population, the human and environmental condition in the tropical countries of Africa will only become worse. Curbing the growth of human populations, and bringing them in line with the sustainable use of the natural resource base, depends largely on effective action by governments, specifically through the development and implementation of population policy and financial incentives (Myers 1993; Struhsaker 1997). Unfortunately, no African nation has a population policy or adequate incentives for population regulation. Major international bodies, such as the United Nations (UN), the Organization of African Unity (OAU), the EU, The World Bank, The African Development Bank (ADB), aid agencies, and NGOs, all have a vital role to play in this effort by providing technical and financial support for the development and implementation of national population policies, as well as for related initiatives and incentives concerned with socio-economic advancement, education, family planning, child mortality and women's rights. Unfortunately, beyond encouraging such action and support, few African primate conservationists are in a position to have significant impact on the ultimate problem facing Africa's primates.

To date, the main work of the Africa Section has involved the gathering of information on African primates, assessing the threats to primate taxa and populations, promoting the gazettement of large protected areas important to primate conservation, establishing priority field sites and field activities, maintaining or enhancing the effectiveness of protected areas, training African primatologists and resource managers, increasing public awareness, and facilitating communication among those concerned with the conservation of African primates.

As shown above, the members of the Africa Section, together with a large number of collaborators, have been reasonably effective in promoting the conservation of Africa's primates through these activities. While the Africa Section should not abandon any of these activities, there is an urgent need for its members and collaborators to more directly and more intensively address two of the main proximate threats facing Africa's primates; hunting and logging. This can be done by more actively supporting efforts to:

- Establish more large protected areas;
- Prevent logging and hunting within protected areas;
- Require that logging companies implement corporate codes of conduct that ensure sustainable forest use (including hunting) and the protection of biodiversity;
- Establish a strong international certification and accreditation program for sustainable tropical forest management, making bushmeat control and the maintenance of biodiversity part of the accreditation process;
- Develop and implement criteria and performance indicators for the sustainable use of tropical forests and wildlife, and for the maintenance of biodiversity;
- Mandate that logging companies finance programs to ameliorate both the direct and indirect damage their activities do to wildlife and to wildlife habitat (e.g., reafforestation);
- Promote enhanced global support (political, technical, financial) for sustainable forest use and hunting practices, particularly among major decision makers and financiers;
- Find and develop domestic food alternatives to bushmeat.

Major donors and conservation bodies can assist in the above efforts by putting into place: (1) trust funds to support the required law enforcement, research, monitoring, evaluation and information/education programs, and (2) financial incentives in the form of conditional grants and loans for logging companies, hunters and others who exploit tropical moist forest. In this case, those who support the protection of parks and reserves, and who practice sustainable forest use, become eligible for preferential financial assistance (Struhsaker 1997).

Conclusions

There is an active and dedicated network of people and institutions involved with the *in situ* and *ex situ* conservation of African primates. According to the Primate Society of Great Britain's listing of *Current Primate Field Studies* (Casperd 1996), there are today no fewer than 45 projects in Africa that are directly concerned with primate research and conservation. There are at least 100 experienced primatologists on these projects. The listing does not include the many hundreds of conservation projects in Africa that, although not primate focused, are also contributing much to primate conservation. These include projects involved with conservation education and training, community conservation, energy and soil conservation, improved crop and livestock production, agroforestry, park protection and management, law enforcement, tourism development, and a wide array of research topics.

The current situation as concerns primate conservation in Africa is that, while some primate populations appear to be secure within protected areas for at least the near-term, both the number of primates and the amount of primate habitat continue to decline rapidly throughout tropical Africa. To date, all that can be claimed is that we have pushed forward somewhat the time when Africa starts to lose some of its primate taxa. The crisis is not only still at hand, it is more serious and formidable than ever. The present trend will not change without more work, more ideas, more approaches, more money, better use of the funds available and, above all, more people who are willing and able to take an active role in tackling the problems.

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Asian Primate Conservation - The Species and The IUCN/SSC Primate Specialist Group Network

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Introduction

As part of the process of reviewing the *Action Plan for Asian Primate Conservation: 1987-91* (Eudey 1987), an effort is being made to assess the status of all known Asian primate taxa to the subspecific level. At the present time, 176 subspecies assignable to 72 species have been recognized. Recently the status of all Asian species (but not all subspecies) was evaluated using the new Mace-Lande categories and criteria formally adopted by the IUCN Council in November 1994, and the results were incorporated into the *1996 IUCN Red List of Threatened Animals* (IUCN 1996). The aim of these criteria is to provide a more objective framework for the classification of species according to their extinction risk. The resulting evaluation (Table 1) does not, in itself, constitute a prioritization for conservation action as is found in the 1987 *Asian Action Plan*.

The 72 Asian species were provisionally assigned to seven categories; the numbers in each category are indicated in parentheses. The three categories, 'Critically Endangered' (4), 'Endangered' (11) and 'Vulnerable' (18), contain 33 or 46% of the Asian species, and constitute the highest degree of threat. At lower risk are the categories 'Conservation Dependent' (3), 'Near Threatened' (13) and 'Of Least Concern' (9). It will not be possible to determine if 14 'Data deficient' species are threatened until they actually have been evaluated: this category includes, among others, taxa of problematic taxonomic assignment. In the 1987 *Asian Action Plan*, 37 (59%) of the then 63 species recognized were judged to need some kind of conservation action to survive into the 21st century, while 47 subspecies were identified as requiring special conservation attention.

The 'Critically Endangered' (CR) species are: *Macaca pagensis*, *Trachypithecus delacouri*, *Rhinopithecus avunculus*, and *Hylobates moloch*. I was prepared to mention that only the insular Mentawai macaque (*M. pagensis*) is not monotypic but there also may be more than one subspecies of Javan or moloch gibbon (*H. moloch*) (Jatna Supriatna pers. comm., 1986, 1987).

The 'Endangered' (EN) species are *Macaca silenus*, *Macaca maurus*, *Macaca nigra*, *Macaca fuscata*, *Trachypithecus poliocephalus*, *Presbytis comata*, *Simias concolor*, *Pygathrix nemaeus*, *Rhinopithecus bieti*, *Rhinopithecus brelichi*, and *Hylobates concolor*. The taxonomy as well as the evaluations should be considered provisional. Current data suggest, for example, that *Nasalis larvatus* (see Yeager 1996) and *Pongo pygmaeus* and *Pongo abelii* should be upgraded from 'Vulnerable' to 'Endangered'.

Threats to Asian Primates

Three of the world's foremost populous nations are in Asia (China, India and Indonesia). Although the economies of some Asian countries are small, much of the region is characterized by, at least up to 1997, booming economic growth. More than half of the world's population - 3.3 billion people - are found in Asia, and by the year 2020 it is predicted that Asian economies will have raised some 2 billion people out of poverty. To accomplish this, it is predicted that Asia will account for half the world's economic growth in the four years remaining in this century. The 1995 Forbes list of the world's wealthiest individuals already contains 123 Asians, of whom 82 are from countries other than Japan (see Anon. 1996). This combination of population numbers and economic growth combine to threaten the environment and all wildlife. Destruction of forest habitat through legal and illegal timbering, conversion to agriculture and hydroelectric projects has resulted in both the di-

Figure 1. Pagai Island macaque, *Macaca pagensis*. Photo by Agustin Fuentes.

Table 1, Preliminary list of Asian primate taxa with species evaluations using the new IUCN criteria[1].

Species	Common Name	Category of Threat
Family Lorisidae		
Subfamily Lorisinae		
Loris tardigradus tardigradus[2]	Slender loris	VU A1(c)(d)
Loris tardigradus nordicus	Northern Ceylonese slender loris	
Loris tardigradus grandis	Highland slender loris	
Loris tardigradus nycticeboides		
Loris tardigradus malabaricus	Malabar slender loris	
Loris tardigradus lydekkerianus	Mysore slender loris	
Nycticebus coucang coucang	Slow loris	LR 3(lc)
Nycticebus coucang menagensis		
Nycticebus coucang bengalensis	Bengalese slow loris	
Nycticebus coucang javanicus	Javan slow loris	
Nycticebus pygmaeus	Pygmy loris	VU A1(c)(d)
Family Tarsiidae		
Tarsius bancanus	Western or Horsfield's tarsier	LR 3(lc)
Tarsius pumilus	Lesser spectral tarsier	DD
Tarsius spectrum	Spectral tarsier	DD
Tarsius syrichta	Philippine tarsier	LR 1(cd)
Tarsius dianae		DD
Tarsius sangirensis		DD
Tarsius pelengensis		DD
Family Cercopithecidae		
Subfamily Cercopithecinae		
silenus-sylvanus group		
Macaca silenus	Lion-tailed macaque	EN C2(a)
Macaca nemestrina nemestrina	Pigtail macaque	VU A1(c)(d)
Macaca nemestrina leonina		
Macaca pagensis pagensis[3]	Mentawai macaque	CR A1(c)(d) A2(c)
Macaca pagensis siberu		
Macaca maurus	Moor macaque	EN B2(c)(d)(e)
Macaca nigra	Celebes or crested black macaque	EN A1(a)(c)(d)
Macaca nigrescens	Gorontalo or Dumonga-Bone macaque	LR 1(cd)
Macaca ochreata	Booted macaque	DD
Macaca brunnescens	Muna-Buton macaque	VU C1
Macaca tonkeana	Tonkean macaque	LR 2(nt)
Macaca hecki	Heck's macaque	LR 2(nt)
sinica group		
Macaca sinica sinica	Toque macaque	LR 2(nt)
Macaca sinica aurifrons		
Macaca radiata radiata	Bonnet macaque	LR 3(lc)
Macaca radiata diluta		
Macaca assamensis assamensis	Assamese macaque	VU A1(c)(d)
Macaca assamensis pelops		
Macaca thibetana	Tibetan macaque	LR 1(cd)
fascicularis group		
Macaca fascicularis fascicularis[4]	Long-tailed or crab-eating macaque	LR 2(nt)
Macaca fascicularis aurea		
Macaca fascicularis philippinenesis		
Macaca fascicularis umbrosa		
Macaca fascicularis fusca		
Macaca fascicularis lasiae		
Macaca fascicularis atriceps		
Macaca fascicularis condorensis		
Macaca fascicularis tua		
Macaca fascicularis karimondjawae		
Macaca mulatta mulatta	Rhesus macaque	LR 2(nt)
Macaca mulatta mcmahoni		
Macaca mulatta villosa		
Macaca mulatta lasiotis		
Macaca mulatta tcheliensis		
Macaca mulatta brevicaudus		
Macaca mulatta littoralis		
Macaca mulatta vestita		
Macaca cyclopis	Formosan rock or Taiwan macaque	VU A1(c)(d)
Macaca fuscata fuscata	Japanese macaque	EN A2(c)(d)
Macaca fuscata yakui	Yakushima macaque	

Cont.

Table 1. Cont.

arctoides group		
Macaca arctoides	Stumptail or bear macaque	VU A1(c)(d)
Subfamily Colobinae		
Trachypithecus geei	Golden langur	DD
Trachypithecus pileatus pileatus	Blond-bellied capped langur	VU A2(c)
Trachypithecus pileatus durga	Orange-bellied capped langur	
Trachypithecus pileatus tenebricus	Tenebrous capped langur	
Trachypithecus pileatus shortridgei	Shortridge'scapped langur	
Trachypithecus obscurus obscurus	Reid's dusky or spectacled langur	LR 3(lc)
Trachypithecus obscurus halonifer	Cantor's dusky langur	
Trachypithecus obscurus styx	Perhentian Island dusky langur	
Trachypithecus obscurus carbo	Terutau Island dusky langur	
Trachypithecus obscurus seimundi	Koh Pennan dusky langur	
Trachypithecus obscurus sanctorum	St. Matthew Island dusky langur	
Trachypithecus obscurus corax	Blackish-bellied dusky langur	
Trachypithecus obscurus flavicauda	Creamy-tailed dusky langur	
Trachypithecus obscurus smithi	Smith's dusky langur	
Trachypithecus phayrei phayrei	Phayre's langur	DD
Trachypithecus phayrei shanicus	Shan States' langur	
Trachypithecus phayrei barbei	Barbe's langur	
Trachypithecus phayrei crepusculus	Elliot's gray langur	
Trachypithecus phayrei argenteus	Silver gray langur	
Trachypithecus cristatus margarita	Elliot's silver lutung	LR 2(nt)
Trachypithecus cristatus germaini	Germain's silver lutung	
Trachypithecus cristatus villosus	Griffith's silver lutung	
Trachypithecus cristatus cristatus	Crested silver lutung	
Trachypithecus auratus auratus	Spangled ebony langur	VU A1(c), B2(c)(d)
Trachypithecus auratus mauritius	West Javan ebony langur	
Trachypithecus francoisi[5]	Francois's langur, white side-burned black langur	VU A1(c)(d). A2(c)(d) C2(a)
Trachypithecus laotum laotum	White-browed black langur	DD
Trachypithecus laotum hatinhensis	Stripe-headed black langur	
Trachypithecus delacouri	White-rumped black langur	CR C2(a), A1(d)
Trachypithecus poliocephalus poliocephalus	Tonkin hooded black langur	EN A2(c), B2(b)(c), C2(a)
Trachypithecus poliocephalus leucocephalus	White-capped black langur	
Trachypithecus johnii	Nilgiri black langur	VU A1(d)
Trachypithecus vetulus monticola	Highland purple-faced langur, bean monkey	VU A1 (c)
Trachypithecus vetulus vetulus	Southern purple-faced langur	
Trachypithecus vetulus nestor	Western purple-faced langur	
Trachypithecus vetulus philbricki	Northern purple-faced langur	
Semnopithecus entellus thersites	Southern or Hanuman gray langur	LR 2(nt)
Semnopithecus entellus priam	Madras gray langur	
Semnopithecus entellus elissa	Crested Hanuman langur	
Semnopithecus entellus anchises	Deccan Hanuman langur	
Semnopithecus entellus entellus	Bengal Hanuman langur	
Semnopithecus entellus hector	Lesser hill langur	
Semnopithecus entellus lanius	Shaggy Himalayan langur	
Semnopithecus entellus schistaceus	Central Himalayan langur	
Semnopithecus entellus ajax	Western Himalayan langur	
Semnopithecus entellus hypoleucus		
Semnopithecus entellus dussumieri		
Presbytis potenziani potenziani	Golden-bellied Mentawai Island leaf monkey	VU A1(c), A2(c), B2(a)(c)
Presbytis potenziani siberu	Sombre-bellied Mentawai Island leaf monkey	
Presbytis comata	Javan grizzled leaf monkey	EN A1 (c), C2 (a)
Presbytis hosei hosei	Hose's grizzled leaf monkey	LR 3(lc)
Presbytis hosei everetti	Everett's grizzled leaf monkey	
Presbytis hosei canicrus	Miller's Bornean grizzled leaf monkey	
Presbytis hosei sabana	Crested or Saban grizzled leaf monkey	
Presbytis thomasi nubila	Miller's Sumatran grizzled leaf monkey	LR 2(nt)
Presbytis thomasi thomasi	Thomas' Sumatran grizzled leaf monkey	
Presbytis fredericae	Javan fuscous leaf monkey	DD
Presbytis frontata	White-fronted leaf monkey	DD
Presbytis femoralis femoralis	Raffles' banded leaf monkey	LR 2(nt)
Presbytis femoralis margae	Hooijer's banded leaf monkey	
Presbytis femoralis robinsoni	Robinson's banded leaf monkey	
Presbytis femoralis batuana	Northwest Sumatran banded leaf monkey	
Presbytis femoralis percura	East Sumatran banded leaf monkey	
Presbytis femoralis chrysomelas	West Bornean banded leaf monkey	

Cont.

Table 1. Cont.

Presbytis femoralis cruciger	North-West Bornean banded leaf monkey	
Presbytis melalophos bicolor	Bicolored banded leaf monkey	LR 3(lc)
Presbytis melalophos melalophos	Yellow-handed mitred leaf monkey	
Presbytis melalophos fluviatilis	Buffy mitred leaf monkey	
Presbytis melalophos mitrata	Southern mitred leaf monkey	
Presbytis rubicunda rubicunda	Muller's maroon leaf monkey	LR 3(lc)
Presbytis rubicunda rubida	Lyon's maroon leaf monkey	
Presbytis rubicunda ignita	Dollman's maroon leaf monkey	
Presbytis rubicunda chrysea	Davis' maroon leaf monkey	
Presbytis siamensis siamensis	Malayan pale-thighed leaf monkey	LR 3(lc)
Presbytis siamensis catemana	Lyon's pale-thighed leaf monkey	
Presbytis siamensis rhionis	Riau Archipelago pale-thighed leaf monkey	
Presbytis siamensis paenulata	Chasen's pale-thighed leaf monkey	
Presbytis siamensis natunae[6]	Natuna Island pale-thighed leaf monkey	
"Odd-nosed" colobines		
Nasalis larvatus	Proboscis monkey	VU A2(c)
Simias concolor concolor	Pagai Island or pig-tailed snub-nosed monkey	EN A1(c)(d), A2(c)
Simias concolor siberu	Siberut Island pig-tailed snub-nosed monkey	
Pygathrix nemaeus nemaeus[7]	Red-shanked douc, Cochin-China monkey	EN A1(c)(d)
Pygathrix nemaeus nigripes	Black-shanked douc or black footed monkey	
Rhinopithecus avunculus[8]	Tonkin snub-nosed monkey	CR C1, E
Rhinopithecus roxellana roxellana	Moupin golden snub-nosed monkey	VU C2(a)
Rhinopithecus roxellana hubeiensis	Hubei golden snub-nosed monkey	
Rhinopithecus roxellana qinlingensis	Qinling golden snub-nosed monkey	
Rhinopithecus bieti	Black or Yunnan snub-nosed monkey	EN C2(a)
Rhinopithecus brelichi	Gray or Guizhou snub-nosed monkey	EN C2(b)
Family Hylobatidae		
(*Bunopithecus*)		
Hylobates hoolock hoolock	Western hoolock gibbon	DD
Hylobates hoolock leuconedys	Eastern hoolock gibbon	
(*Symphalangus*)		
Hylobates syndactylus continentis	Malayan siamang	LR 2(nt)
Hylobates syndactylus syndactylus	Sumatran siamang	
(*Nomascus*)		
Hylobates concolor concolor	Tonkin black gibbon	EN A1(c)(d), C2(a)
Hylobates concolor hainanus	Hainan black gibbon	
Hylobates concolor jingdongensis	Jingdong black gibbon	
Hylobates concolor lu	Lu crested gibbon	
(*Hylobates concolor* cf. *nasutus*)[9]	(NE Vietnam)	
Hylobates leucogenys leucogenys	Northern White-cheeked gibbon	DD
Hylobates leucogenys siki	Southern white-cheeked gibbon	
Hylobates gabriellae	Buff-cheeked gibbon	DD
(*Hylobates*)		
Hylobates agilis agilis	Mountain agile gibbon	LR 2(nt)
Hylobates agilis unko	Lowland agile gibbon	
Hylobates agilis albibarbis	Bornean agile gibbon	
Hylobates klossii	Kloss's or Mentawai gibbon	VU A1(c), A2(c), B2(a)(c)
Hylobates lar carpenteri	Carpenter's lar gibbon	LR 2(nt)
Hylobates lar entelloides	Lar or white-handed gibbon	
Hylobates lar lar	Malayan lar gibbon	
Hylobates lar vestitus	Sumatran lar gibbon	
Hylobates lar yunnanensis	Yunnan lar gibbon	
Hylobates moloch	Moloch, silvery, or Javan gibbon	CR A1(c), C2(a)
Hylobates muelleri abbotti	Gray or Muller's gibbon	LR 2(nt)
Hylobates muelleri funereus	Abbott's gray gibbon	
Hylobates muelleri muelleri	Northern gray gibbon	
Hylobates pileatus	Pileated or capped gibbon	VU A1(c)(d), A2(c)(d)
Family Pongidae		
Pongo pygmaeus pygmaeus	Bornean orang-utan	VU A1(c)(d), C1
(or *Pongo pygmaeus*)[10]		
Pongo pygmaeus abelii	Sumatran orang-utan	
(or *Pongo abelii*)[10]		

CR - "Critically endangered", EN - "Endangered", VU - "Vulnerable", LR - "Lower Risk", (nt) - Near threatened (1), (cd) - Conservation Dependent (2), (lc) - Least Concern (3), DD - "Data Deficient", NE - Not evaluated. See Appendix for definitions of these categories and the criteria for inclusion.

