

Primate conservation

Across the globe, primate species in natural environments are under increasing pressures from a growing human population. According to the International Union for the Conservation of Nature (IUCN), 35% of living primates (62 of 177 species) are currently considered either "critically endangered" (defined as "facing an extremely high risk of extinction in the wild in the immediate future") or "endangered" (defined as "facing a very high risk of extinction in the wild in the near future"), while an additional 51 species are considered "vulnerable" to extinction in the medium-term future (see **table**). Most living primates are restricted to tropical and subtropical forests, and the vast majority of critically endangered and endangered primates are either found in or are endemic to 11 of the 25 biodiversity "hotspots" recently identified by Conservation International as priority areas for global conservation. In fact, all critically endangered primate species, and over half of the endangered species, can be found in just six hotspots that together comprise just over 0.5% of the Earth's surface, suggesting very clear priority habitats where immediate conservation efforts should be focused (**Fig. 1**). See BIODIVERSITY HOTSPOTS.

Threats to primates. The most serious anthropogenic threats facing primates come from habitat loss due to deforestation and conversion of forests to agricultural land, habitat fragmentation, habitat degradation and modification associated with logging and other forms of natural resource extraction, and subsistence and commercial hunting. All of these processes are ultimately tied to human population growth, which tends to be greatest in developing countries where most of the world's primates are found. See POPULATION GROWTH AND SUSTAINABLE DEVELOPMENT.

Deforestation and habitat conversion. Over the last 8000–10,000 years, human activity has reduced the moist tropical forests of Africa, Southeast Asia, and South America that are home to most primates to less than one-half of their former extent. Deforestation and the conversion of forested lands to agricultural use have been particularly dramatic during the past several decades: tropical forests were deforested at an average rate of nearly 0.9% per year globally during the 1980s and at a rate of 0.52% per year between 1990 and 1997. Depending on the precise data used, it has been estimated that up to 12.3 million hectares

of tropical forest were lost annually to deforestation throughout the 1990s, a figure only slightly lower than in preceding decades. The rate of tropical deforestation and conversion varies with geographic region and is highest in Southeast Asia, where human population density is greatest. Some of the highest rates of deforestation are seen in precisely those areas of the tropics identified as biodiversity hotspots and containing large numbers of threatened primates (**Fig. 1**). Indeed, habitat loss is often considered to be the primary risk factor for future primate extinctions.

Habitat fragmentation and modification. In a number of regions of the world, primates are threatened not just by habitat loss but also by fragmentation and modification of their natural environments. Such changes may coincide with large-scale deforestation but may also arise as incidental effects of less drastic habitat disturbances. For example, "selective" logging and other putatively sustainable extractive forestry practices typically require the building of a network of roads, which can fragment existing forest patches or make previously unexposed areas of forest accessible to colonization by humans thus facilitating subsequent deforestation and hunting.

Although the effects of fragmentation and modification per se on the risk of extinction of local primate populations are poorly understood, based on ecological theory and limited empirical studies it is clear that a number of factors influence whether a particular primate species can persist in such a habitat. In general, primate populations are more likely to persist in larger fragments and in fragments that are closer to potential source populations from which recolonization is possible. Additionally, primates with less specialized dietary and other ecological needs, those with smaller home range requirements, and those that are predominantly folivorous (leaf-eating) rather than frugivorous (fruit-eating) appear more likely to survive in fragmented or selectively modified habitats.

Another general consequence of fragmentation is the more rapid loss of genetic diversity due to inbreeding and stochastic (random) genetic drift. This loss of diversity may compromise a population's ability to respond adaptively to changing environmental conditions and thus increase its risk of extinction. Today some of the most highly endangered primates, such as the muriquis and lion tamarins endemic to Brazil's Atlantic Forest, exist only in fragmented and modified habitat landscapes (**Fig. 2**).

Geographic region	Critically endangered	Endangered	Vulnerable	Lower risk or data-deficient	Total
Africa	2	12	7	23	44
Asia	6	16	15	30	67
Americas	9	9	21	4	43
Madagascar	2	6	8	7	23
Total	19	43	51	64	177

