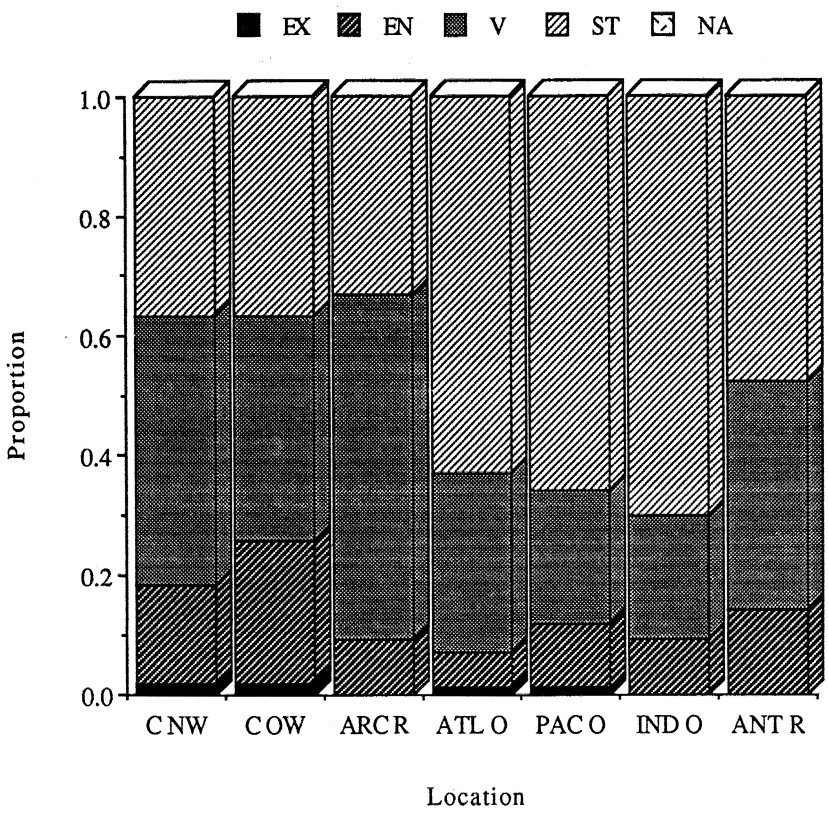

FIG. 6.—Conservation status of marine mammal species inhabiting coastal New World and Old World, Atlantic, Pacific, and Indian oceans, and Arctic and Antarctic regions. Status categories include extinct (EX), endangered (EN), vulnerable (V), stable (ST), and no assessment (NA).

populations within a species can be highly variable, and the listing for the species says nothing about the status of individual subspecies or populations of that species. How should subspecies assignments be weighed when assessing the status of the species?

We recommend the development and adoption of objective and scientifically-based methods for rating the conservation status of mammal species. In addition, educational programs for the public are needed to raise awareness and generate support for conservation efforts. Community participation projects, which address local or regional conservation issues, should be encouraged.

Training programs should be available to biologists, particularly in tropical countries where biological diversity is high. Comprehensive training in scientific theory and hands-on experience in the techniques of collecting, analyzing, and interpreting field data for the conservation and management of wild fauna and flora should be provided. Methods for conducting inventory and monitoring studies should be emphasized.

More inventory and monitoring studies are necessary to determine the status of the world's mammal species. Adoption worldwide of standard field methods would facilitate comparisons among studies and accurate appraisals of the conservation needs for specific mammal species. Protocols for biological surveys should be coordinated at the state, national, and international levels. Data gathered by various governmental and nongovernmental organizations should be easily assessable through a single international agency.

The establishment and maintenance of a worldwide system of reserves, parks, and natural areas to preserve biological diversity would allow conservation and management of entire ecosystems rather than the species-centered approach to preservation often practiced at present. Preserves might be multipurpose in design, combining conservation with sustainable development. Local people should be involved in the planning and management of each preserve.

Long-term, coordinated strategies for conserving mammal taxa throughout the world should be designed. A dependable mechanism for funding the implementation of these international strategies should be established. Professional societies devoted to mammalian studies in all regions of the world should take the lead in organizing such a worldwide, mammal conservation effort.