Table 1. Cont.

[1] I am indebted especially to D. Brandon-Jones and C. P. Groves for their comments on the taxonomy of the Colobinae (Colobidae) and other taxa. See also Brandon-Jones (1984), Groves (1993) and Eudey (1987).

[2] As a consequence of strict interpretation of the International Code of Zoological Nomenclature, the proposed rejection of Brisson's (1792) *Regnum Animale* has led to the genus name of *Loris* for the slender loris of Sri Lanka and southern India being threatened by the senior synonym *Tardigradus*.

[3] There appear to be two distinct taxa of macaques on the Mentawai Islands, although a final decision remains to be made on their taxonomy.

[4] The subspecific classification of *Macaca fascicularis* recently was proposed by Fooden (1995).

[5] The *francoisi* group is tentative but there is strong support for recognizing *delacouri* as a monotypic species (Brandon-Jones 1996; Nadler 1996; R. Wirth and T. Nadler pers. comm.).

[6] R. Wirth (pers. comm.) considers this to be a very distinctive form.

[7] A new subspecies, *Pygathrix nemaeus cinereus*, the gray-shanked douc langur, was recently described for Vietnam by Nadler (1997).

[8] The differentiation of *Rhinopithecus* from *Pygathrix*, as proposed by Jablonski and Peng (1993), is accepted here.

[9] Recognition of *nasutus*, as proposed by Geissmann (1995), would result in *hainanus* being subsumed within the taxon.

[10] The research of Zhi *et al.* (1996) supports the differentiation of the orangutan into two species.

rect loss of primate populations and their increased vulnerability to hunting and capture for illegal trade. The amount of forest habitat remaining in a country almost may be used as a measure of its economic development. Development of investment pacts and trading alliances within Asia, such as the expanding ASEAN (Association of South East Asian Nations), are propelling the region's economic growth while establishing routes for illegal wildlife trade. Such routes between Taiwan and Indonesia, south China and Vietnam, and China and Vietnam have been documented. Both commercial trade and trafficking appear to have contributed to the decline of widespread species, such as the macaques, as well as rarer species, such as the orangutan (Eudey 1995a, 1995b).

Networks

The compilation of the *Asian Action Plan* over a four-year period in the 1980's established channels of communication with government officials, NGO's and primatologists in Asian countries, and this network has been reinforced by my participation in both national and international meetings, such as the Congresses of the International Primatological Society (IPS), meetings of the Parties to CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), Technical Meetings of the Species Survival Commission, IUCN General Assemblies (including the First World Congress in 1996), and four PHVA's (Popu-

Figure 2. Delacour's langur, *Trachypithecus delacouri*. Photo by Tilo Nadler.

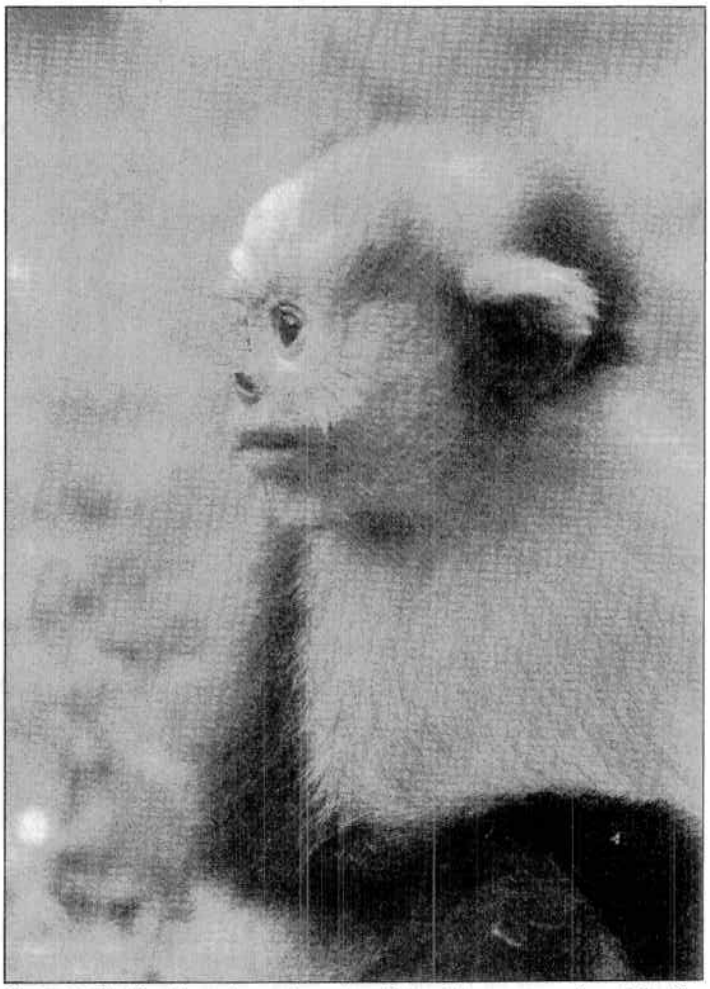

Figure 3. The Tonkin snub-nosed monkey, *Rhinopithecus avunculus*, at the Cuc Phuong National Park Rescue Center. Photo by Tilo Nadler.

lation and Habitat Viability Assessments) on Asian primates conducted by the IUCN/SSC Conservation Breeding Specialist Group (CBSG): Javan gibbon (Supriatna *et al.* 1994); lion-tailed macaque (Kumar *et al.* 1995); orangutan (Tilson *et al.* 1993); and the Thai gibbon (Tunikhorn *et al.* 1994; Brockelman 1993-1994).

In 1990, at the 18th IUCN General Assembly held in Perth, Australia, I volunteered to publish a (quarterly) newsletter to facilitate communication among members of the Asian section of the Primate Specialist Group (PSG). *Asian Primates*, the resulting publication, which I envisioned as a hybrid between the newsletter of the American Anthropological Association and the political newsletter of I. F. Stone, has entered its sixth year of publication. Numbers 1 and 2 of volume 5 were distributed at the XVIth Congress of IPS in Madison, Wisconsin. Over 600 copies are mailed directly to recipients, of which about 40% are in Asia. The PSG now produces three other regional newsletters for Africa (*African Primates*), the Neotropics (*Neotropical Primates*) and Madagascar (*Lemur News*).

As part of the policy encouraging increasing regional autonomy within the PSG and IUCN itself, I have been forming PSG regional committees in Asia. To date, regional committees have been established for Japan, Indonesia, South India, North-East India, Nepal and China. The Primate Society of Great Britain (PSGB) recently made a small contribution to the operation of the two Indian committees, as well as to help establish a committee in Bangladesh. Lack of funding has limited the effectiveness of some of the committees, or, at least, my ability to work with them; and less formal but more focused networks of expatriates and local primatologists, such as the one that exists for Sulawesi and produces its own newsletter, the *Sulawesi Primate Newsletter*, may have resulted in more concrete conservation action.

Figure 4. Silver Javan gibbon, *Hylobates moloch*. Female with infant born at the International Center for Gibbon Studies, Santa Clarita, California, in january 1988. Photo by Alan Moornick, International Center for Gibbon Studies.

Problems in Conserving Asian Primates

Lack of systematic implementation may have reduced the effectiveness of the *Asian Action Plan* in contributing to the conservation of Asian primates. Although no funding mechanism for projects was included within the 1987 plan, individuals have used its species and project ratings to secure funding, and these same ratings have been used in the evaluation of research proposals. The World Wide Fund for Nature (WWF) support for the conservation of the endangered Yunnan snub-nosed monkey (*Rhinopithecus bieti*) during 1992-1994 as proposed by R. C. Kirkpatrick and Y. C. Long (1995; Zhong *et al.* in press) is a case in point.

Ethical considerations in Asia (as elsewhere) cannot be overlooked in assessing the potential for, or effectiveness of, conservation action. In Sri Lanka, for example, more than 50,000 people have been killed since 1983 in civil war between minority Tamils and majority Sinhalese. In 1995, more than 6% of the gross domestic product (GDP) was expended on the civil war and, due in part to the continuing warfare, direct foreign investment in Sri Lanka fell from US$ 110 to about US$ 33 million (see Anon. 1995b). The effects of the civil war on environmental and conservation efforts may be incalculable. As a different kind of example, in Myanmar (formerly Burma) the human rights violations of the military junta, the State Law and Order Restoration Council or SLORC, and its failure to relinquish political power to the democratically-elected government headed by Aung San Suu Kyi, the 1991 Nobel Peace Prize recipient, have resulted in economic sanctions being imposed by the United States and other Northern countries, although not by neighboring countries such as Thailand, for which Myanmar is a source of natural resources. Private or governmental aid for conservation in Myanmar could well be interpreted as endorsement of the present regime.

Captive breeding remains controversial in that it may divert money (and personnel) from habitat protection efforts. Two of three projects with a captive component (southern Mentawai primates and *Rhinopithecus bieti*) were withdrawn informally from the *Asian Action Plan* because of the possibility that they might lead to the exploitation of wild populations.

On 11 July 1995, the United States extended diplomatic recognition to Vietnam. The interest of U. S. firms in entering Vietnam's economic market of 71 million people, as epitomized by Deering (1995) in the political cartoon "Apocalypse Now" (Fig. 5a), appears to have contributed to this decision. Earlier in April, Vietnam had announced that US$ 1.9 billion worth of ventures and projects were approved during the first quarter of 1995, almost triple the value of those licensed in the same period during the previous year. The 270% increase, reported by the State Committee for Cooperation and Investment, was attributed in part to the emergence of U. S. investment (see Anon. 1995a).

A memorandum of agreement entitled "Rescue of Endangered Primates of the Socialist Republic of Vietnam", negotiated at a

March 1993 meeting between a consortium of foreign zoological parks and non-governmental organizations and the then Ministry of Forestry, contained a draft provision recommending exportation "on breeding loan...of a maximum of 20 specimens of each primate taxon in question" to zoological parks outside Vietnam.

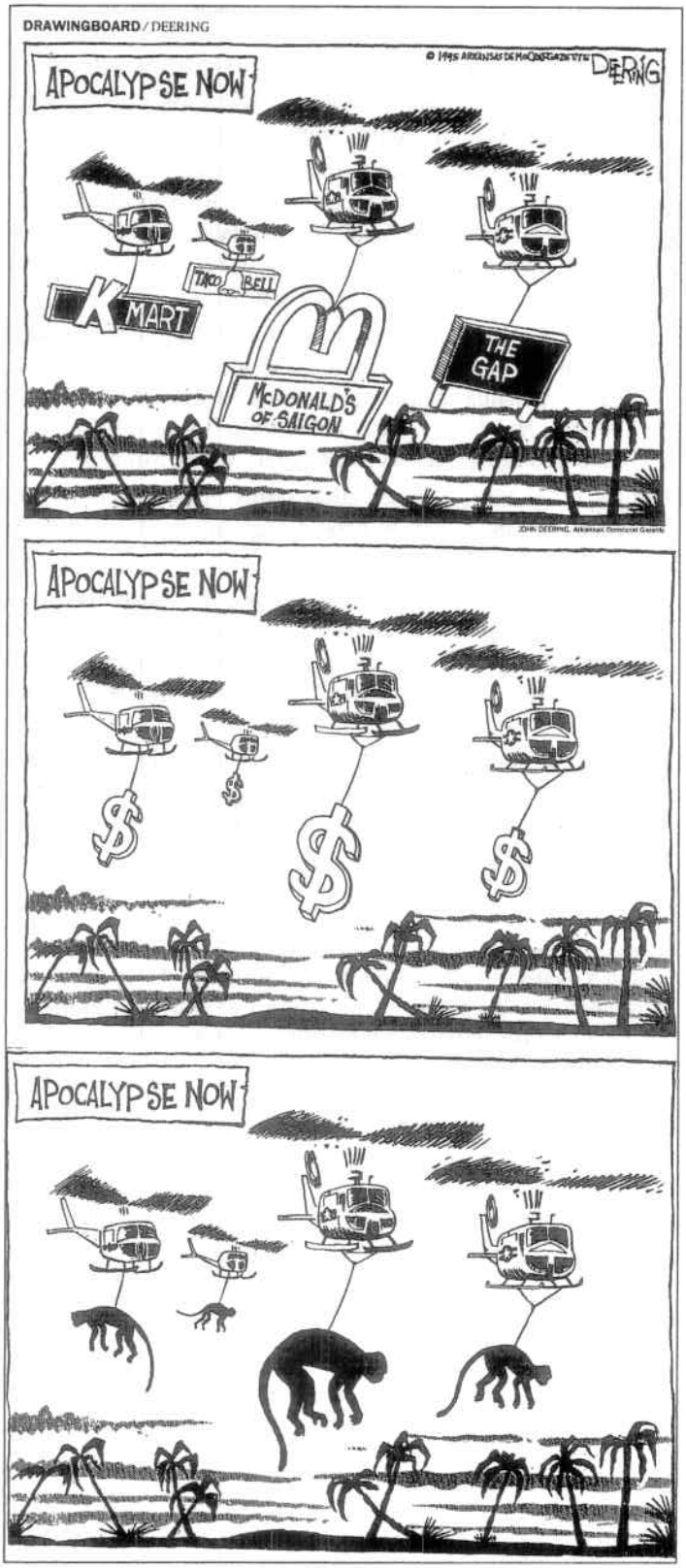

Figure 5. Apocalypse Now. Cartoon by John Deering which first appeared in the *Arkansas Democrat Gazette* in 1995, with modifications by Stephen D. Nash. (With permission of the artist)

The provision was rejected by the Vietnamese participants and the Ministry of Forestry, and was rewritten so that some primates may be available outside of Vietnam, with ownership remaining with the Ministry of Forestry, but only after the F2 generation and with the permission of the Government of Vietnam (see Anon. 1993). Although the Vietnamese may envision the United States (and other Northern countries) as being a source of hard currency, including conservation dollars (as depicted in Fig. 5b), the exchange of rare and endemic primates for dollars (as depicted in Fig. 5c) has proved to be unacceptable to the Vietnamese.

Outlook for the Future

Although Struhsaker and Oren (1996) attributed much of the loss in the conservation race, in the short and medium term, to inappropriate foreign aid development programs and projects, the interest of international agencies in protecting biodiversity may contribute to the conservation of Asian primates. The Vietnam Protected Areas for Resource Conservation (PARC) Project, a five-year project scheduled to begin in September 1997 and budgeted for US$ 8.3 million, of which US$ 6 million comes from the GEF (Global Environment Facility), may, for example, provide protection for the critically endangered *Rhinopithecus avunculus* through the set of comprehensive interventions planned for the management of Ba Be National Park and Nahang Nature Reserve in northern Vietnam (Kevin Hill, pers. comm., August 1997).

Ultimately the fate of primates in Asia may hinge on the recruitment of young field primatologists and conservationists within the habitat countries. The active participation of students (and young professionals) in the PHVA's on the Lion-Tailed Macaque in Madras, India in 1993 (Kumar *et al.* 1995) and the Javan Gibbon and Javan Langur in Cisarua-Bogor, Indonesia in 1994 (Supriatna *et al.* 1994) suggests the human potential in these two countries. Obtaining support for their academic and field experience is critical. Generating comparable enthusiasm among young people elsewhere in Asia would appear to be of equal importance.

Acknowledgments

I thank John Deering for permission to reproduce his political cartoon, "Apocalypse Now", which first appeared in the *Arkansas Democrat Gazette* in 1995, and for granting permission for Stephen D. Nash, to whom I express my gratitude for artistic assistance, to make two improvisations on the original drawing.

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Appendix

Key to IUCN Categories of Threat (IUCN 1994)

Critically Endangered (CR)

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

A. population reduction in the form of either of the following:

An observed, estimated, inferred, or suspected severe reduction of at least 80% over the last 10 years or three generations, whichever is longer, based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate for 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.

A reduction of at least 80%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), (d) or (e) above.

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

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

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

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

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

1. An estimated continuing decline of at least 25% within 3 years or one generation, whichever is longer, or
2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either (a) severely fragmented (i.e. no subpopulation estimated to contain more than 50 mature individuals; (b) all individuals are in a single subpopulation.

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

E. Quantitative analysis showing the probability of extinction in the wild at least 50% within 10 years or 3 generations, whichever is the longer.

Endangered (EN)

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

A. Population reduction in the form of ether of the following:

1. An observed, estimated, inferred, or suspected reduction of at leas 50% over the last 10 years or three generations, whichever is longer, based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate for 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. A reduction of at least 50%, projected or suspected to be met within the next ten years or three generations, whichever is longer, based on (and specifying) any of (b), (c) our (d) or (e) above.

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

1. Severely fragmented or found only at no more than five locations.
2. Continuing decline, inferred, observed, or projected, in any of the following: (a) extent of occurrence; (b) area of occupancy; (c) area, extent and/or quality of habitat; (d) number of locations or subpopulations; (e) number of mature individuals.
3. Extreme fluctuations in any of the following: (a) extent of occurrence; (b) area of occupancy; (c) number of locations or subpopulations; (d) number of mature individuals.

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

1. An estimated continuing decline of at least 20% within 5 years or 2 generations, whichever is longer, or
2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either (a) severely fragmented (i.e. no population estimated to contain more than 250 mature individuals); (b) all individuals are in a single subpopulation.

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

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

Vulnerable (VU)

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

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

An observed, estimated, inferred, our suspected reduction of at least 20% over the last 10 years or 3 generations, whichever is longer, based on (and specifying) any of the following: (a) direct observation; (b) an index of abundance appropriate for 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.

A reduction of at least 20%, projected or suspected to be met within the next 10 years or 3 generations, whichever is the longer, based on (and specifying) any of (b), (c), (d) or (e) above.

Extent of occurrence estimated to be less than 20,000 km², and estimates indicating any two of the following:

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

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

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

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

1. An estimated continuing decline of at least 20% within 5 years or 2 generations, whichever is longer, or
2. A continuing decline, observe, projected, or inferred, in numbers of mature individuals and population structure in the form of either (a) severely fragmented (i.e. no population estimated to contain more than 250 mature individuals); (b) all individuals are in a single subpopulation.

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

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

Lower Risk (LR)

A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:

1. Conservation Dependent (cd). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
2. Near Threatened (nt). Taxa which do not qualify for Conservation Dependent or Near Threatened.
3. Least concern (lc). Taxa which do not qualify for Conservation Dependent or Near Threatened

Data Deficient (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is lacking. Data Deficient is therefore not a category of threat or Lower Risk. 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 threatened status. If the range of a taxon is suspected to be relatively circumscribed, and if 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 has not yet been assessed against the criteria.