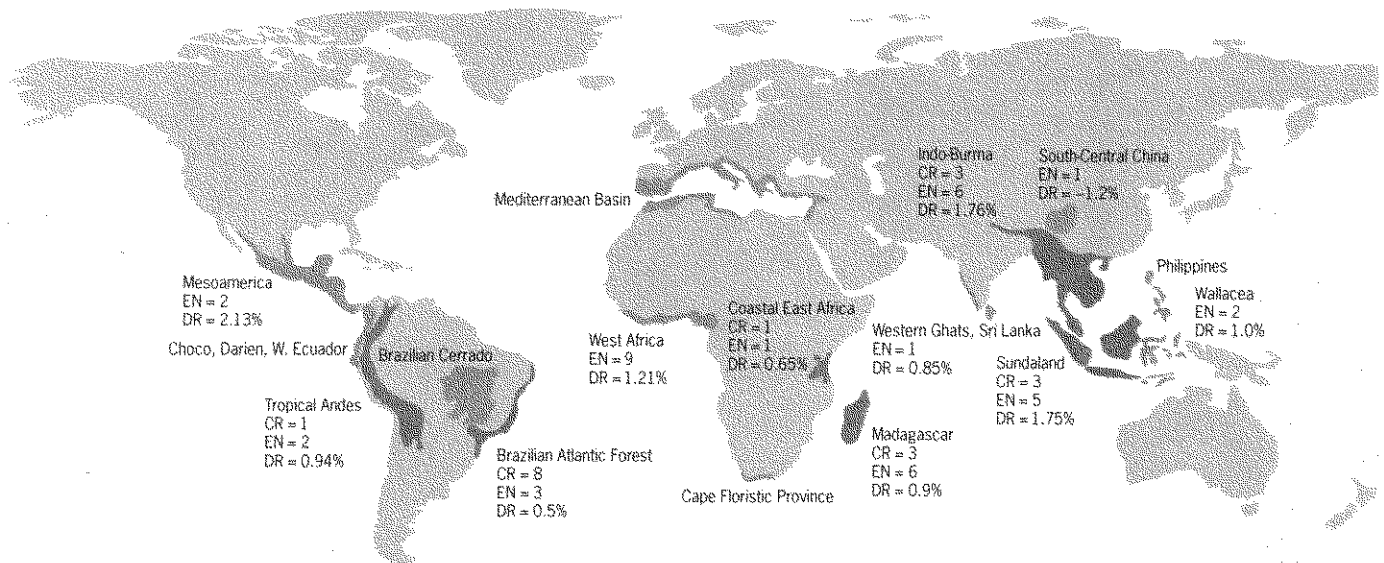


Fig. 1. Sixteen global biodiversity hotspots in which nonhuman primates are found. Eleven of these hotspots harbor critically endangered and/or endangered primates, and six (darkly covered) contain all 19 critically endangered species and over 50% of endangered species. CR = number of critically endangered primate species found in the hotspot, EN = number of endangered species, and DR = estimated rate of deforestation during the 1990s. (Adapted from N. Myers et al., *Biodiversity hotspots for conservation priorities*, *Nature*, 403:853–858, 2000)



Fig. 2. The critically endangered Northern muriqui, *Brachyteles arachnoides*, one of the largest living South American primates. It is estimated that about 500 mature Northern muriquis remain in the wild, divided among several remnant and regenerating forest patches in a highly fragmented landscape. Although muriquis still face multiple risks from humans, international conservation efforts have been effective in improving their chances for survival. (Photo by Luiz G. Dias, courtesy of K. B. Strier)

Hunting. Hunting is also a major threat to primate populations. Humans have been important predators of primates for tens of thousands and perhaps hundreds of thousands of years, and human hunting has been suggested as a direct causal factor in the extinctions of a number of primate taxa (for example, multiple species of lemurs on Madagascar following human colonization of the island 1500 to 1000 years ago; and Miss Waldron's red colobus, a large red-and-black monkey, from western Africa during the twentieth century). Recent studies have demonstrated the dramatic effect that even small-scale subsistence hunting can have on primate populations. For example, surveys of vertebrate biomass in 25 primary rainforest sites across western Amazonia have revealed that the density of large-bodied ateline primates—the prehensile-tailed howler, spider, and woolly monkeys—is as much as 10 times lower in areas subject to intense subsistence hunting than in sites facing little or no hunting pressure. Throughout Amazonia, these three primate species are often cited as the preferred prey of local subsistence hunters, and it has been estimated that between 1 and 2.6 million individual atelines (yielding between 6800 and 16,700 tons of meat) are harvested annually by hunters in the Brazilian Amazon alone.

Today commercial hunting is thought to pose one of the most significant threats to local primate populations, particularly in parts of West Africa where bushmeat is a highly desirable food resource and where many species of primates are being hunted for market at rates that significantly exceed estimates of maximum sustainable yield. Beyond being hunted for food, primates are commonly killed as agricultural pests in some parts of the world, a trend that can only be expected to increase as human population

density increases. Finally, many primates are hunted as part of the trade in exotic pets and in animal parts used as souvenirs or in traditional medicines, as well as in the endeavor to acquire subjects for biomedical research, although international restrictions on the trade in endangered species (for example, legislation of the Convention on International Trade in Endangered Species) have effectively lessened some of these pressures over the past few decades.