Acknowledgments

This summary would not have been possible without the database compiled for the second edition of *Mammal Species of the World,* a joint publication of The American Society of Mammalogists and the Smithsonian Institution (Wilson and Reeder, 1993). The individual authors of that work included C. G. Anderson, R. L. Brownell, Jr., M. D. Carleton, F. Dieterlen, A. L. Gardner, C. P. Groves, P. Grubb, L. R. Heaney, R. S. Hoffmann, M. E. Holden, R. Hutterer, K. F. Koopman, J. G. Mead, G. G. Musser, J. L. Patton, D. A. Schlitter, R. W. Thorington, Jr., C. A. Woods, and W. C. Wozencraft. In addition, we are grateful to the many professional mammalogists from throughout the world who took the time to respond to our questionnaire regarding the conservation status of species within their area of expertise. We also thank J. Payne and M. Sanderson for their assistance in tabulating and analyzing data. This research was funded by the Office of Biodiversity Programs, Smithsonian Institution, and by a sabbatical grant to FRC from the Howard Hughes Medical Institutes Fund, Colby College.

Literature Cited

Hoage, R. J. (ed.). 1985. Animal extinctions: what everyone should know. Smithsonian Institution Press, Washington, D.C., 192 pp.

International Union for the Conservation of Nature and Natural Resources. 1990. 1990 IUCN red list of threatened animals. International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland, 228 pp.

Klinowska, M. 1991. Dolphins, porpoises, and whales of the world: the IUCN red data book. International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland, 482 pp.

Mace, G., et al. 1993. The development of new criteria for listing species on the IUCN red list. Species, 19:16–21.

Miller, G. T., Jr. 1992. Living in the environment. Seventh ed. Wadswoth Publishing Company, Belmont, California, 705 pp.

Nowak, R. M. 1991. Walker's mammals of the World. Fifth ed. The Johns Hopkins University Press, Baltimore, Maryland, 1:1–642, 2:643–1629.

Ryan, J. C. 1992. Life support: conserving biological diversity. Worldwatch Paper, Worldwatch Institute, 108:1–62.

Soulé, M. E. (ed.). 1986. Conservation biology: the science of scarcity and diversity. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, 584 pp.

Soulé, M. E., and B. A. Wilcox (eds.). 1980. Conservation biology: an evolutionary-ecological perspective. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, 395 pp.

Vaughan, T. A. 1978. Mammalogy. Second ed. W. B. Saunders Company, Philadelphia, 522 pp.

Wilson, D. E., and D. M. Reeder (eds.). 1993. Mammal species of the world: a taxonomic and geographic reference. Second ed. Smithsonian Institution Press, Washington, D.C., 1,206 pp.

Wilson, E. O. (ed.). 1988. Biodiversity. National Academy Press, Washington, D.C., 521 pp.

———. 1992. The diversity of life. Harvard University Press, Cambridge, Massachusetts, 424 pp.

Appendix I.—*Extinct or probably extinct mammal species and their historical distribution among the geographical regions. Only species not definitely located in the wild during the past 50 years are included in this list.*

Taxon	Region
Order Dasyuromorphia	
Family Thylacinidae	
Thylacinus cynocephalus	Australian
Order Peramelemorphia	
Family Peramelidae	
Chaeropus ecaudatus	Australian
Macrotis leucura	Australian
Perameles eremiana	Australian
Order Diprotodontia	
Family Potorridae	
Caloprymnus campestris	Australian
Potorous platyops	Australian