Primate Conservation 1996/1997 (17): 111-116

Current Status and Future Viability for the Mentawai Primates

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Introduction

The Mentawai Islands constitute some of the most unique and interesting places on this planet. Lying 85 to 135 km off the west coast of central Sumatra, the four islands of Siberut, Sipora and North and South Pagai (Fig. 1) are home to a wide variety of endemic flora and fauna. Due to their long-term separation from Sumatra and the rest of the Sunda region, the Mentawais have developed, in a sense, as an evolutionary laboratory, a unique experiment in adaptation, change and isolation. It is on these remote islands that four unique primates live (Table 1). The sleek, black Kloss' gibbon, *Hylobates klossii*, the smallest of the gibbons and suggested to have the most "primate" of gibbon calls. The Mentawai macaque, *Macaca pagensis*, previously considered a subspecies of *M. nemestrina* (see, for example, Fooden 1980), is now recognized as a distinct species and represented by two subspecies in the Mentawais (Wilson and Wilson 1977; Whitten and Whitten 1982; Fuentes and Olson 1995). The unusual morphology, distinct vocalizations and interesting social organization of the monospecific pig-tailed langur, *Simias concolor*, set it apart from all other colobines. Lastly, the unique Mentawai Island langur, *Presbytis potenziani*, is the only cercopithecoid primate which is found in monogamous groups throughout its range. All three cercopithecoid species are represented by two subspecies; a Siberut form and a form found on the three other islands (Table 1).

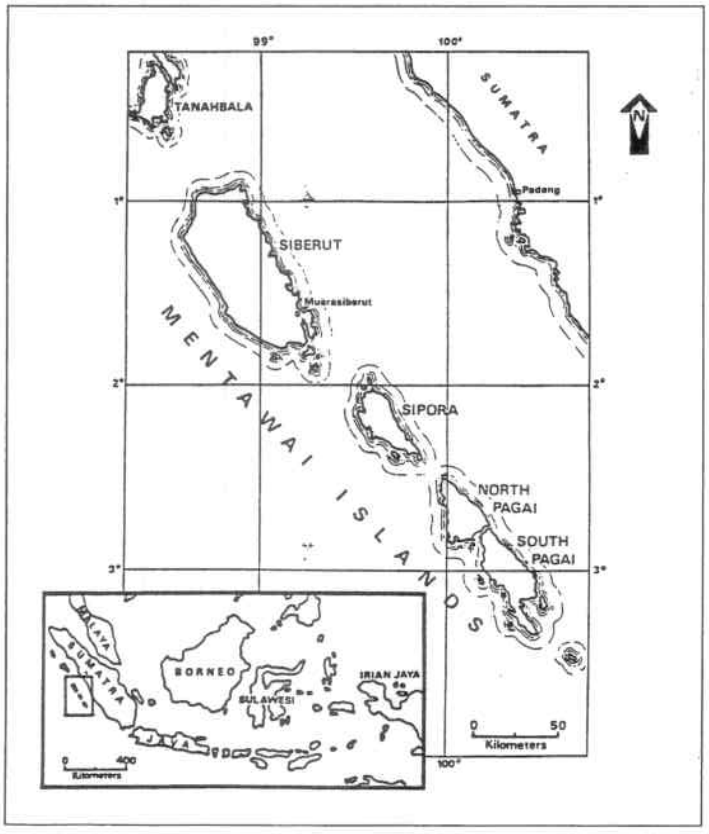

Figure 1. Map of the Mentawai islands.

These Mentawai primates, seldom observed and infrequently researched, are on the brink of disaster. Eudey (1987) ranked all four species as endangered, and *Simias concolor* and *Macaca pagensis* as amongst the eight most threatened primates in Asia. The three endemic species, *M. pagensis*, *P. potenziani*, and *H. klossii*, and the endemic genus, *Simias*, are under continuing attack from hunting, deforestation, modernization and population growth. All are included on the *1996 IUCN Red List of Threatened Animals* (Table 1). Although these fascinating islands and their unique primates have been the focus of few studies (*H. klossii* - Tenaza 1974; Tilson 1980; Whitten 1980; *M. pagensis* - Fuentes and Olson 1995; Fuentes and Tenaza in press; Tilson 1977; Wantanabe 1981; Whitten and Whitten 1982; *P. potenziani* - Fuentes 1994, 1996; Tilson and Tenaza 1976; and *S. concolor* - Tenaza and Fuentes 1995; Fuentes and Tenaza 1996), all of the researchers have noted and agree on the fact that these animals are in danger and that multiple factors are driving them towards extinction (Fuentes 1994; Fuentes and Ray 1995/1996). At present there are a few Mentawai macaques in zoos in Indonesia and Europe. However, there are no captive populations or breeding programs for the other three Mentawai primates.

In this report I will present an overview of the current status and future potential of non-human primate populations on the four Mentawai Islands. Material for this report was gathered during 1989-90 and 1992 by myself, 1996 by myself and Elsworth Ray (University of California, Berkeley), from conversations and inter-

Table 1. The non-human primates of the Mentawai Islands and their IUCN status for the species (IUCN, 1966). CR = critically endangered, EN = endangered, VU = vulnerable.

Species/subspecies	Common name	Islands	IUCN
Macaca pagensis pagensis[1]	Mentawai macaque, Pagai macaque	Sipora, North Pagai, South Pagai	CR
Macaca pagensis siberu		Siberut	
Presbytis potenziani potenziani	Mentawai island leaf monkey, Pagai island langur	Sipora, North Pagai, South Pagai	VU
Presbytis potenziani siberu		Siberut	
Simias concolor concolor[2]	Pig-tailed or snub-nosed monkey, Pig-tailed langur	Sipora, North Pagai, South Pagai	EN
Simias concolor siberu		Siberut	
Hylobates klossii	Mentawai gibbon, Kloss' gibbon	Sipora, North Pagai, South Pagai, Siberut	VU

[1] Listed by Fooden (1980) and Groves (1993) as a subspecies (synonym) of *M. nemestrina*. Wilson and Wilson (1977) and Whitten and Whitten (1982) argued that it is a distinct species.

[2] Listed by Groves (1993) as a species of the genus *Nasalis*.

views with Mentawai islanders and also individuals who have conducted research in the Mentawai Islands, as well as from the existing literature on their status (Fuentes 1994; Fuentes and Olson 1995; Fuentes and Ray 1995/1996; Kawamura and Megantara 1986; Mitchell and Weitzel 1983; Mitchell and Tilson 1986; Tenaza 1987, 1988, 1989, 1991; Tenaza and Mitchell 1985; WWF 1980). I will first, however, briefly discuss each island and its primate populations (human and non-human, see Table 2) in their overall ecological, economic and social contexts.

The Mentawai Islands

Siberut

Siberut, at 4,030 km² is the largest, the longest inhabited and the most intensively researched of the Mentawai chain. Siberut's human population as of 1995 was reported at 25,000 people, of which at least 18,000 are indigenous Mentawai islanders. This northernmost island was the first to be colonized by humans and has been inhabited continuously for the last 2-3,000 years. However, Siberut was the last to be contacted by Christian missionaries and South-east Asian logging concerns, and remains the only island of the Mentawai chain where some indigenous inhabitants retain strong connections to traditional religious beliefs and cultural practices (PHPA 1995; Schefold 1972, 1991).

As of 1995, nearly one half of Siberut's total area (1,926 km² has been designated as a national park and a portion of that, 465 km², consists of protected "no-use" sanctuary zones. Much of the area within the national park boundary is primary, mixed, or robust secondary forest, and nearly all of the sanctuary zone is forested (PHPA 1995). Most importantly, all logging activity ceased on Siberut in 1994, and the government of Indonesia has pledged not to renew any logging permits for the island.

Although no complete primate census has been conducted on Siberut, various "guestimates" have been made of the surviving non-human primate populations. The most optimistic of these was put forward in the World Wildlife Fund's *Conservation Master Plan for Siberut* (WWF 1980). The WWF report suggested a total of 140,000 non-human primates on the island. Based on primate density calculations of forested areas on the Pagai Islands (Fuentes and Ray 1995/1996, in prep.), I suggest that a slightly more accurate and less optimistic range of between 68,000 and 119,000 non-human primates is more appropriate. Although sufficient data are not yet available to support this, I feel that the lower end of the spectrum is probably more accurate.

Since the cessation of logging on Siberut, it is hunting and land conversion that are the primary threats to the non-human primates. Hunting is still practiced on Siberut quite frequently. The ever increasing use of air rifles and the ease with which they are bought is the main concern. Although many areas are officially "protected", Mentawai islanders continue to hunt in them and there is little or no enforcement of the ban on hunting in them. The cessation of logging, on the other hand, has meant that logging trucks are no longer available on a daily basis to transport hunters to the interior.

Land conversion is still a major threat to Siberut. Plans exist for increased transmigration of Indonesians from other islands. If these settlements are constructed and many new migrants arrive and stay, the massive conversion of forest land to wet rice and dry gardens could have a major impact on the primates of the island.

Sipora

Sipora, at 845 km², is the third largest Mentawai island. The human population as of 1995 was reported to be approximately 9,000 inhabitants. Estimates of the total forest cover remaining vary, but as much as 20% of the total land mass was suggested in 1990. Given that logging has been extensive and that four logging companies remain active, I suggest that previous estimates of forest cover are probably too high. Conversations with local officials in the main town of Sioban, in March of 1996, suggest that 10-15% is a more realistic prediction of forest cover at present. This figure would represent approximately 85-127 km² of remaining forest. Based on primate densities at two sites on the southern Pagai islands we can calculate between 3,600 and 6,250 non-human primates in the forested areas of Sipora (Fuentes and Ray 1995/1996, in prep.). At present there are no protected areas on Sipora nor are there any research projects underway.

Most of Sipora's arable land has been converted to wet rice cultivation and swidden agricultural plots, and large tracts of land have been cleared for maize and other dry crop agriculture. The logging company's few replanting efforts have concentrated on monocultures (primarily various *Eucalyptus* and *Shorea* spp.).

Table 2. Island size, human and non-human primate populations on the Mentawai Islands.

Island	Population estimate (1996) non-human primates	Human population as of 1996
Siberut (4,030 km²)	68,000-119,000	25,000
Sipora (845 km²)	3,600 -6,250	9,000
North and South Pagai (1,674 km²)	8,500-15,000	22,000
Total for Mentawai Islands	80,100-140,250	56,000

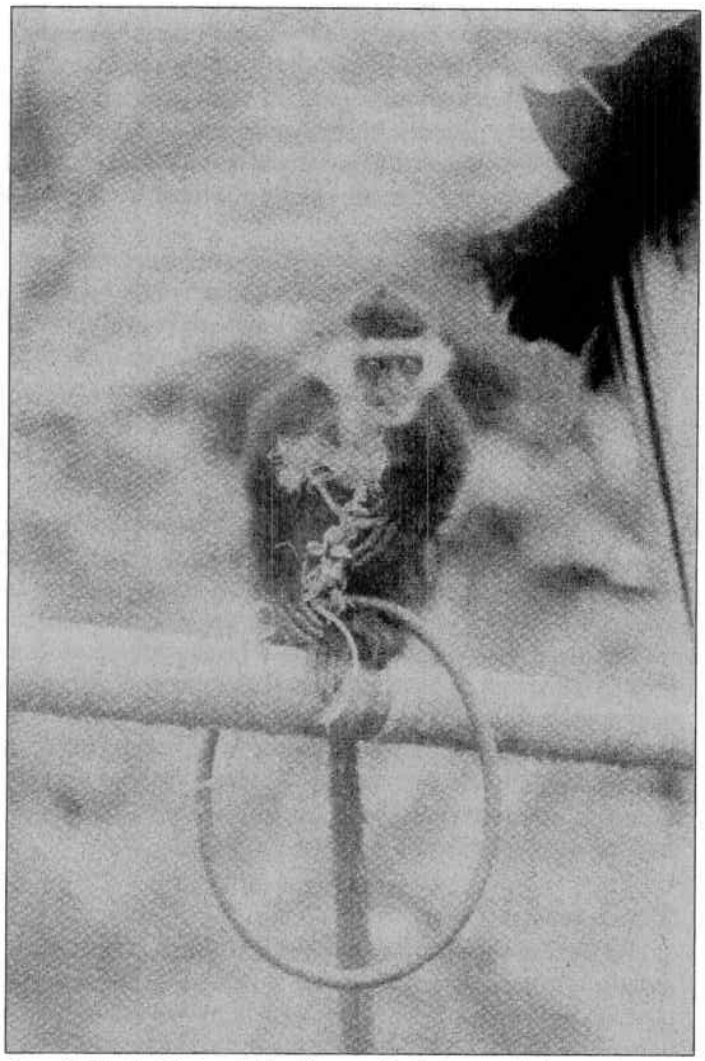

Figure 2. Captive Mentawai Island langur, *Presbytis potenziani potenziani*, juvenile (photo: Monica Olson).

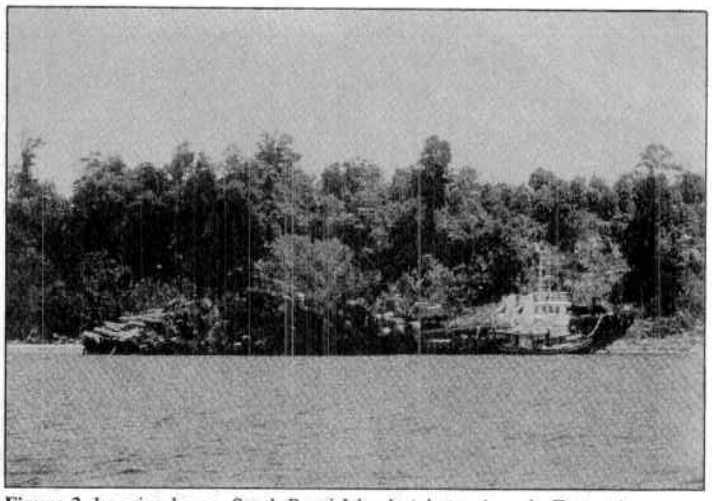

Figure 3. Logging barge, South Pagai Islands (photo: Agustin Fuentes).

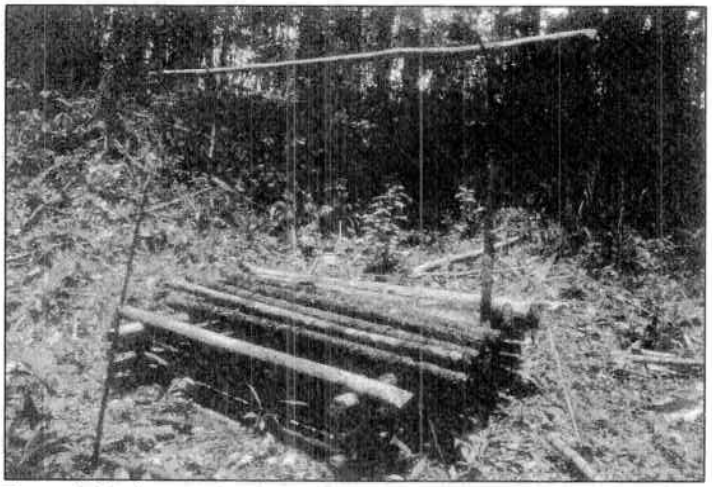

Figure 4. Monkey trap, North Pagai Island (photo: Agustin Fuentes).

Given these land use practices, the potential land available for primates outside of the remaining forests is rather small. Additionally, erosion has recently begun to affect previously logged or cleared-then-abandoned, hillsides throughout the island.

Hunting of the four Mentawai primates is still practiced on Sipora. While the traditional methods have dramatically decreased, the use of air rifles and opportunistic hunting has increased. At present there are no Mentawai primates left around the main town of Sioban. However, hunters from Sioban occasionally travel to the North of the island to hunt monkeys, gibbons and birds. Opportunistic hunting is quite common in forest areas near villages and along logging roads and paths between villages.

North and South Pagai

The southern two islands, North and South Pagai, have a total land area of 1,675 km² (approximately 775 km² for North Pagai and 900 km² for South Pagai) and make up over 25% of the total Mentawai land mass. The 1995 human population of the Pagais was reported at 22,000, of which 17,000 are indigenous Mentawai islanders. Although they were the last islands in the chain to be colonized by humans (this occurred only 300 years ago), they were the first to undergo religious conversion and the first to experience large scale logging, marine products extraction, and the introduction of a cash economy (Fuentes 1994; Loeb 1928, 1929; Nooey-Palm 1968).

As recent as 1990, estimates of remaining forest cover were as high as 20%. However, surveys in the Pagais during 1992 and 1996 suggest that this number is no longer accurate. The entire 400 km² timber concession on North Pagai has been logged, and the main logging company has begun the final stages of extraction on their 500 km² concession on the southern island. In addition, at least one company is involved in intensive logging in many of the coastal areas of both North and South Pagai. Given the current situation and recent surveys, we estimate the remaining forest cover at 15% of the land area. With this amount of remaining forest, and using population densities calculated from two sites in North and South Pagai (Fuentes and Ray 1995/1996, in prep.), we can estimate between 8,500 and 15,000 non-human primates remaining in the forested areas of the Pagais.

On the Pagais, unlike much of Sipora, there remain many tracts of highly disturbed secondary forest, mixed swamp forest, and extensive mixed forest garden plots. Non-human primates have

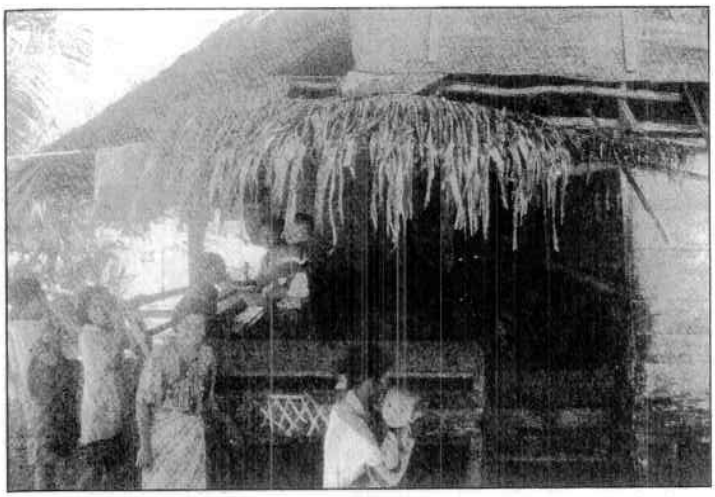

Figure 5. Mentawai Islanders, Betumonga Village, North Pagai Island (photo: Agustin Fuentes).

been observed using these areas on both of the Pagai Islands. Given that some areas which are not classified as forest areas are used by the Mentawai primates and that they make up an area nearly equal to the remaining forest cover, it is possible that the actual number of non-human primates on the Pagais is larger than that reported here. However, it is important to note that only two of the four primate species (the Mentawai island langur and the Mentawai macaque) have been reported to use these disturbed areas regularly.

The amount of hunting varies around the Pagais. In general, it is no longer done with bows and poison arrows, but rather with air rifles and poison pellets. However, organized primate hunts are becoming infrequent. The standard mode of hunting consists of two or more men armed with air rifles moving through the forest and shooting at any animal they come across. This has led to the local extinction of many primate species around villages and in what were once favored hunting areas. Since the cessation of most logging activities on North Pagai. many villagers around the island no longer have access to logging trucks which previously took them to the interior for their hunting trips. Likewise, as the younger men continue to move away from traditional hunting and subsistence collection towards cash crop/forest product collection for the emerging cash economy, the actual predation danger on the local primates is reduced.

Given this brief overview of the situations on the four Mentawai islands what can we say about the overall status and future viability of the non-human primates on these islands?