Importance. There are a number of reasons why primates are critical focal taxa for wildlife conservation efforts. First, it is likely that primates play crucial ecological roles in some of the ecosystems in which they are found, and the loss of primates from these ecosystems may have dramatic and far-reaching effects. For example, in many tropical forests primates are important dispersers of seeds for numerous species of plants. In the neotropics (southern Mexico, Central and South America), up to 90% of woody plant species depend on frugivores for dispersal of their seeds; primates constitute a major portion of the total biomass of neotropical frugivores and are known to swallow and disperse in their feces enormous numbers of viable seeds from hundreds of different plants. Moreover, the germination success of seeds is often significantly improved following passage through the digestive tracts of primates. Consequently, frugivorous primates have the potential to significantly impact the recruitment patterns (number and likelihood of dispersed seeds surviving to adulthood) of many plant species, including those of economic value to local human populations, and can thus influence the long-term health and persistence of forested ecosystems. Recent studies have found that seedling recruitment is markedly lower in forest fragments lacking primate seed dispersers.

Second, given their long lifespans and slow reproductive rates, primates may be some of the most sensitive indicators of anthropogenic stress on an area; successful efforts to conserve primates are thus likely to also serve the broader goal of preserving many other elements of the same ecosystems. This may be an especially compelling reason to focus primate conservation efforts on those tropical forest hotspots that harbor considerable plant and animal biodiversity beyond just primates. Moreover, primates may be particularly charismatic and effective “flagship species” around which to rally local and international conservation interest.

Finally, primates tend to be better studied than many other vertebrates in the tropical ecosystems in which they are found; as a result, their ecological requirements may be well understood, thus making management plans designed to meet these ecological requirements more likely to be effective.

Approaches. Central to most conservation efforts is the prioritization of species or habitat areas for conservation attention. Once priority habitats or species have been identified, there are many tactics that may be employed to meet conservation goals. The most common of these involve setting aside specific areas as protected reserves and trying to promote the

sustainable use of primates and their forest habitats among the local people.

Prioritization of habitats or species. The biodiversity hotspot concept is an example of a habitat prioritization approach, identifying critical areas for conservation action based on the enormous diversity in plant and animal life that these various areas support. Particular primate species are often prioritized for conservation based on an evaluation of their risk of extinction, and one of the workhorse techniques for such risk assessment is a set of procedures known as population and habitat viability analysis (PHVA). PHVA typically uses computer simulation to evaluate the likelihood that a particular population will persist in an area for a specified period of time given a set of demographic parameters defining the population (for example, fertility and mortality schedules, and the age and sex composition) and the specific extrinsic forces operating on both the population and local people (for example, stochastic fluctuations in environmental conditions, rates of habitat loss and fragmentation, and the availability of alternative economic opportunities).

Protected reserves. In the last two decades, much has been written about general principles of reserve design, but it is important to note that the efficacy of reserves is often limited by problems of enforcement; in many developing countries, there is little funding to support enforcement and, as a result, many reserves are protected in name only. This has led some conservationists to suggest that reserves should be designed with the additional explicit criterion of minimizing their accessibility via roads or river courses.

Promoting sustainable use. In the last 10 years, many conservationists have advocated the use of integrated conservation and development projects (ICDPs) as a strategy for promoting the sustainable use of primate populations and their habitats. Such projects aim to provide an economic incentive to local human populations for participating in conservation efforts, and are born of the realization that local people are unlikely to embrace conservation actions imposed by governments or external agencies without some clear benefit to themselves. While theoretically compelling, in practice ICDPs have seldom lived up to their promise, in part because they often fail to take into account the fact that successful projects may provide an economic incentive for increased human migration into an area, thus further taxing the natural resource base they aim to protect.

Other approaches. A number of other tactics have been used in recent primate conservation efforts with varying degrees of success, including breeding animals in captivity with the implicit goal of restocking wild populations, translocating animals between different natural areas to manage genetic diversity in situ, establishing stricter legal obstacles to trade in animal parts, and promoting ecotourism as an alternative source of revenue for local human populations. What appears clear is that no single conservation approach can be applied across the board; instead, effective conservation strategies vary de-

pending on the demographic characteristics and ecological requirements of the species targeted for conservation and on the economic values that humans place on these species.

For background information see BIODIVERSITY HOTSPOTS; ECOLOGICAL MODELING; ECOSYSTEM; ENDANGERED SPECIES; POPULATION VIABILITY; PRIMATES in the McGraw-Hill Encyclopedia of Science & Technology.

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