APPENDIX I.—*Continued.*

Taxon	Region
Family Macropodidae	
Lagorchestes asomatus	Australian
Lagorchestes leporides	Australian
Macropus greyi	Australian
Onychogalea lunata	Australian
Order Xenarthra	
Family Dasypodidae	
Tolypeutes tricinctus	Neotropical
Order Insectivora	
Family Solenodontidae	
Solenodon marcanoi	Neotropical (West Indies)
Family Nesophontidae	
Nesophontes edithae	Neotropical (West Indies)
Nesophontes hypomicrus	Neotropical (West Indies)
Nesophontes longirostris	Neotropical (West Indies)
Nesophontes major	Neotropical (West Indies)
Nesophontes micrus	Neotropical (West Indies)
Nesophontes paramicrus	Neotropical (West Indies)
Nesophontes submicrus	Neotropical (West Indies)
Nesophontes zamicrus	Neotropical (West Indies)
Order Chiroptera	
Family Pteropodidae	
Acerodon lucifer	Oriental (Philippines)
Dobsonia chapmani	Oriental (Philippines)
Nyctimene sanctacrucis	Australian (New Guinea)
Pteropus brunneus	Australian
Pteropus pilosus	Oceania
Pteropus subniger	Oceania
Pteropus tokudae	Oceania
Family Vespertilionidae	
Kerivoula africana	Ethiopian
Scotophilus borbonicus	Oceania
Family Mystacinidae	
Mystacina robusta	Australian
Order Carnivora	
Family Canidae	
Dusicyon australis	Neotropical
Family Phocidae	
Monachus tropicalis	Neotropical (West Indies)
Family Procyonidae	
Procyon gloveralleni	Neotropical (West Indies)
Order Sirenia	
Family Dugongidae	
Hydrodamalis gigas	Palearctic (North Asia)
Order Perissodactyla	
Family Equidae	
Equus quagga	Ethiopian
Order Artiodactyla	
Family Hippopotamidae	
Hexaprotodon madagascariensis	Ethiopian (Madagascar)
Hippopotamus lemerlei	Ethiopian (Madagascar)

APPENDIX I.—*Continued.*

Taxon	Region
Family Cervidae	
Cervus schomburgki	Oriental
Family Bovidae	
Gazella rufina	Palearctic (West Asia)
Bubalus mephistopheles	Palearctic (East Asia)
Hippotragus leucophaeus	Ethiopian
Order Rodentia	
Family Muridae	
Microtus bavaricus	Palearctic (Europe)
Leimacomys buettneri	Ethiopian
Conilurus albipes	Australian
Leporillus apicalis	Australian
Notomys amplus	Australian
Notomys longicaudatus	Australian
Notomys macrotis	Australian
Notomys mordax	Australian
Pseudomys fieldi	Australian
Pseudomys gouldii	Australian
Rattus macleari	Oceania
Rattus nativitatis	Oceania
Solomys salamonis	Australian (New Guinea)
Uromys imperator	Australian (New Guinea)
Uromys porculus	Australian (New Guinea)
Megalomys desmarestii	Neotropical (West Indies)
Megalomys luciae	Neotropical (West Indies)
Nesoryzomys darwini	Neotropical
Oryzomys nelsoni	Nearctic
Peromyscus pembertoni	Nearctic
Family Erithizontidae	
Sphiggurus pallidus	Neotropical (West Indies)
Family Echimyidae	
Boromys offella	Neotropical (West Indies)
Boromys torrei	Neotropical (West Indies)
Brotomys contractus	Neotropical (West Indies)
Brotomys voratus	Neotropical (West Indies)
Heteropsomys antillensis	Neotropical (West Indies)
Heteropsomys insulans	Neotropical (West Indies)
Puertoricomys corozalus	Neotropical (West Indies)
Family Capromyidae	
Geocapromys thoracatus	Neotropical
Hexolobodon phenax	Neotropical (West Indies)
Isolobodon montanus	Neotropical (West Indies)
Isolobodon portoricensis	Neotropical (West Indies)
Plagiodontia araeum	Neotropical (West Indies)
Plagiodontia ipnaeum	Neotropical (West Indies)
Rhizoplagiodontia lemkei	Neotropical (West Indies)
Family Heptaxodontidae	
Clidomys osborni	Neotropical (West Indies)
Clidomys parvus	Neotropical (West Indies)
Amblyrhiza inundata	Neotropical (West Indies)
Elasmodontomys obliquus	Neotropical (West Indies)
Quemisia gravis	Neotropical (West Indies)
Order Lagomorpha	
Family Ochotonidae	
Prolagus sardus	Palearctic (Europe)