Status of the Non-human Primates

Siberut

Overall, it would seem evident that the potential outlook for the primates on Siberut is good. The newly established national park along with the 25-year plan presented in the *Siberut National Park Integrated Conservation and Development Management Plan* (ICMP) as part of the Biodiversity Conservation Project in Flores and Siberut (PHPA 1995), at least sets the tone for a long term multi-faceted conservation program. The emphasis on conservation alongside economic development for the local peoples, and a managed increase in eco- and ethno-tourism, could serve as a strong defense for the forests and primates of the island. The plan also calls for the establishment of long-term research projects examining all aspects of the islands diverse flora and fauna. However, as with all conservation plans, it looks great on paper but remains primarily untested. This program is in its infancy and it is largely up to the combined efforts of the international community and the government of Indonesia to see it through to its promised potential.

The present population estimates of non-human primates on Siberut suggest that viable populations of each of the four species occur on the island. If in fact logging and massive land conversion are no longer major threats, then it would seem that these Siberut forms will retain viable populations well into the next century.

This is where the good news ends.

Sipora

The future for the Mentawai primates on the island of Sipora is very bleak. There are no protected areas, no proposed research, and only small, dispersed populations of the non-human primates. The government of Indonesia has more transmigrants scheduled for the island, four logging companies remain active, and forest product extraction continues at a breakneck pace. A growing human population, combined with disappearing forests and no protected areas, indicates very little chance of Sipora's primates surviving much into the next century. Although isolated pockets of monkeys may survive, it is unlikely that the four species of Mentawai primates have a future on this island.

North and South Pagai

For the Pagais, the situation is bleak, with but a few potentially promising notes. The southern end of South Pagai is not scheduled for any logging activity, has a small human population, and potentially as much as 30 km² of primary and swamp forest occupied by the Mentawai primates. A portion of this area has also been proposed, by Dr. Richard Tenaza, as a potential marine/forest reserve. On North Pagai the only large remaining stand of forest is in the south-west (the Betumonga region) and consists of over 10 km² of primary and secondary forest. This area has been, and continues to be, the focus for primate behavior and ecology research projects. It is highly likely that as long as research projects are being undertaken in this area both the forest and the primates within it will be protected.

However, we cannot be too optimistic. The general trend in the Pagais is one of continued logging, dramatically increased forest products extraction, continued forest conversion for human settlements and gardens, and sporadic hunting of the primates. Additionally, the government of Indonesia has recently re-designated North Pagai as a site for the transmigration program.

All in all, isolated pockets of Mentawai primates on the Pagai Islands may last well into the next century, but their overall viability is heavily dependent on human intervention on a significant scale.

Discussion

With the increase in human populations, the area needed for subsistence gardens and cash crops increases. This increase in

forest conversion, coupled with extensive logging of primary and swamp forests, dramatically decreases the available habitat for the non-human primates. Many of these primates will be forced into poor quality habitats and become easier prey for occasional hunters. Overall, the effects of increasing human population, and continued deforestation and hunting pressure, continue to have a highly negative impact on the populations of the Mentawai primates on the southern islands of Sipora and North and South Pagai. While there are probably well over 12,000, possibly as many as 20,000, Mentawai primates remaining on these three islands, the numbers could well be halved before the end of the next decade.

It is only on the northern island of Siberut that a major glimmer of hope exists for continued, viable, long-term populations of the Mentawai primates. However, this situation will only remain positive with continued interest and support for research in the proposed national park. More importantly, the investment of funds and continued assistance and pressure on the government of Indonesia will be necessary to assure that logging and transmigration programs are not renewed, and that the *Siberut National Park Integrated Conservation and Development Management Plan* is allowed to run its course successfully.

Therefore, I suggest the following specific points of action for the Mentawais between now and 2010:

1) Research projects and financial support for the Betumonga region of North Pagai, and continued efforts and funding to establish and enforce the proposed South Pagai Reserve.

2) Funding for researchers and students to initiate and continue long-term research on Siberut in conjunction with the *Siberut National Park Integrated Conservation and Development Management Plan*.

3) Financial assistance to indigenous Mentawai islanders to encourage the cessation of hunting and to put forward alternatives to the current high-intensity collection of forest products.

4) Methodological and financial assistance by either international organizations, US or European zoos, and/or US or European universities, in cooperation with Indonesian universities and primate facilities, to establish captive breeding programs in Indonesia and/or abroad.

Acknowledgments

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As of October 1997 the situation in the Southern Mentawais has deteriorated. Logging activity has removed nearly 50% of the Betumonga research site forest (N. Pagai) and at least two logging companies are active in the coastal forests of both North and South Pagai. Lisa Paciulli of the State University of New York (SUNY), Stony Brook, has spearheaded an effort to halt logging in the Betumonga region, and as of this printing, is still conducting research on North Pagai island. Given the pace of logging since early 1996, estimates of forest cover for the Southern Mentawais presented in this paper should be reduced by as much as 3-5%. In addition to the continuing logging the dense smoke from fires burning throughout Sumatra, Kalimantan and Sarawak has reached the Mentawais. Recent reports (Sept. 28 and Oct. 1, 1997) indicate that visibility on Siberut is between 100-1000 m and that residents (as in most of Sumatra) are being advised to remain indoors and to wear smoke masks when outdoors. The immediate and long-term effects of the smoke combined with draught conditions on the non-human primates of Siberut (and Sumatra) are unknown. However, as with the human primate population, we can expect to see an increase in respiratory ailments and possible food shortage or contamination.

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Endangered Primate Species in Vietnam

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Introduction

Vietnam extends from 6°50'N to 23°32'N along the southeastern margin of mainland Southeast Asia. The total land area is 330,360 km², three-quarters of which is comprised of hills and mountains, with the highest peak, Mount Phangcipang, reaching more than 3,000 m above sea level. The original vegetation of the country is almost entirely comprised of tropical forest, two-thirds of which was dry evergreen and semi-evergreen forest. From 1943, however, forest cover had declined to around 43% of the total land area, and recent information from the Ministry of Forestry in 1993 gave about 87,254 km² (26%) of remaining natural forest. The highly diverse ecosystems include: Islands, mangrove forest, coastal areas, midland ecosystems (on the mainland with altitudes ranging from 70-150 m, and including grassland and secondary forest), humid tropical evergreen forest, semi-evergreen forest, and high mountain limestone forest. Each type of ecosystem has unique biological characteristics. The diversity of plant and animal species, including primates, is very high. To date, about 16 species of primates have been recorded for Vietnam, as described in the Red Data Book for the country.

Taxonomy

The primate species occurring in Vietnam are listed in Table 1. The taxonomy used here follows Groves (1993). However, it is important to note that the systematics of the Asian colobines has been revised by Brandon-Jones (1995, 1996a, 1996b) giving a number of former subspecies species status. His taxonomy is given in the notes below Table 1. Whereas that of Groves (1993) would indicate just five colobine species in Vietnam, the revisions of Brandon-Jones (1984, 1996a, 1996b) argue for 10, and including the species and endemic subspecies *Semnopithecus (Trachypithecus) auratus ebenus* Brandon-Jones 1995, with the type locality believed to be in northwestern Vietnam, possibly Lai Chau. Following Brandon-Jones' (1996b) taxonomy of the colobines, the total number of primate species in Vietnam increases from the 16 to 21.

Distribution of Primate Species in Vietnam

Table 1 gives the composition and geographic distribution of the primate species in Vietnam. The status of each is also shown, as listed in the *Red Data Book of Vietnam* (Vietnam, Ministry of Science, Technology and Environment 1992), and according to the *1996 IUCN Red List of Threatened Animals* (Baillie and Groombridge, 1996).

Some species occur only in the southern provinces of Vietnam. They include: *Macaca fascicularis*, *Trachypithecus cristatus*, *Hylobates gabriellae*, and *Hylobates lar*. Likewise, some species are restricted to the northern provinces: *Pygathrix avunculus* only in Tuyen Quang and Bac Thai provinces, *Trachypithecus francoisi poliocephalus* only on Cat Ba Island, *T. f. delacouri* in Nam Ha and Thanh Hoa provinces, and *T. f. hatinhensis*, only in the provinces of Central Vietnam.

Nycticebus coucang

The slow loris occurs throughout a large part of Southeast Asia. There are at least four distinct subspecies ranging from Bangladesh, to Myanmar, Burma, Indonesia and Borneo (Fooden 1991). In Vietnam, it ranges widely in the forested areas from Lang Son province (21°30'N, 106°20') to the south of the province of Tay Ninh (14°43'N, 108°48'E).

Nycticebus pygmaeus

The pygmy loris occurs in north Vietnam (Son La, Tuyen Quang provinces) as well parts of central to south Vietnam (from the provinces of Thua Thien Hue to Dong Nai) (see Fig. 1). Table 2 shows that the two *Nycticebus* species have been recorded from at least 35 localities, in 22 provinces of five of Vietnam's zoogeographical zones, and include among them six national parks and 12 nature reserves.

Macaca spp.

Macaques of five species are widely distributed in Vietnam, and have been recorded from 40 parks and nature reserves. The Rhesus macaque, *Macaca mulatta*, is found mostly

Figure 1. Distribution of *Nycticebus coucang* and *N. pygmaeus* in some National Parks and Nature Reserves in Vietnam. Map by Stephen Nash.

in north to central Vietnam, *Macaca assamensis* in the north-west, *M. fascicularis* only in south Vietnam, and *M. arctoides* and *M. nemestrina* are widespread from the north to the south.

Trachypithecus (Trachypithecus) cristatus

Formerly in the genus *Presbytis* and also considered by Brandon-Jones (1996b) to properly belong to the genus *Semnopithecus*, the silvered langur occurs only in south Vietnam, from the province of Kontum to Tay Ninh province.

Trachypithecus phayrei

All museum specimens of the subspecies *T. p. crepusculus* examined in Hanoi originate from the central and north-western provinces of Vietnam, specifically Lai Chau, Yen Bai, Vinh Phu, Hoa Binh, Ninh Binh, Bac Thai, Thanh Hoa, and Nghe Tinh (Fig. 2). As in most primates in Vietnam, the conservation status of this subspecies of Phayre's leaf monkey has declined in recent years. It is apparently able to survive in secondary forest where it may even reach higher population densities than in primary growth (MacKinnon and MacKinnon 1987), but hunting in central Viet-

Table 1. Distribution and status of primate species in Vietnam. Distribution: NE = North-east, NW = North-west, NC = North-central, SC = South-central, S = South, End = Endemic. Status in Vietnam according to the *Vietnam Red Data Book* (Vietnam, Ministry of Science, Technology and Environment 1992) and the *1996 IUCN Red List of Threatened Animals* (Baillie and Groombridge 1996). DD = Data Deficient, LR = Lower Risk near threatened, VU = vulnerable, EN = endangered, CR = critically endangered.

Species	Geographic Distribution in Vietnam and Status							
	NE	NW	NC	SC	S	End	Vietnam	IUCN
Family Lorisidae								
Nycticebus pygmaeus Bonhote 1907[1]	+	+	+	+	+	+	VU	VU
Nycticebus coucang Boddaert 1785	+	+	+	+	+		VU	
Family Cercopithecidae								
Macaca nemestrina (Linnaeus 1766)	+	+	+	+			VU	
Macaca mulatta (Zimmermann 1780)	+	+	+	+			LR	LR
Macaca arctoides (I. Geoffroy 1831)	+	+	+	+			VU	VU
Macaca assamensis (M'Clelland 1840)	+	+	+	+			VU	VU
Macaca fascicularis (Wroughton 1815)					+		LR	LR
Trachypithecus cristatus (Raffles 1821)[2]					+		VU	LR
Trachypithecus francoisi (Pousargues 1898)[3]	+	+	+				EN	VU
Trachypithecus phayrei (Blyth 1847)[4]		+					VU	DD
Pygathrix avunculus (Dollman 1912)[5]	+					+	CR	CR
Pygathrix nemaeus (Linnaeus 1771)[6]				+	+		EN	EN
Family Hylobatidae								
Hylobates concolor (Harlan 1826)[7]	+	+		+			EN	EN
Hylobates gabriellae Thomas 1909				+			EN	DD
Hylobates lar (Linnaeus 1771)					+		EX	LR
Hylobates leucogenys Ogilvy 1840	+	+	+				EN	DD

[1] Corbet and Hill (1992) recognize *N. intermedius* Dao 1960, from the forest of Hoa Binh, north-west Vietnam, 21°50'N, 108°20E'. On the basis of specimens examined from Yunnan, skulls appear indistinguishable in size and form from those of *N. pygmaeus*. Pelage characteristics seem distinct, however, the form is heavier (500-800 g, cf. 250-400 g in *N. pygmaeus*), and there are differences in the chromosomes (Wang Ying-xiang, 1992). Groves (1993) gives it as a synonym of *N. pygmaeus*.

[2] Considered to be a subspecific form of *Semnopithecus (Trachypithecus) obscurus* by Brandon-Jones (1984, in litt. to R. A. Mittermeier, October 1994, 1996b).

[3] Corbet and Hill (1992) list the white-sideburned leaf monkey as *Trachypithecus (Semnopithecus) francoisi*, although Brandon-Jones (1995, 1996a) argues *Trachypithecus* to be the correct subgeneric name, hence *Semnopithecus (Trachypithecus) francoisi* Pousargues 1989 (part of the *auratus* superspecies group). This colobine, occurring in Vietnam, southern China and Laos shows significant racial variation in pelage (see T'an 1985; Weitzel and Vu Ngoc Thanh, 1992). The endemic form *hatinhensis* Dao 1970 from north-central Vietnam (vicinity of Cuc Phuong National Park) is given by Groves (1993) as a synonym of *T. francoisi*. Corbet and Hill (1992) considered it a subspecies of *Semnopithecus francoisi*. Brandon-Jones (1995, 1996a, 1996b) however, gives it full species status: *Semnopithecus (Trachypithecus) hatinhensis* (Dao 1970), part of the *auratus* superspecies group. The form *poliocephalus* Trouessart 1911, known only from Cat Ba Island, north-east Vietnam, is listed as a synonym of *T. francoisi* by Groves (1993), but Brandon-Jones (1995) regards it as a subspecies of *Semnopithecus (Trachypithecus) johnii*. The form *delacouri* endemic to north-central Vietnam is likewise considered a synonym of *T. francoisi* by Groves (1993), and as a subspecies of *Semnopithecus francoisi* by Corbet and Hill (1992). Brandon-Jones (1995) lists this form as a valid species: *Semnopithecus (Trachypithecus) delacouri* (Osgood 1932), of the *auratus* superspecies group.

[4] Brandon-Jones (1984, 1996b) lists this species as a subspecies of *Semnopithecus (Trachypithecus) obscurus*.

[5] Formely a species of the genus *Rhinopithecus*, now relegated to a subgenus (Groves 1993; see also Brandon Jones 1984, 1996b).

[6] Two subspecies, *P. nemaeus nemaeus* (Linnaeus 1771), from central Vietnam, and *P. n. nigripes* Milne-Edwards 1871, from south Vietnam, are recognized by Corbet and Hill (1992), but considered by Brandon-Jones (1984, 1996b) to be valid species (subgenus *Pygathrix*). Corbet and Hill (1992) also recognize the subspecies *P. n. moi* Kloss 1926 from north-central Vietnam, but it is considered a variant of *P. n. nigripes* by Lippold (1977), Weitzel *et al.* (1988) and Jablonski (1995).

[7] Five subspecies were recognized by Groves and Wang (1992): *H. c. furvogaster, jingdongensis, nasutus, hainanus* and *lu*, all given as synonyms in Groves (1993). Dao Van Thien (1983) suggested that *H. c. hainanus* occurs on the mainland, in northeastern Vietnam. The subspecies *H. c. siki* Delacour 1951, occurring in central Vietnam and adjacent Laos, is listed by Groves (1993) as a synonym of *H. gabriellae*.

nam is a serious problem and this primate must be considered quite vulnerable. Note that Brandon-Jones (in litt. to R. A. Mittermeier, October 1994) considers Phayre's leaf monkey to be a subspecies of *Semnopithecus (Trachypithecus) obscurus* (see notes to Table 1).

Trachypithecus francoisi

François' leaf monkey is found in Vietnam, southern China and Laos. Six subspecies have been described: *Trachypithecus francoisi francoisi, T. f. poliocephalus, T. f. delacouri, T. f. leucocephalus, T. f. hatinhensis* and *T. f. laotum* (Fig. 3), and some may be distinct species (*v.* Brandon-Jones 1984, 1996b, who considers them all to be valid species of the genus *Semnopithecus*, subgenus *Trachypithecus*, superspecies *auratus*; see also notes to Table 1). Four of them occur in Vietnam. *T. f. francoisi* occurs in southern China and northern Vietnam. The population of this subspecies is estimated to be less than 200. Using a working density of three *T. f. francoisi* per km² (see MacKinnon and MacKinnon 1987), it is theoretically possible that the forest in Ba Be National Park could support as many 117 of these animals. At present, however, the actual number of *T. f. francoisi* in the area is probably much lower, given the extent of uncontrolled hunting. *T. f. poliocephalus* is the most easily observed subspecies, living on the open cliffs of Cat Ba Island near the Port City of Hai Phong. *T. f. hatinhensis* occurs in the provinces of Hatinh and Quang Binh port city (Fig. 3). Formely thought to be very localized in its geographic range (Le Xuan Canh 1992), Lippold and Vu Ngoc Thanh (1995a) reported a new locality, the Kong Cha Rang Nature Reserve, Gia Lai province. It is also known from the Phong Na forest in Quang Binh (Le Xuan Canh 1992/1993), the Vu Quang Reserve in Ha Tinh province (MacKinnnon 1992) and the Bach Ma National Park, Thua Thien-Hue province (Bach Ma Management Plan 1990, in Lippold and Vu Ngoc Thanh 1995a).

Table 2. Some localities and the density of prosimian species in different forest types. Localities for *Nycticebus* in Vietnam. + = rare, ++ = not very rare, +++ = common, NR = Nature Reserve, NP = National Park.

N°	Locality	Province	Location	Density	Protected area
01	Huu Lung	Lang Son	23°30'N, 106°20'E	+	
02	Binh Gia	-	21°51'N, 106°40'E		
03	Ba Be	Cao Bang	22°29'N, 105°44'E 22°52'N, 106°31'E	+	NP
04	Trung Khanh	Bac Thai	14°42'N, 107°31'E	+	
05	Dai tu	-			
06	Cho Don	-			
07	Na Hang	Tuyen Quang	22°14'N, 105°30'E	+++	NR
08	Chiem Hoa	-			
09	Cat Ba	Hai Phong	20°40'N, 1107°11'E	+	NP
10	Con Linh	Ha Giang	23°10'N, 105°55'E	+	NP
11	Sa Pa	Lao Cai	22°31'N, 103°58'E	++	
12	Muong Nhe	Lai Chau	22°23'N, 102°50'E	+	NR
13	Dien Bien Phu	-			
14	Sop Cop	Son La	21°26'N, 103°54'E	+	NR
15	Xuan Nha	-			NR
16	Da Bac	Hoa Binh	21°20'N, 103°54'E	+	
17	Chi Ne	-			
18	Kim Boi	-			
19	Cuc Phuong	Ninh Binh	20°29'N, 105°46'E	+	NP
20	Ben En	Thanh Hoa	20°22'N, 105°35'E	++	NP
21	Quan Hoa	-			
22	Pu Huong	Nghe An	19°43'N, 105°38'E	++	
23	Pu Mat	-			NR
24	Vu Quang	Ha tinh	18°26'N, 105°33'E	++	NR
25	Phong Nha	Quang Binh	17°51'N, 106°15'E	+	NR
26	Tuyen Hoa	-			
27	Khe Xanh	Quang Tri	16°39'N, 108°00'E	+	
28	Kon Cha Rang	Gia Lai	14°25'N, 108°30'E	++	NR
29	Kon Ha Nung	-			
30	Chu Mom Ray	Kon Tum	14°30'N, 105°58'E	++	NR
31	Yok Don	Dac Lac	12°45'N, 108°20'E	+	NP
32	Chu Jang Xin	-			NR
33	Cat Tien	Dong Nai	11°27'N, 107°19'E	++	NP
34	Bu Gia Map	Song Be	11°57'N, 106°50'E	+	NR
35	Tan Bien	Tay Ninh	11°43'N, 108°48'E	+	

Pygathrix avunculus

The Tonkin snub-nosed monkey is very limited in its distribution. It is endemic to northern Vietnam, where it is largely restricted to primary forest on steep limestone hills (Ratajszczk *et al.* 1990, 1992; Wirth 1992; Cox *et al.* 1994). Historically, records have shown that the monkeys once inhabited five provinces: Tuyen Quang, Cao Bang, Yen Bai, Bac Thai, and Quang Ninh. From more recent observations it is evident that they are currently restricted to only two adjacent provinces: Tuyen Quang and Bac Thai (Fig. 2) (Ramesh Boonratana and Le Xuan Canh 1994). Wirth (1992) reported that less than 300 are thought to survive, scattered over four widely separated forest fragments, each smaller than 20 km². Ratajszczak *et al.* (1992) estimated a total known population of about 290-350 animals, of which 190-250 live in Ha Tuyen province and around 100 in Bac Thai province.

Pygathrix nemaeus

The douc langur occurs in central and south Vietnam. There are two forms, listed here as subspecies although Brandon-Jones (1984) considers them to be valid species. The general coordinates of the distribution of *Pygathrix n. nemaeus* (red-shanked) and *P. n. nigripes* (black-shanked) are from Tay Ninh Province (11°22'N) to Nghe An province (19°16'N and between 104°21'E and 109°00E) (Pham Nhat 1993; Lippold 1995). The Red-shanked douc langur is found in north and Central Vietnam, between 19°16'S and 12°00'N, and the black-shanked in central and southern Vietnam, between 14°22'N and 11°22'N (Lippold 1995). Lippold (1995) recorded them in several locations, mostly within primary forest, in Bach Ma National Park, Thua Thien-Hue province, in Son Tra Provincial Park (despite severe deforestation), Quang Nam-Danang province), and in the Kong Cha Rang Reserve, Gia Lai province, along with *P. n. nigripes*. Both black-shanked and red-shanked douc langurs overlap in their distributions in the Central Highland provinces of Kon Tum, Gia Lai and Dac Lac (Fig. 2) (Lippold 1995), where the possibility remains of a hybrid zone (Lippold and Vu Ngoc Thanh 1995b; see also Nadler 1995). A third form, *Pygathrix n. moi* Kloss 1926 was first described from "Lang Bian Peak". Very little is known of this primate, but Lippold (1977), Weitzel *et al.* (1988) and Jablonski (1995) all consider it to be a variant (smaller amount of black on brow, hands and lower abdomen) of *P. n. nigripes*.

Hylobates

The crested gibbons are the least well known of these lesser apes (Fig. 2) and the taxonomy of the *concolor* group is still problematic. It includes the white-cheeked gibbon, *H. leucogenys*, and the red-cheeked (or golden-cheeked) gibbon, *H. gabriellae*, and

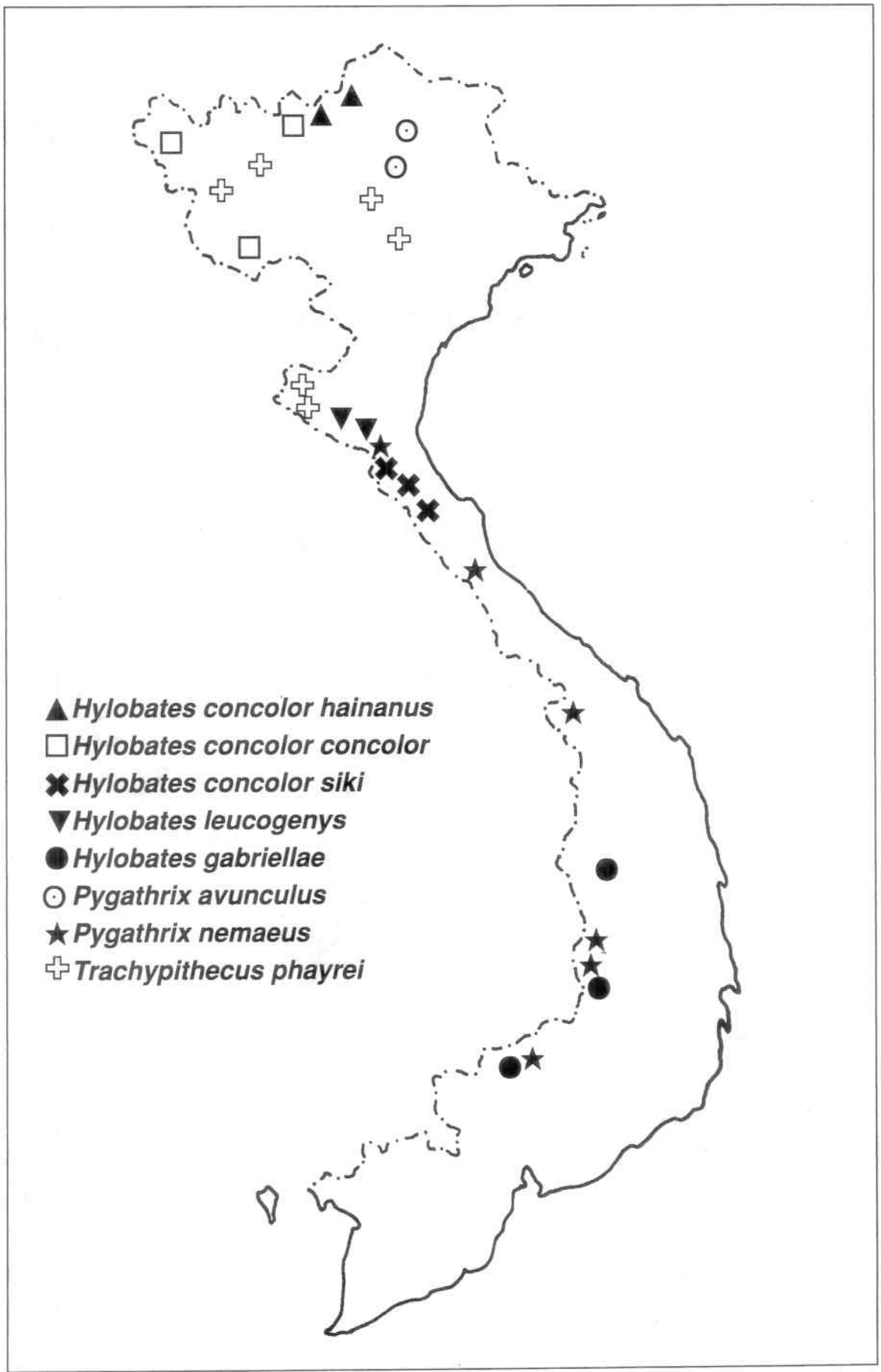

Figure 2. Distributions of *Hylobates c. hainanus*, *H. c. concolor*, *H. c. siki*, *H. leucogenys*, *H. gabriellae*, *Pygathrix avunculus*, *P. nemeaus*, and *Trachypithecus phayrei* in Vietnam.

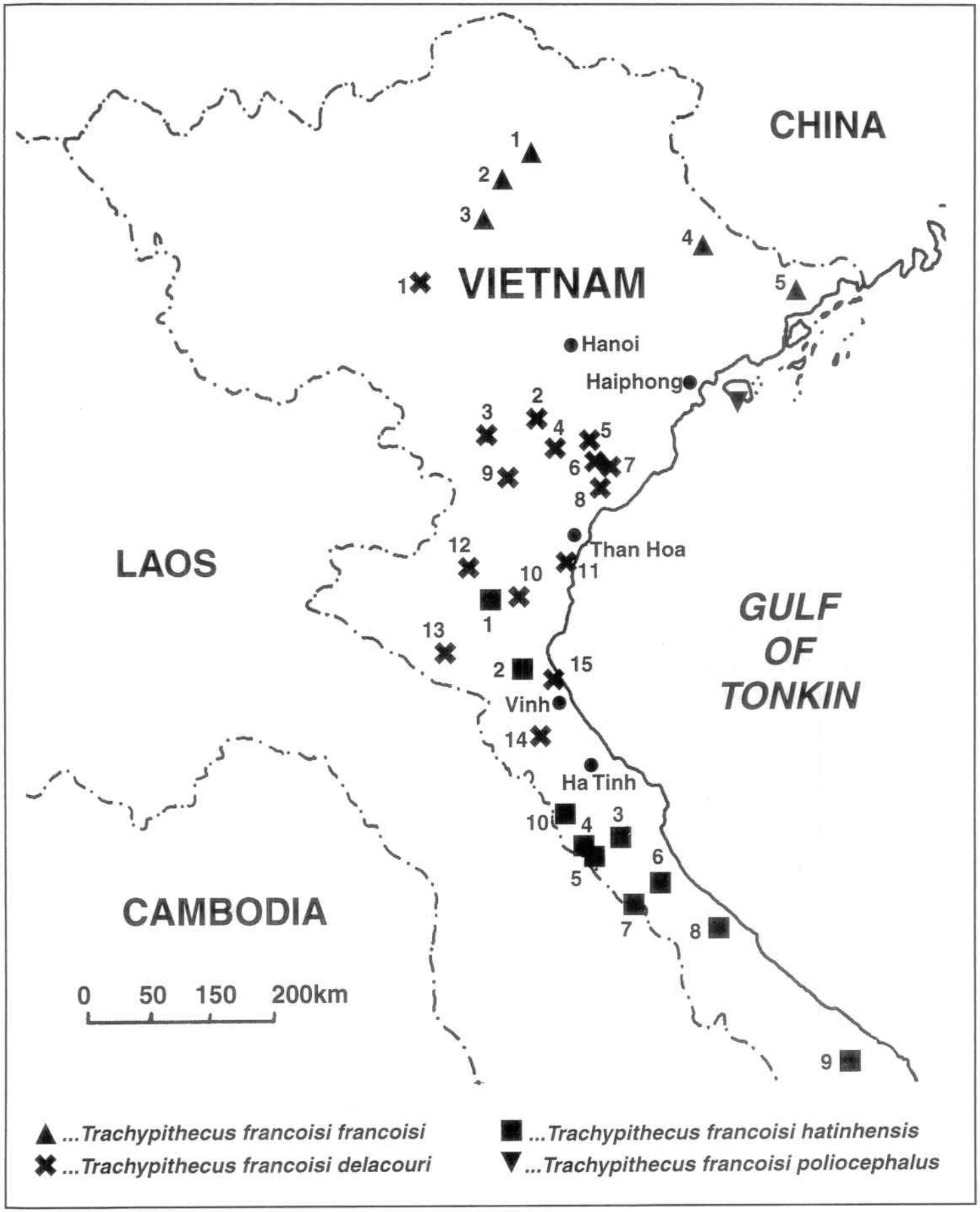

Figure 3. Distributions of *Trachypithecus francoisi francoisi*, *T. f. hatinhensis*, *T. f. delacouri*, and *T. f. poliocephalus* in Vietnam. Map by Stephen Nash.

the black-crested gibbon, *H. concolor*. Until recently, *leucogenys* and *gabriellae* were considered to be subspecies of *H. concolor*. However, based on evidence of sympatry as well as morphological and behavioral differences, two or more separate species are recognized (Dao Van Thien 1982; Ma Shi Lai and Wang Ying-xiang 1986; Groves and Wang Ying-xiang 1990). The white-cheeked gibbon, *H. leucogenys*, and black-crested gibbon, *H. concolor*, have partially overlapping ranges in China, Laos and Vietnam (Dao Van Tien 1983; Ma Shi Lai and Wang Ying-xiang 1986; Fooden *et al.* 1987). Black-crested gibbons were once widespread, inhabiting subtropical and montane evergreen forests throughout southern China, in Vietnam north of 20° latitude and into Laos. White-cheeked gibbons also occur in some of these areas and to the south, but may be restricted to lowland evergreen forest. They can still be found in the Mcgla and Shangyong reserves in China, in Laos (where they may still be relatively abundant), and in Vietnam (MacKinnon and MacKinnon 1987). However, the subspecies *H. c. siki*, which has a small range in central Vietnam and adjacent Laos, may be near extinction. The red-cheeked gibbon, *H. gabriellae*, occurs in southern Vietnam and Cambodia, where it may still be relatively abundant. All these gibbons, however, are highly threatened, primarily because they are found only in undisturbed forests, which are being rapidly depleted, and because of their low reproductive rate. Gibbons in isolated forest patches are especially susceptible to overhunting. In Vietnam, they are still hunted for food and for medicinal use.

Status of Primate Species in Vietnam

Populations of primates in Vietnam are declining very rapidly through habitat destruction and overhunting. After many years of war, the habitat is continuing to be destroyed through varying types of land use and logging. Hunting is a major threat to the primate species, for food and medicinal beliefs. All of the 16 species in Vietnam have been described as endangered or otherwise threatened in the Red Data Book of Vietnam. Table 1 shows the different threat categories for each.

All the primate species in Vietnam are threatened. *Trachypithecus f. poliocephalus*, for example, is found only on the small Cat Ba island, with a population numbering less than 200 (Le Xuan Canh and Campbell 1993/1994). *T. f. francoisi* is also on the verge of extinction, with few remaining groups in the Bac Thai and Cao Bang provinces. The population of this species is estimated to be less than 200 in Vietnam (Le Xuan Canh in press). *T. f. hatinhensis* occurs only in the provinces of Quang Binh and Ha Tinh (Le Xuan Canh, 1992/1993), and our recent research has shown that the total population number is only around 500. *Pygathrix avunculus* in the Tat Ke and Ban Bung forests, province of Tuyen Quang, numbers around 180-200 animals (Dang Huy Huynh *et al.* 1993). Other langur and gibbon species are also endangered. Urgent measures are required in the different ecosystems for the conservation of the primate species in Vietnam.

Extinct (Ex)

Hylobates lar was known only from the Phu Quoc Nature Reserve. However, there has been no information of its existence in the wild forthcoming for the last six years. Three animals are kept in the Ca mau Zoo and Ho Chi Minh City Zoo.

Critically Endangered (CR)

Two subspecies and a species deserve special attention: *H. concolor hainanus* and *T. francoisi delacouri* and *P. avunculus*. It is highly probable that *H. c. hainanus* will go extinct in the wild in the near future (see Zhang Yongzu and Sheeran 1993/1994). A few years ago (1992) the total population was estimated to be only 50-60 animals in north-east Vietnam, but from 1995-1996 no information has been obtained to confirm that it still survives. *T. f. delacouri* is in a similar situation. The total population has been estimated to be less than 100 animals (in Cuc Phuong National Park and a few other localities in the province of Thanh Hoa). Delacour's langur has been recorded in 10 isolated areas in the provinces of Hoa Binh, Nam Ha, Ninh Binh, Thanh Hoa and Nghe An, and is endemic, rare and critically endangered. There is only one protected area for the langur, the Cuc Phuong National Park, and hunting pressure remains very high.

Pygathrix avunculus survives in two separate forests in Na Hang Nature Reserve, with the total population numbering about 180 (Dang Huy Huynh *et al.* 1993).

Endangered (EN)

This is the largest grouping with nine species and subspecies of two families: Cercopithecidae and Hylobatidae. A few subspecies have populations numbering less than 300, small distributions, and are endemic to Vietnam, such as: *T. f. poliocephalus*, and *Hylobates concolor. T. f. francoisi* is also considered endangered, but extends into China.

Vulnerable (VU)

Most of this group belong to the families Lorisidae and Cercopithecidae: *Nycticebus*, *Macaca*.

Lower Risk (LR)

The Rhesus mascaque, *Macaca mulatta*, is widely distributed in Vietnam, occurring in 40 protected areas. It is a highly adaptable species in the face of habitat degradation and even urbanization. *Macaca fascicularis* is common in the south of Vietnam.

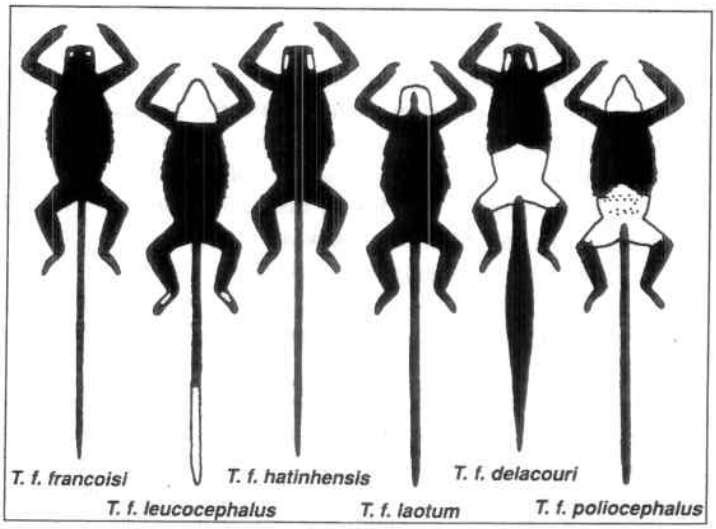

Figure 4. Different races of *Trachypithecus* in Southeast Asia.

Data Deficient (DD)

The taxonomic status of *Nycticebus intermedius* is still undecided. Some information on this loris was given by Dao (1960), but too little is known to make any judgment on its status. It is not recognized as valid by Groves (1993). Another obscure form, *Pygathrix n. moi*, was first described by Kloss in 1926, based on a specimen from Lang Bian (Lam Dong province), but as mentioned above the taxonomic validity of this form is doubted.

Threats

Habitat destruction

Much of many nature reserves has been partially logged and subjected to various forms of land clearance. Although timber operations stopped a few years ago, illegal logging continues and is very wasteful. Large trees are felled for the construction of houses and dugout canoes. Due to the steepness of the terrain in many places and its relative inaccessibility, only some blocks of wood are transported out of the area, while most are left in the forest. Fruits of *Dracontomelum dupreanum* and *Canarium album* are harvested for sale by local people. Sometimes villagers resort to chopping entire trees to harvest the fruits. These fruits are likely to be important foods for many bird and mammal species. The major form of habitat destruction is caused by both permanent and shifting cultivation by the various ethnic minorities.

Hunting

Hunting is a major threat to primate species throughout the country. Although the meat of some primate species is considered to have a bad taste, for example, *P. avunculus, Trachypithecus* spp., and *Presbytis* spp., they are nevertheless killed when encountered. They are consumed locally or made into a medicinal stock as a cure for fatigue. Market trade, both national and international (for example, China) contributes to or drives much of the hunting of all primates in Vietnam.

Conservation Measures for Primate Species in Vietnam

Measures for the protection of Vietnam's biodiversity are urgent and important not only for the country, but also for the survival of some of the world's most remarkable primates. The following are some immediate priorities:

1. Conduct a long-term survey and inventory for the accurate assessment of the status of each primate species, especially endangered and rare species such as: *P. avunculus, T. f. poliocephalus, T. f. hatinhensis,* and *Hylobates lar.*

2. Management *in situ* for all the primate species in the 10 national parks and 47 nature reserves.

3. Effective implementation of CITES (Vietnam became a signatory on 20 April, 1994), enforcement of trade regulations and the control of the trade in primate species within the country and in border regions.

4. Education programs are needed to increase the awareness of rural communities on matters concerning forest conservation, and especially for the protection of endangered species, and to discuss the role of the protected areas with local people, explain why hunting and forest exploitation are illegal, and research and implement measures for economic alternatives to reduce the pressure on protected areas and the primates.

5. Training courses concerning bioresources and nature conservation problems are needed for local communities, forest rangers, and managers of protected areas.

6. There is an urgent need for international cooperation, especially with neighboring countries.

7. It is particularly important that consideration be given to increasing the number of personnel currently engaged in the protection of forests and natural resources. The principal threats to primate species are hunting and habitat loss, and effective patrolling would do much to limit the extent to which these activities are carried out in the protected areas. Unauthorized use of forest resources would be further reduced if the protected areas were fenced.

8. The remaining villages in protected areas should be relocated as there is a danger that these settlements will attract new residents. If relocation is not possible, then immigration of outsiders into the village must be prohibited, and managers-officials should ensure that no land is cleared or houses erected by people not already resident.

9. Agricultural expansion by residents of villages in protected areas should be restricted. The tolerable limits must be clearly defined and appropriate buffer zones established.

10. The ban on hunting inside protected areas should be actively enforced by guards, patrols, and the use of a system of fines.

11. In some areas the government should consider the development of ecotourism, which would increase the income of the local communities and provide additional revenue for management.

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Proyecto Titi: Developing Alternatives to Forest Destruction

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Introduction

Developing an effective conservation plan for the cotton-top tamarin (*Saguinus oedipus*) involves a multi-disciplinary and multi-institutional approach. Since 1987, the Colombian Ministry of the Environment (formerly INDERENA), the University of Wisconsin, Roger Williams Park Zoo, and CARSUCRE have been involved in a cooperative program to conserve one of Colombia's most endangered primates.

History

Cotton-top tamarins are found only in the northwest region of Colombia and have been continually threatened by habitat destruction, the biomedical industry, and the pet trade (see Mast *et al.* 1993 for a complete review). They have been kept in zoos and laboratories since the early 1960's, with approximately 64% of the population found in research laboratories (Tardif and Colley 1989). Cotton-top tamarins are one of the most well-studied callitrichids in captivity, with studies ranging from colony management (Johnson 1991; Kirkwood 1983; Kirkwood and Underwood 1984; Kirkwood *et al* 1983; Snowdon *et al.* 1985; Tardif *et al.* 1988), to reproductive biology (Ziegler *et al* 1987a, 1987b, 1993; Widowski *et al.* 1990, 1992; French *et al.* 1983; Tardif, 1984; Tardif *et al.* 1984), and social organization and behavior (Savage *et al.* 1988; Tardif *et al.* 1986; 1990; Price and McGrew 1991), infant development (Cleveland and Snowdon 1984; Snowdon 1996; Price 1990) and studies of colonic adenocarcinoma (see Clapp 1993, for a complete review).

The number of captive cotton-top tamarins has decreased in recent years due to the disbanding of several biomedical colonies (N. Clapp pers. comm., D. Lee-Parrtiz, pers. comm.). However, efforts to manage the population in North American zoos has been ongoing through the efforts of the Cotton-top Tamarin Species Survival Plan (SSP) (Savage 1995, 1996a; Savage and Zirofsky 1997). With more than 200 animals in 55 zoos in the U. S. and Canada, the cotton-top tamarin SSP has begun to develop a program that integrates field conservation efforts with long-term management of the species in captivity. Using captive cotton-top tamarins as ambassadors for conserving Colombia's biodiversity, several zoos such as the Akron Zoo, Utah's Hogle Zoo, the Biodome de Montreal, Tulsa Zoo, and Roger Williams Park Zoo, working in cooperation with the SSP, have developed exhibits that highlight the importance of conserving this endangered species in its natural habitat. These institutions, and others, are now disseminating information generated from field-based conservation programs, so that zoo visitors increase their interest, knowledge, and support of conservation programs world-wide.

Development a Conservation Program for the Cotton-top Tamarin

Developing effective long-term conservation programs for endangered species requires more than just captive breeding and scientific studies. We suggest that successful in-country conservation programs should use a multi-disciplinary approach that combines field research and effective scientific assessment of habitats, as well as community initiatives that involve local inhabitants, in culturally relevant, action-based programs. Making the conservation of natural habitat and resources economically feasible for local communities will help ensure success. Developing collaborative programs that have direct benefit to communities and that generate political and public interest and support of wildlife and habitat preservation will be the most effective.

Our goals in the development of a conservation program for the cotton-top tamarin were, therefore, to 1) conduct long-term field studies to evaluate the wild population, as well as provide information for comparison with previous captive studies (Gyllensten *et al.* 1994; Power *et al.* 1997; Savage in press; Savage *et al.* 1996a, 1996b, 1997a, 1997b), 2) promote community awareness and public education programs in Colombia, (Savage 1996b, in press; Savage *et al.* 1997a), 3) establish training programs in conservation biology (Savage 1996b, in press; Savage *et al.* 1997a), 4) provide economic incentives for habitat preservation and alternatives to forest destruction (Savage *et al.* 1997a; Savage in press), 5) develop material that could be used in zoos

and public education programs to promote the conservation of the cotton-top tamarin and its habitat (Savage 1995) and 6) foster international collaboration between scientists, conservationists, and educators from zoos, universities and conservation organizations.

We have described the many aspects of our conservation program for cotton-top tamarins in various publications (see above). This paper will examine our most recent project to develop a viable alternative to protecting habitat for cotton-top tamarins and the natural flora and fauna of Colombia.

Developing Alternatives to Forest Destruction - Bindes

Given the dramatic rate of forest destruction for human and agricultural consumption (Myers 1991), it is critical that programs are developed to reduce the dependency on non-sustainable forest products. The community of Colosó is located in one of the most economically depressed departments of Colombia. Although there is electricity in the village, the majority of the population cooks over an open fire. This is due to the high cost of electricity, in addition to an actual taste preference; many of the individuals we surveyed preferred the smoky taste of food cooked over an open fire.

For this reason, we began a study to investigate how human harvesting of trees for firewood was effecting the long-term survival of cotton-top tamarin habitat. We surveyed 100 families and our results indicated that, on average, a family of five individuals consumes 15 ±3.2 logs of wood (1-1.5 m in length) daily. Given this high rate of consumption, and without efforts to replenish the trees that are harvested, the forested regions of Colosó were evidently facing a substantial yearly loss.

To decrease forest product consumption, we examined the feasibility of using solar box cookers. We conducted a study in which five families were instructed in the use of the solar ovens and asked to evaluate their effectiveness. There was an overwhelming negative response to the solar oven for several reasons: 1) coffee could not be made quickly in the oven, 2) food cooked in the oven did not have an appealing taste, and even with the addition of products which mimicked the flavor of food cooked over an open fire, the food prepared in solar box cookers was considered unsatisfactory, 3) because of the lengthy cooking time, solar box cookers were only useful for preparing dinner, and 4) it was difficult to reheat food quickly.

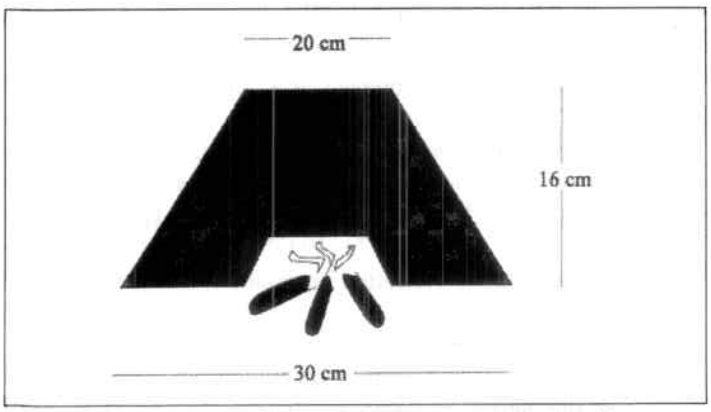

Fig. 1: A schematic drawing of a clay bindes used in Colosó, Colombia.

Taking the criticisms of solar box cookers into consideration, we examined another traditional method of cooking. Some inhabitants of these communities, have used "bindes" to cook their food. Villagers collect large termite mounds from the forest, bring them back to their homes, and reinforce them with mud. These "bindes" have a hole cut at the top, yet are still strong enough to support the weight of a large kettle, and a hole cut in the side so that wood can be fed directly into a fire. Smaller holes are cut on the top and sides which allow sufficient air exchange to support a fire. Villagers have told us that bindes are much more efficient, and less wood is consumed using this method. Despite the numerous benefits, the use of termite mounds is problematic. It is quite labor intensive to search for and remove a termite mound from the forest. Moreover, a traditional binde may last only a few months with constant use.

Given that bindes were already culturally acceptable, we were interested in modifying the materials used in the construction of a binde that would allow for greater long-term use. With funding provided by the Disney Foundation Conservation Excellence Fund, we began one of our most successful programs. After consulting several sources, we contacted a local artisan that created small items out of clay. Using his expertise, a prototype clay binde was designed and tested (Fig. 1). Briefly, bindes are constructed out of a mixture of sand, water, and clay and are crafted into their desired form. They are designed for use with large cooking pots but can be modified to accommodate smaller ones. They are left to dry in the sun for approximately one week and then fired prior to use.

The community of Colosó was invited to participate in a demonstration of the effectiveness and versatility of the newly designed binde. Several salient features emerged from this new prototype: 1) refuse, such as corn cobs, corn husks, and coconut shells, could be burned just as efficiently as wood, and 2) significantly less smoke was produced which is likely to result in less of a health hazard for the women.

We carried out a comparative study examining the effectiveness and efficiency of using the traditional method of cooking over three stones or a binde (Table 1). We concluded that bindes were significantly more efficient, burning 2/3 less wood per day than cooking over three stones. Food cooked using a binde retained its flavor and women reported less eye and lung irritation from the smoke.

Bindes are inexpensive (US$3-4 including labor) and remarkably easy to construct, and their construction and use has been incorporated into our local education programs in Colombia. We now have a group of motivated students ready to begin their own microenterprise. The demand for bindes in Colosó has been tremendous. Villagers appreciate that using bindes not only helps to conserve the forest for the cotton-top tamarins but actually makes their lives easier, since the firewood they gather from the forest now lasts significantly longer.

Table 1. Firewood consumption and cooking time using bindes or three stones.

Cooker	Fuel	Quantity	Average Time to Cook Sanchocho
3 Stones (N=10)	Firewood	5950g (15±3.2 logs)	1 hr 15 min
Bindes (N=10)	Firewood	1675 g (5±2.7 logs)	1 hr 10 min
Bindes (N=10)	Yuca stalks	9100 g	1 hr 30 min
Bindes (N=10)	Corn cobs	3200 g	1 hr 29 min

Program Expansion for the Future

With the remarkable acceptance of bindes by the community of Colosó, we are now anxious to take this program to neighboring communities. It is our hope that the use of bindes will provide a true economic alternative for many individuals dependent on the forest for firewood. Moreover, we are investigating the potential of developing areas that can be planted with fast-growing, native trees species harvested strictly for firewood to further lessen the demand for forest products.

Programs such as that for the bindes which incorporate the welfare of communities and local traditions can have a positive impact on any conservation program. The interest and commitment to conservation are present in many rural communities, but what are often lacking are the resources and alternatives to assist individuals in making choices that can benefit conservation efforts.

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The Endangered Muriqui in Brazil's Atlantic Forest

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Introduction

The muriqui monkey (*Brachyteles arachnoides*) is one of the most endangered primates surviving in what remains of the Atlantic forest of southeastern Brazil. Muriquis have managed to persist, despite severe habitat disturbance, in part because of their adaptable way of life, which includes their ability to exploit secondary as well as primary forest (Fonseca 1983, 1986; Strier 1987). In disturbed forests, habituated muriquis appear to use all available strata, including the ground when they need to cross gaps in the canopy (Dib *et al.* 1997). At many sites where muriquis have been studied, they prove able to rely on substantial quantities of leaves, as well as items such as bark and bamboo, in addition to their preferred fruits and flowers (Milton 1984; Strier 1991a; Rímoli 1994; Carvalho, Jr. 1996; Nogueira 1996; Petroni 1996).

Muriquis live in large, multi-male, multi-female groups comprised of more than 50 individuals (Strier 1996a). Two populations studied in Minas Gerais exhibited strong preferences for exploiting large food patches (Lemos de Sá and Strier 1992), which can support cohesive groups of up to more than 20 individuals that can adjust their size to avoid feeding competition (Strier 1989; Strier *et al.* 1993). In São Paulo, variable associations of mixed and single-sexed groups and solitary individuals have been observed (Milton 1984; Petroni 1996; Carvalho, Jr. 1996), suggesting that food patch size may not be the only determinant of grouping patterns in the genus (Moraes *et al.* in press).

As in many New World primates, males are philopatric, remaining in their natal groups for life, whereas females generally disperse into other groups as they reach adolescence at about 5-7 years of age (Strier 1990, 1991b). Our long-term data from the Estação Biológica de Caratinga indicate that in the wild, males reach sexual maturity at about 5½ years of age, and females at an average of 11 years (Strier 1996b). Such delayed maturation is consistent with the long lifespans found in muriquis and other large-bodied primates. We also know that muriqui interbirth intervals average three years in the wild, a slow rate of reproduction that, together with their delayed maturation, sets natural limits on how fast wild populations can recover in size (Strier 1996a).

The muriqui's Atlantic forest home once stretched continuously from southern Bahia to São Paulo, and inland into Minas Gerais. This ecosystem has been reduced to less than 5% of its original extent (Fonseca 1983, 1985), and only a decade ago, fewer than 500 muriquis were reported from just 11 isolated forests (Mittermeier *et al.* 1987). Over the last five years, additional muriqui populations have been reported, nearly doubling both the number of localities and the total estimated population size (Table 1, and references therein).

This paper reviews the current status of muriquis and threats to their survival, and proposes guidelines for the development of conservation strategies on the muriqui's behalf. We emphasize, however, that our assessment of muriqui localities and population sizes, and hence, our proposed guidelines for their conservation, are limited in many instances to reported sightings, which may have been made as long as a decade ago. Population estimates, involving unhabituated animals or extrapolated from single study groups to large forested areas, are likely to be lower than actual population sizes, particularly in the largely unexplored forests throughout the muriquis' range. Thus, we regard the present effort as an example of how much we still must establish about muriquis before we can ensure their continued survival.

Systematics

Muriquis have traditionally been classified as a monotypic species, *Brachyteles arachnoides* E. Geoffroy 1806 (Aguirre 1971). However, in response to recent morphological and genetic findings, the taxonomic status of muriquis is undergoing some revision. Northern and southern populations have recently been divided into two subspecies, *Brachyteles arachnoides hypoxanthus* and *B. a. arachnoides*, as originally proposed by Vieira (1944, 1955), and possibly even separate species, *B. hypoxanthus* and *B. arachnoides* (Coimbra-Filho *et al.* 1993; Rylands *et al.* 1995).

Northern muriquis from the states of Minas Gerais and Espírito Santo have distinctive individual patterns of pink and white mottling on their faces and genitalia, and a vestigial thumb, whereas southern muriquis, from the state of São Paulo, have uniformly black facial and genital coloration, and lack any vestige of a thumb (Lemos de Sá and Glander 1993). Evidence suggesting that canine

Table 1. Muriqui localities.

Site	State[1]	Area (ha)	Area (km²)	Pop.	Status	Notes	Density(ha)	Density(km²)
Fazenda Côrrego de Areia	MG	60	0.60	8	Private	1	0.1333	13.3333
Parque Estadual Rio Doce	MG	36,000	360.00	21	State	2	0.0006	0.0583
Estação Biológica de Caratinga	MG	860	8.60	90	Private	3	0.1047	10.4651
Estação Biológica da Mata do Sossego	MG	800	8.00	21	Private	4	0.0263	2.6250
Fazenda Esmeralda	MG	44	0.44	12	Private	5	0.2727	27.2727
Parque Estadual da Ibitipoca	MG	1,488	14.88	2	State	6	0.0013	0.1344
Parque Estadual Serra do Brigadeiro	MG	20,000	200.00	50	State	7	0.0025	0.2500
Reserva Biológica Augusto Ruschi	ES	4,000	40.00	11	Federal	8	0.0028	0.2750
Parque Nacional Caparaó	ES	26,000	260.00	19	Federal	9	0.0007	0.0731
Parque Estadual Serra do Mar	SP	66,250	662.50	25	State	10	0.0004	0.0377
Estação Estadual Juréia	SP	20,000	200.00	8	State	11	0.0004	0.0400
Parque Estadual Jacupiranga	SP	30,000	300.00	2	State	12	0.0001	0.0067
São Francisco Xavier	SP	4,000	40.00	15	Private	13	0.0038	0.3750
Fazenda Barreiro Rico	SP	3,259	32.59	95	Private	14	0.0292	2.9150
Parque Estadual Carlos Botelho	SP	37,644	376.44	500	State	15	0.0133	1.3282
Fazenda Intervales	SP	38,000	380.00	240	State	16	0.0063	0.6316
Parque Estadual Alto Ribeira	SP	35,000	350.00	12	State	17	0.0003	0.0343
Parque Estadual Jurupará	SP	26,300	263.00	5	State	18	0.0002	0.0190
Fazenda São Sebastião do Rio Grande	SP	10,700	107.00	22	Private	19	0.0021	0.2056

[1]MG = Minas Gerais, SP = São Paulo, ES = Espírito Santo.

Notes to Table 1.

1. Area and minimum population based on 1981 observations reported in Mittermeier *et. al.* (1987).
2. Area based on Stallings and Robinson (1991). Population based on minimum number of muriquis observed in Mittermeier *et. al.* (1987). Stallings and Robinson observed only nine individuals in their subsequent census.
3. Area based on Hatton *et al.* (1983). Population based on known size of one group as of November 1996 (K. B. Strier, unpubl. data), and minimum number of individuals observed in two other groups (11 and >20) in February, 1992 (Strier *et al.* 1993).
4. Area and minimum population based on reported observations by Mittermeier *et al.* (1987). The forest was named the Estação Biológica da Mata do Sossego by Fundação Biodiversitas following their purchase of the core area of forest in 1992.
5. Area reported in Mittermeier *et al.* (1987). Population size based on Lemos de Sá *et al.* (1990). Note that population size declined from 15-18 in 1986-1987 (Lemos de Sá 1988, 1991) to 11 individuals in July 1991 (Andrade 1996).
6. Area and minimum population size based on Braz Consenza (pers. comm.), the leading biologist conducting surveys in the area, information as yet unpublished.
8. Area and minimum population size based on Pinto *et al.* (1993). Note that Mendes and Chiarello (1993) describe probable additional populations of muriquis in the state of Espírito Santo, but do not provide population estimates and so these areas are not included in the present analyses.
9. Area and minimum population size based on Alves (1986).
10. Area and minimum population size based on summing four of the Park's nuclei, which represent continuous forest. Total areas and populations for each nuclei are as follows: Reserva Estadual de Cunha, with 2,230 ha and 16 individuals (Mittermeier *et al.* 1987); and Núcleo Mongaguá, with 30,000 ha and 2+ individuals; Núcleo Curucutu, with 23,697 ha and 2+ individuals; and Núcleo Pedro de Toledo/Itariri, with 10,323 ha and 5 individuals (Martuscelli *et al.* 1994).
11. Area and population size from Martuscelli *et al.* (1994). Of the 4-8 individuals estimated in 1989, 2 infants were reported captured in September 1990 and possible evidence of predation is indicated in December 1993 (Martuscelli *et al.* 1994).
12. Area and population size from Martuscelli *et al.* (1994), who indicate that only 30,000 of the original 150,000 ha of this state park remain. According to Martuscelli *et al.* (1994), three individuals were observed in 1992, but in 1994 one female was captured.
13. Area and population size based on Antonietto and Mendes (1994). Martuscelli *et al.* (1994) report only 12 individuals.
14. Area and population size based on Mittermeier *et al.* (1987).
15. Area and population size based on Paccagnella (1991), who estimated a population of at least 500 individuals during her census.
16. Area and population from Martuscelli *et al.* (1994), who report one study group with 24 individuals and a total of 10 groups with an estimated population of 240 individuals. Using a more conservative estimate of a minimum of 5 individuals in each of the other 9 groups, the total population size may be only 69-70+individuals.
17. Area and population from Martuscelli *et al.* (1994). who report observations of 12 individuals in April 1990.
18. Area and population based on observations from Martuscelli *et al.* (1994).
19. Area and population based on observations in January 1996 by Oliveira and Manzatti (1996).

sizes are sexually monomorphic in northern populations and sexually dimorphic in southern populations (Lemos de Sá *et al.* 1993) is consistent with the egalitarian mating patterns of northern muriquis (Strier 1990, 1997a) and the more hierarchical mating patterns reported from one southern population (Milton 1985). Nonetheless, there is still some disagreement about whether regional patterns in canine size dimorphism exist (Leigh and Jungers 1994; Kelley and Strier in prep.).

Preliminary genetic comparisons between individual muriquis sampled from one northern and one southern population reveal some of the highest levels of polymorphism and heterozygosity known for any primate (Pope 1996). Contemporary muriqui populations may be descendants of refuge populations isolated from one another during the Pleistocene glaciations that fragmented the continuous Atlantic forest into smaller centers of endemism (Kinzey 1982). Massive deforestation during the last century (Fonseca 1983) has led to further geographic isolation and morphological and genetic divergence between remaining northern and southern populations. The high levels of genetic heterozygosity still found today may persist because muriqui population sizes declined rapidly relative to their generation length (Pope 1996; Strier 1997b), and may be one of the critical factors contributing to the apparent ability of at least one isolated population at the Estação Biológica de Caratinga to avoid the deleterious effects of inbreeding depression (Strier 1996a).

We recommend that conservation programs distinguish between northern and southern populations on the basis of their current geographic distribution independent of whether two taxonomic

subspecies or species are ultimately accepted. In addition to the importance of preserving extant variation within the genus, such geographical distinctions will help increase the sensitivity of conservation programs to local and regional differences that affect remaining muriqui populations.

Forest and Population Distribution and Status

Muriqui populations are distinguished from one another by whether they occur in federally or state protected forests versus forests that are owned by private landholders. Threats to muriqui survival differ between protected and private forests, and this must be taken into consideration when formulating conservation priorities. For example, the large federal and state protected forests are less vulnerable to the logging and development pressures that affect muriquis inhabiting the small, privately-owned forests. Conversely, protected areas are more vulnerable to illegal hunting and poaching pressures because most of them are critically understaffed. Most wealthy private landholders prohibit hunting in their forests, and unlike public lands, they have the autonomy and means to enforce hunting prohibitions. When reviewing muriqui populations, it is thus necessary to consider not only their geographic location, but also whether threats to their continued survival come largely from hunting, as in the protected forests, or from habitat disturbances, as in the private forests.

We examined the size of forests known to support muriquis and the minimum estimated populations of muriquis in these forests by region (northern versus southern) and forest status (protected versus private). As shown in Figure 1, the 19 forests with reported muriqui population estimates represent a total area of 360,405 ha, and a total population of 1,158 individuals. Over 70% of the total forest area supporting muriquis today is part of the large São Paulo state park system, which also supports over 68% of the total estimated muriqui population. By contrast, the privately-owned forests in the northern states of Minas Gerais and Espírito Santo account for less than 1% of remaining muriqui forests. Contrary to expectations based on forest area, over 11% of all muriquis survive in the small private forests in Minas Gerais.

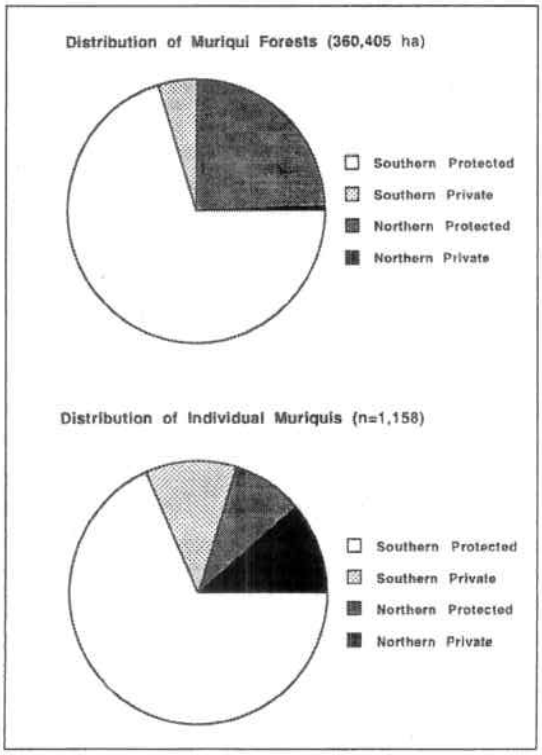

Figure 1. Total distribution of muriqui forest areas and populations.

The importance of emphasizing different conservation strategies for different regions is particularly apparent when the distributions of northern and southern muriquis are considered separately. As shown in Figure 2, protected forests account for 93-98% of the area supporting southern and northern populations, respectively. The correspondingly high proportion (85.7%) of southern muriquis found in these forests support the suggestion that conservation priorities for southern muriquis should be concentrated in these protected areas (Martuscelli *et al.* 1994). Increasing the number of guards to enforce established hunting prohibitions would have the greatest impact on muriqui survival in these protected southern forests.

A disproportionately high percentage (56%) of the northern muriqui population persists in private forests, which account for less than 2% of northern muriqui habitats (Fig. 2). The development of sustainable economic activities would be the most effective targets for conservation efforts in these private northern forests. While it may never be possible to provide adequate economic incentives to compensate private landholders for the value of the hardwood trees in their forests, developing responsible harvesting plans that include reforestation could help preserve, and ideally, expand the size of the private forests which are so evidently critical to the survival of northern muriquis.

One way of evaluating which of the protected southern forests and private northern forests would be the most effective targets for conservation is to compare muriqui population densities across sites (Fig. 3). In general, private forests throughout the muriqui's range support higher population densities than the protected forests, which may be due to a number of factors, including, but not limited to: i) hunting pressures at the protected forests, which reduce muriqui numbers; ii) predator pressures, which are probably greater in the larger, protected forests that still support populations of large predators (but see Printes *et al.* 1996); iii) the effects of habitat compression in the private forests due to agricultural encroachment; and iv) the possible beneficial effects

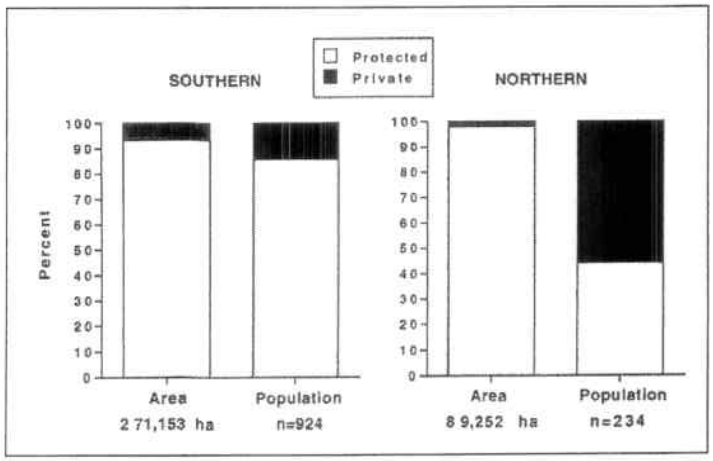

Figure 2. Distribution of southern and northern muriqui forest areas and populations.

of small-scale logging, which may maintain a more heterogeneous vegetation with higher overall potential food availability. For example, at the Estação Biológica de Caratinga, regenerating pastures became important muriqui feeding spots within a 10-year period, increasing the effective size of the forest for these muriquis and illustrating the success of collaborative conservation and research efforts in this privately-owned forest.

Captive Breeding

Captive breeding efforts have been underway at the Centro de Primatologia do Rio de Janeiro (CPRJ) since the late 1980s (Coimbra-Filho *et al.* 1993, 1994). The captive stock has come exclusively from orphaned animals, which generally arrive in poor condition, and are kept in quarantine until they recover their health. They are then moved to a large enclosure where they can move about and interact with one another. They are fed a balanced diet, which includes plant species they are known to eat in the wild that are collected from the forest surrounding the CPRJ.

The policy of not removing muriquis from wild populations is one of the many admirable features of the CPRJ's breeding program, but it also means that the CPRJ has had to rely on fate to determine its breeding population. By coincidence, the muriqui breeding population has so far included only females from the northern part of the muriquis' distribution and males from the south. The ability of these northern females and southern males to reproduce together confirms that, despite their geographic isolation and morphological and genetic differences, they have not yet become reproductively isolated from one another.

Role of Protected Areas

One of the principle goals of the captive muriqui breeding program at the CPRJ has been to produce animals that one day could be released into secure forests in the wild. Protected forests are critical areas, not only for the preservation of muriqui habitat and wild populations, but also as potential areas for future reintroduction efforts. The large size and low muriqui densities at these sites make them ideal possibilities for future reintroduction if hunting and poaching pressures can be eliminated. Nonetheless, we recommend three guidelines for any such future reintroduction(s). First, captive-bred muriquis targeted for reintroduction must be determined to be free from any infectious diseases that could harm wild populations. Second, in order to retain the historical isolation of northern and southern variation in wild muriquis, only individuals conceived by parents originally from the same regions should be reintroduced to their respective area. Lastly, based on consistent reports of female-biased dispersal among northern muriquis, we recommend that only captive-bred females be targeted for reintroduction, as the integration of unrelated males in an extant population is not expected to succeed.

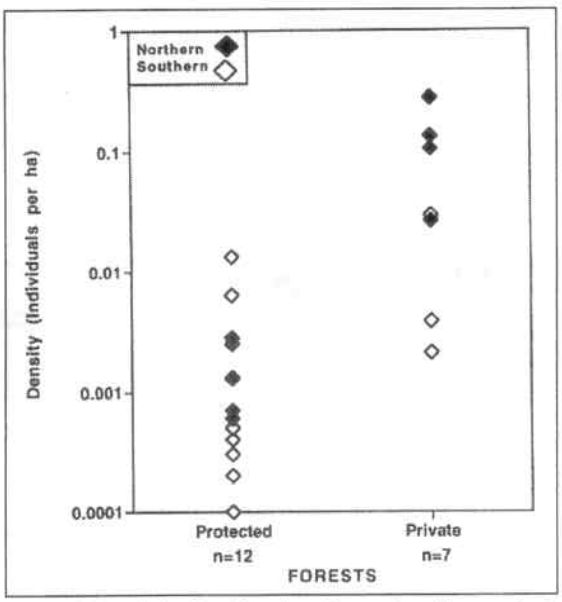

Figure 3. Population densities of southern and northern muriquis in protected and private forests.

Although high muriqui densities at the small, private forests make them less desirable for reintroduction projects, they nonetheless provide invaluable opportunities for studying the behavior, life history, and population dynamics that must be understood before informed conservation programs can be implemented. Some of these private forests, such as the 44 ha forest at Fazenda Esmeralda, have suffered population declines since monitoring began (see note 5 to Table 1), and are evidently at high risk of short-term extinction. Other populations, such as the one at the 880 ha forest of the Estação Biológica Caratinga Biological, has nearly tripled in size since 1982. Such rapid recovery is probably a result of effective hunting prohibitions enforced by the landowner, successful regeneration of surrounding areas that had once been cleared for pasture and farmland but are now being allowed to grow back, and a corresponding low mortality and high birth rate among muriquis. Indeed, extinction probabilities for this population over the next 100 years appear to be very low, and population size is expected to continue to increase if we can continue to increase the size of the forest (Strier 1996a).

Recommendations for Continuing Conservation Efforts

One of the keys to the success of past conservation efforts on behalf of muriquis has been the effective collaboration between Brazilian and international conservationists and scientists associated with NGOs and universities. This collaboration has been instrumental in generating a strong political influence on Brazilian environmental policy and legislation, as well as in initiating conservation education programs and supporting basic research.

The education programs have been fundamental in stimulating local conservation awareness, and, in some regions, conservation action such as the setting aside of additional land for forest recovery projects. They have also helped generate interest among students, creating a trained and dedicated workforce for future conservation endeavors.

Basic research has also contributed to muriqui conservation at multiple levels beyond the basic data needed in the development of informed conservation plans (Strier 1993; Mendes 1994). By maintaining a scientific presence in an area, researchers have opportunities to involve local people and to demonstrate international interest in conservation. Because researchers develop trail systems and habituate their study subjects, they can make an area more

attractive to ecotourists, and thus indirectly help bring funds into conservation pockets. Research results, especially on a species as charismatic as the muriqui, attract media attention, extending conservation outreach to an even wider public.

The most serious limitations facing future conservation efforts for muriquis are linked to practical constraints. Global conservation priorities routinely shift from country to country and among regions within any country, and, as was evident during the 1992 Earth Summit in Rio de Janeiro, the Atlantic forest has been a prime concern for nearly two decades. Maintaining world concern with, and essential investment in, the Atlantic forest, will be an increasingly serious challenge to future muriqui conservation efforts.

Economic realities affect muriqui conservation as much as they do any endangered species. Limitations on resources mean that economic alternatives to hunting and logging will need to provide genuine incentives to the appropriate people in the appropriate regions. Restricted funding has also meant that there are still very few long-term studies on muriquis from different populations in different ecological settings. Most of our knowledge of muriqui reproductive and demographic parameters come from our single long-term study, and it is still unclear how well these data can be generalized across other populations of both northern and southern muriquis (Strier 1996a).

The next 15 years, which translate into two muriqui generations, will be critical ones. The protection of all remaining muriqui habitat, including the small, privately-owned forests that support the highest muriqui densities, remains a top conservation priority. Increased efforts to involve local communities in the development of economic incentives that integrate local people and conservation objectives are essential. In addition, the available distribution and population data on muriquis indicate the necessity of tailoring long-term conservation initiatives so that they are sensitive to the hunting pressures on muriquis in the southern protected forests and the pressures of habitat disturbance on muriquis in the small, northern private forests. Nonetheless, evaluating the extent of these regional distinctions requires much more extensive comparative knowledge of muriquis across their range. A thorough survey of the forests where Aguirre (1971) documented muriquis nearly 30 years ago would provide a more accurate assessment of the muriqui's status today, and permit us to identify priorities for comparative research on remaining populations.

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Extinction Faces Ghana's Red Colobus Monkey and Other Locally Endemic Subspecies

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Introduction

Three subspecies of forest primate are known only from southwestern Ghana and parts of neighboring Côte d'Ivoire to the east. These are the white-naped mangabey (*Cercocebus atys lunulatus*), the Roloway guenon (*Cercopithecus diana roloway*), and Miss Waldron's red colobus (*Procolobus badius waldroni*) (Fig. 1). The rainforest area where these endemic primates occur has undergone very rapid development since World War II. Logging activity has been more intense than in almost any other part of tropical Africa, and many people have moved into the region to cultivate the land as it has been opened up. Logging, farming and human population growth in the region have been accompanied by the increased hunting of wild mammals and larger birds for meat, much of which has been traded out of the immediate area for sale in towns (Martin 1991).

The threats posed to Ghana's forest primates by hunting and habitat modification have long been apparent. In 1956, Angus Booth noted that the extinction of the red colobus "must be regarded as a probability, unless effective legislation to protect both the animal and its environment is forthcoming" (Booth 1956). Writing from her home in western Ghana in 1970, Sonia Jeffrey observed that logging roads had encouraged farming on a large scale, and noted that hunting was rife, even in Forest Reserves; echoing the views expressed in an IUCN report by Kai Curry-Lindahl (1969), she called for a forest area to be protected against hunting (Jeffrey 1970).

In response to these concerns, Emmanuel Asibey of the Ghana Game and Wildlife Department oversaw plans that led to the establishment of the 306 km² Bia National Park in 1974 (Asibey and Owusu 1982). One reason why Bia was selected as a park was that it still contained a population of red colobus monkeys, which had by then been hunted out of most other forests (Rucks 1976). But under pressure from logging interests, 228 km² were excised from the National Park in 1977 and made into a "Game Production Reserve" where logging was permitted and where it was thought that animals might eventually be harvested. Partly in response to the pressures on Bia, another forest area was sought for wildlife protection; this lead to the creation of the Nini-Suhien National Park and the Ankasa Game Production Reserve from the 524² km Ankasa River Forest Reserve in 1976 (Martin 1976).

In the mid-1970s, an IUCN/WWF project devoted resources to the development of the Bia and Ankasa wildlife conservation areas, and a group of American scientists studied primates at Bia (Martin 1991; Olson 1986). These projects ended in 1978, at a time when the Ghanaian economy was in crisis; from then on the two conservation areas and Ghana's forest wildlife in general were neglected by the outside world. Stephen Gartlan visited Ghana briefly in 1981, and in his subsequent report he called for more research on the primates of Bia, for the Ankasa and Nini-Suhien reserves to be consolidated into one park, and for more conservation education efforts in Ghana as a whole (Gartlan 1982). Gartlan did not make a careful assessment of the primate population in Bia and Ankasa, and he and others assumed that both forests supported populations of Ghana's 10 forest primates. In addition to the Roloway guenon, mangabey and red colobus, these are the white-thighed black-and-white colobus (*Colobus vellerosus*), the olive colobus (*Procolobus verus*), Campbell's guenon (*Cercopithecus campbelli*), the spot-nosed guenon (*C. petaurista*), the chimpanzee (*Pan troglodytes*), the potto (*Perodicticus potto*) and Demidoff's bushbaby (*Galagoides demidoff*).

Following Gartlan's visit, virtually no further attention was given to Ghana's forest primates for more than a decade. Some disturbing information appeared in 1990, in a report of the findings of an ornithological survey of Ankasa and Nini-Suhien by a group of Cambridge University students in 1988. During a month in the forest, the group saw Roloways only twice and black-and-white colobus once; they did not see red colobus, mangabeys or chimpanzees. Unfortunately, their report (Dutson and Branscombe 1990) was not widely read by primatologists.

In 1993, TTS and JFO visited Ghana at the invitation of Conservation International to assess the status of primates in the Kakum conservation area. As part of a tourism-development project in the Central Region of Ghana supported by USAID and UNDP, the 212 km² Kakum Forest Reserve was converted into a National Park in 1991, and the adjacent 154 km² Assin Attandanso Forest Reserve became a Game Production Reserve (in 1995 all Ghana's Game Production Reserves were renamed Resource Reserves). From

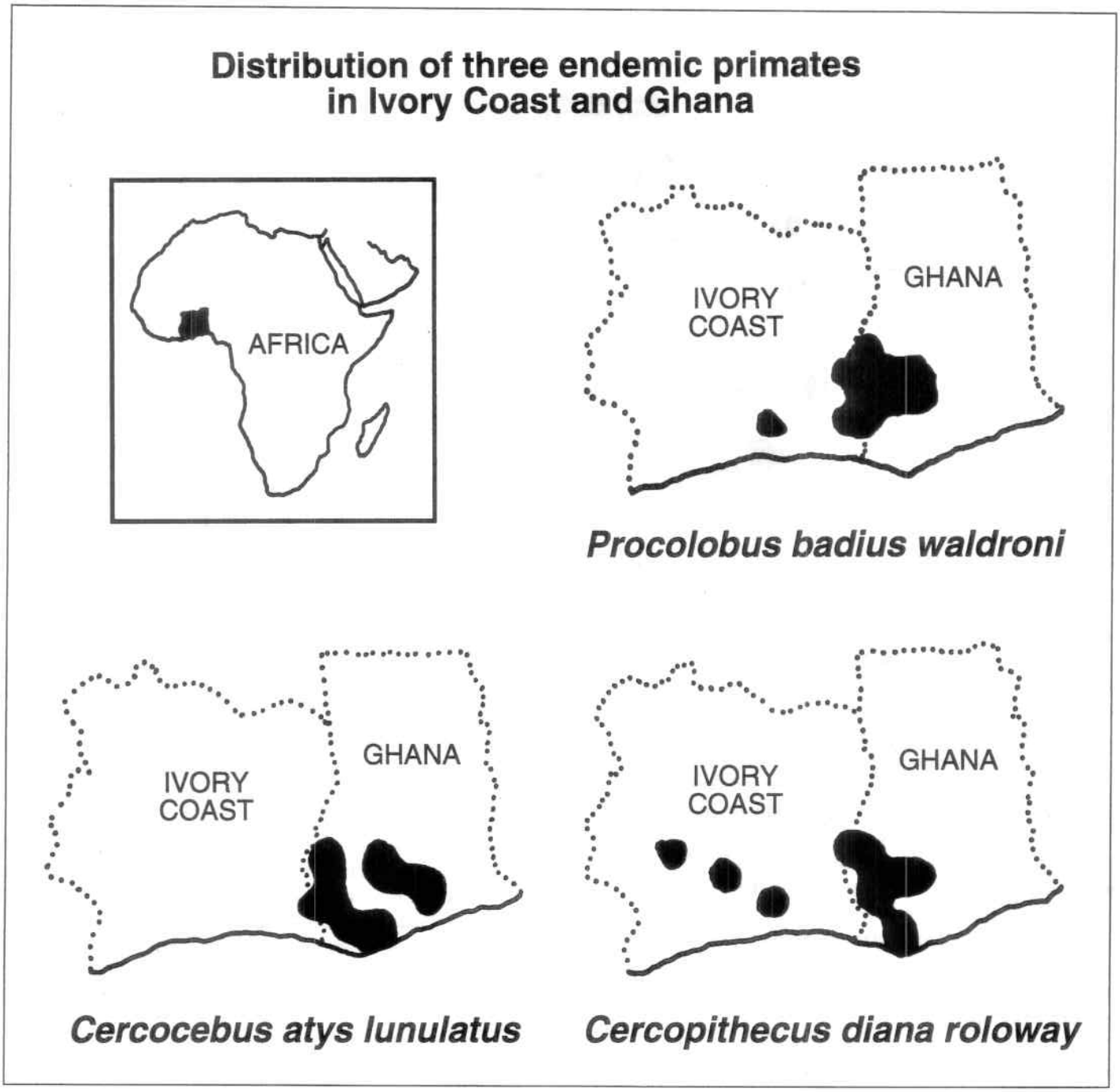

Figure 1. Distribution of three endemic primate subspecies in Ghana and Côte d'Ivoire.

Table 1. Ghana forest sites surveyed for primates, with survey dates and names of surveyors (N.P. = National Park; R.R. = Resource Reserve; F.R. = Forest Reserve; TS = T. Struhsaker; JO = J. Oates; EO = E. Owusu; GW = G. Whitesides; ML = M. Abedi-Lartey; BD = B. Dickinson).

Site	Survey dates	Surveyors
Kakum N.P.& Assin Attandanso R.R.	26 March-9 April 1993	TS, JO & EO
	11-12 & 18-24 August 1993	JO & EO
	17-22 November 1993	TS & EO
Pra Suhien F.R.	6 April 1993	JO & EO
Ankasa R.R. & Nini-Suhien N.P.	13-16 August 1993	JO
	3-7 August 1995	GW & ML
	22 December 1995-4 January 1996	JO & ML
Bia N.P. & Bia R.R.	11-15 November 1993	TS & EO
	23 July 1993	JO & GW
Ayum F.R. & Subim F.R.	17-19 July 1995	JO, GW & BD
Krokosua Hills F.R.	21-22 July 1995	JO, GW & BD
Yoyo F.R.	29-30 July 1995	GW, ML
Boin River F.R.	31 July 1995	GW, ML

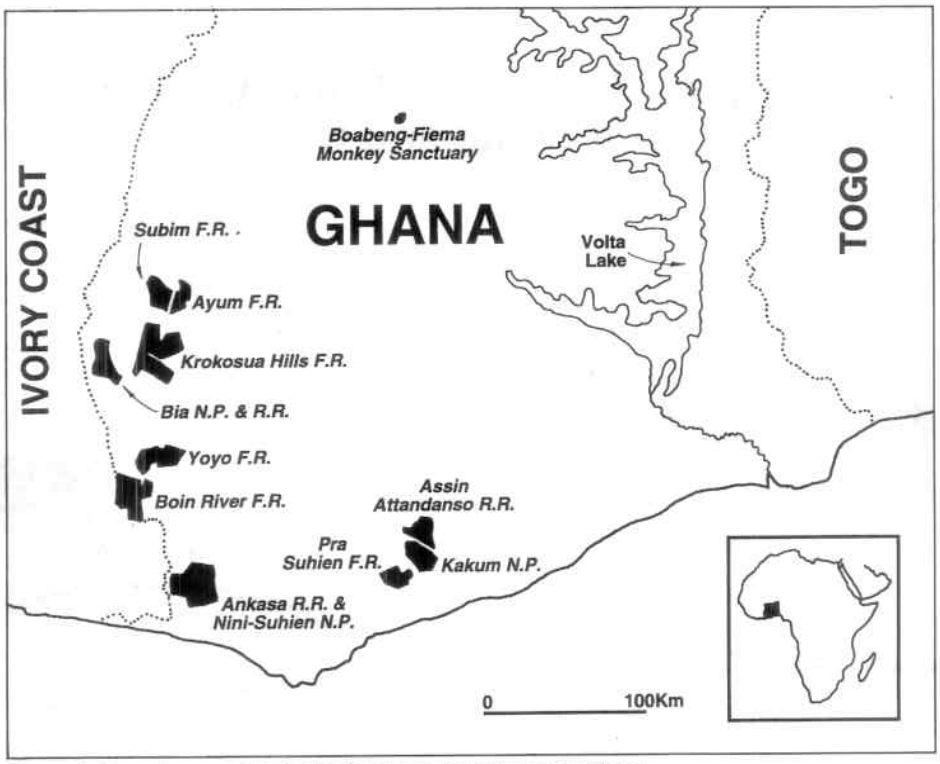

Figure 2. Map of survey sites in the forest zone of southwestern Ghana.

project-planning documents that we had read before making our survey, we were lead to believe that the Kakum forest contained all the primates reported from Bia and Ankasa, with the possible exception of chimpanzees.

Our surveys found firm evidence for only four monkey species and the two prosimians in Kakum. We therefore arranged a series of further surveys, which encompassed Ankasa, Bia, Nini-Suhien and several Forest Reserves in south-western Ghana. These surveys were designed to assess the status of anthropoid primates as a whole, but with special attention to Miss Waldron's red colobus which had long been regarded as Ghana's most threatened primate, and which we now feared might be on the brink of extinction. This paper summarizes the results of our surveys, which have found Ghana's forest anthropoids, and especially the locally endemic subspecies, to be even more seriously threatened than we had suspected.

Methods, Survey Sites and Personnel

We gathered information on the condition of different forests and on the presence and abundance of anthropoid primates both from foot surveys and from questioning people living near and/or working within the forests (e.g., hunters, farmers, and forestry and wildlife personnel). We regarded information obtained from interviews as a source of clues to the status of the primates; our final conclusions on their status relied most heavily on evidence from our own foot surveys.

Foot surveys were of two types. When making initial visits to forests we generally used existing paths (often hunters' trails), boundary lines, or logging roads. We walked these slowly and quietly, looking and listening for sounds of primates, often in the company of a local guide. In two areas, the Kakum and Nini-Suhien National Parks, we also cut 4-km transect lines through the forest understorey, and made repeated walks along these lines at speeds of 1-1.5 km/hr; on these transects, one of us was the primary, lead observer, while a second observer followed quietly at a distance of 25-50 m. If primates were detected, we stopped and noted evidence on whether detection was from calls or sightings, the species and number of individuals present, their distance from the survey route, and their height in the forest canopy (see Whitesides *et al.* 1988).

The sites we surveyed, and our itinerary, are listed in Table 1, and the locations of the reserves visited are shown in Figure 2.

In addition to local guides, participants in our surveys were Erasmus Owusu (Ghana Wildlife Department; Kakum and Bia), Bryan Dickinson (Ghana Association for the Conservation of Nature; Subim, Ayum and Krokosua Hills), and Michael Abedi-Lartey (Ghana Wildife Department; Yoyo, Boin River, Ankasa and Nini-Suhien).

Findings

Habitat Disturbance and Hunting

With the exception of the Bia and Nini-Suhien National Parks, every forest we visited had been subject to varying intensities of selective logging, and some were being logged at the time of our visits. Although no records exist of logging in Bia N. P. or Nini-Suhien N. P. (Hawthorne and Juam Musah 1993), the forest in Bia had a very broken canopy with few large trees and much low, dense vegetation, probably as a result of past cultivation; the poor condition of the forest is the reason why it retained National Park status when the protection status of the remainder of Bia was downgraded to a Game Production Reserve (J. Wong pers. comm.).

In every forest we visited, we found evidence of recent hunting. Hunters were encountered, or shots were heard inside the forest, at Ankasa, Bia, Boin River, Kakum, Nini-Suhien, Subim,

Table 2. Anthropoid primate species seen or heard at different survey sites.

Site	Species Detected
Ayum F.R.	*Cercopithecus campbelli, C. petaurista, Procolobus verus*
Bia N.P. & Bia R.R.	*Cercopithecus campbelli, C. petaurista, Pan troglodytes*
Boin River F.R.	*Cercopithecus campbelli*
Kakum N.P. & Assin Attandanso R.R.	*Cercopithecus campbelli, C. petaurista, Colobus vellerosus, Procolobus verus*
Krokosua Hills F.R.	No anthropoids detected
Nini-Suhien N.P. & Ankasa R.R.	*Cercopithecus campbelli, C. petaurista, C. diana*
Pra Suhien F.R	No anthropoids detected
Subim F.R.	*Cercopithecus campbelli, C. petaurista*
Yoyo F.R.	*Cercopithecus* sp., *Colobus vellerosus*

and Yoyo; at all sites surveyed, we saw spent shotgun shells, piles of spent calcium carbide from acetylene headlamps, traps and/or recently-used hunters' camps. The few monkeys we did encounter fled rapidly on detecting us, a strong indication of hunting pressure. At most villages we visited we easily found hunters who could be interviewed about animals they knew in the forest, and as we traveled around the country we often passed armed hunters walking along the roads.

The links between logging and hunting are clear and obvious. Logging roads make access to the interior of forests easier, and logging crews often employ a hunter to obtain meat for them. But even without logging or logging roads, hunting pressure can be intense, as we witnessed inside the Nini-Suhien N. P.

Wildlife Protection Efforts

Outside the national parks and resource reserves, we encountered no evidence of any measures to protect wildlife. While certain rare mammals are strictly protected under Ghanaian law wherever they occur, little or no effort is made to enforce the law. Several months of the year are a closed season for hunting, but we still saw hunters on the road with guns at these times, and "bushmeat" being sold along the roadside. When asked about this, wildlife staff responded that the hunters can always claim to be shooting crop pests on their farms, which is permitted.

Within the Bia and Ankasa conservation areas we found evidence of rampant hunting, despite the presence of Wildlife Department protection staff. We found the staff in these places to be poorly paid, poorly housed and equipped, and generally poorly motivated. Patrols were said to be made into the forest, but our impression was that these efforts were superficial.

The best protected area we visited was Kakum, where protection efforts had been bolstered through the presence of the CI/USAID conservation project, which had improved the equipment, pay, and motivation of the staff. Although we had evidence of active poaching in the center of Kakum (e.g., shots heard in November 1993, and recent hunting camps seen), more patrolling was occurring and poachers were arrested occasionally.

Presence or Absence of Species

Table 2 shows which anthropoid primates were detected at each of our survey sites. Two small guenons, Campbell's and spot-nosed, were detected at most sites; the olive colobus and black-and-white colobus were each detected at two sites; the Diana guenon was detected at only one site (Ankasa/Nini-Suhien); and the chimpanzee was also detected at only one site (one distant vocalization heard at Bia). No direct evidence for the presence of mangabeys or red colobus was obtained at any site.

With the exception of the Diana guenon and chimpanzee, all the species we detected are relatively resilient to both logging and hunting; they do well in secondary growth, and often hide from hunters in thick undergrowth or vine tangles (Martin 1991).

Abundance of Species

Table 3 presents data on the rates at which monkeys were encountered within 50 m of a census route in the three forest conservation areas nominally under the protection of the Wildlife Department; these data are from slow censuses where the distance traveled was measured or closely estimated. Our data are compared with similar information collected in the 1970s at Bia and Ankasa (Martin 1976; Martin and Asibey 1979). The data are roughly but not exactly comparable; our data include monkeys distinctly heard near the census path, but not seen; the data of Martin (1976) and Martin and Asibey (1979) refer only to monkeys seen, with the exception of red colobus in Ankasa (reported

Table 3. Encounter rates with anthropoid primates (number of groups detected for each km censused) in three Ghanaian conservation areas, Kakum, Ankasa and Bia. Our data from 1993-96 are compared with similar information collected at Ankasa in 1976 (Martin 1976) and at Bia in 1977-78 (Martin and Asibey 1979). Figures do not include sounds of possible monkeys jumping in the canopy, or distant vocalizations.

Site (surveyor)	Distance censused (km)	Species and encounter rate (see key)								
		C. cam	*C. pet*	*C. dia*	*C. sp*	*Cb.atys*	*Co. vel*	*P. bad*	*P. ver*	Total
Kakum, Antikwaa (JO)	12	0.50	0.42	0	0.17	0	0	0	0.17	1.26
Kakum, Obuo River (JO)	16	0.25	0.31	0	0.25	0	0	0	0.19	1.00
Kakum, Obuo River (TS)	16	0.19	0.50	0	-	0	0	0	0.06	0.75
Bia N.P. + R.R (TS)	22	0.07	0.14	0	0.05	0	0	0	0	0.26
Bia N.P. (Martin & staff)	123	-	-	0.18	0.39	0.02	0.29	0.01	0.06	1.04
Bia G.P.R. (Martin & staff)	662*	-	-	0.14	0.35	0.02	0.16	0.02	0.07	0.76
Ankasa + Nini-Suhien (JO)	24	0.04	0.04	0.04	-	0	0	0	0	0.12
Ankasa (Martin)	35**	0.09	0.03	0.20	-	0.06	0.09	0.03	0	0.50

Key: *C. cam., Cercopithecus campbelli*; *C. pet., Cercopithecus petaurista; C. dia, Cercopithecus diana*; *C.* sp., small *Cercopithecus* species, almost certainly *C. campbelli* or *C. petaurista* - reported by Martin & Asibey (1979) as "mona and/or spot nosed monkey"; *Cb. atys, Cercocebus atys; Co. vel., Colobus vellerosus; P. bad., Procolobus badius; P. ver., Procolobus verus.*

* The figures reported here are the average rates from three different transects in Bia Game Production Reserve.

** Martin reported encounters as "frequency of observation per hour" from 14.5 hours of surveys; those data have been converted to encounters per km using the average walking speed of 2.4 km/hr reported in Martin & Asibey (1979). Encounter rates would obviously be higher if the walking speed was slower.

on the basis of vocalizations); and the census speed used by Martin and Asibey was faster than ours (reported as 2.4 km/hr by Martin and Asibey 1979).

These data on encounter frequencies highlight a number of points. We encountered monkeys in Bia and Ankasa at about 25% of the frequency with which they were encountered in the 1970s. We encountered monkeys more frequently at Kakum than in other Ghanaian forests (although the number of species was low, and the monkeys present were secondary forest species). Monkey densities at Kakum seem similar to those in Bia in the late 1970s, but Bia then had a full complement of forest species. In the late 1970s, Bia was the best protected forest area in Ghana, but at the time of our surveys Kakum was the only area receiving a serious protection effort. Despite the relatively high rates of encounter at Kakum (0.75-1.26 monkey groups/km) compared with other Ghanaian sites, these rates are still lower than in several other well-protected sites at which we have worked in Africa. In the Kibale Forest of Uganda, TTS sighted 2.08 monkey groups/km in mature unlogged forest, and 2.01 groups/km in heavily logged forest (Struhsaker 1975); at Tiwai Island in Sierra Leone, GHW sighted 2.08 groups/km in a mosaic habitat that was predominantly old secondary forest (Whitesides *et al.* 1988). The encounter rate with small guenons in Kakum is comparable to that in other forests (Tiwai: *Cercopithecus campbelli* + *C. petaurista*, 0.68 groups/km; Kibale logged forest: *Cercopithecus ascanius* + *C. mitis*, 0.66 groups/km); the total encounter rate is lower at Kakum because of the scarcity or absence of other species.

We detected very few monkeys in the six Forest Reserves we surveyed, and on several censuses in these forests we detected no monkeys of any kind.

Conclusions

With the exception of the spot-nosed and Campbell's guenon, and possibly the olive colobus, the forest monkeys of Ghana and the chimpanzee are under very serious threat. We will briefly discuss the status of each of the threatened species, based on our findings.

The white-thighed black-and-white colobus monkey (*Colobus vellerosus*) is hanging on in small numbers in a few forests. Its large size and attractive coat make it an obvious target for hunters, and the loud call of adult males can reveal the position of a group. However, this species is tolerant of habitat disturbance, and small groups can hide quite well in vine tangles. Kakum could support a viable population of this species if protection continues to be effective. The black-and-white colobus is also present at the Boabeng-Fiema Monkey Sanctuary, north of the forest zone, where this species and Campbell's guenon are traditionally protected (Fargey 1992); however, the Boabeng-Fiema sanctuary is small and totally isolated.

The Roloway guenon (*Cercopithecus diana roloway*) is only definitely still present in Ankasa/Nini-Suhien, where it is rare and almost certainly heavily hunted. Hunters and wildlife staff reported its presence in many others forests, including Kakum, but we neither saw nor heard this species (which has a very distinctive adult male loud call) anywhere but Ankasa. Under questioning, most hunters who reported the presence of this species said they had not seen it for some months or years. Although the Roloway population density is low in Ankasa, the species was historically relatively abundant here (Martin 1976, and see Table 3); the population would probably rebound to a viable size under effective protection.

We met no signs of white-naped mangabeys (*Cercocebus atys lunulatus*) in the field, but we saw a small captive group in the Kumasi Zoo, and all or most of the members of this group were apparently captured in the wild. These largely terrestrial monkeys are easy to hunt, but they can also use secondary forest and farmland outside reserves (Booth 1956). Based on hunters' reports, our guess is that this species is still present in several areas, but in very low numbers.

The chimpanzee (*Pan troglodytes verus*) is probably in a similar position to the mangabey, with the Bia area perhaps retaining the largest numbers (Bia is the only locality where a chimpanzee call was heard, and here TTS also saw a young captive animal in the possession of wildlife staff, said to have been confiscated from a hunter). We saw no chimpanzee nests at any site.

Miss Waldron's red colobus (*Procolobus badius waldroni*) is possibly now extinct in Ghana. As in other parts of Africa, this species is the easiest forest primate to hunt. The monkeys are large, brightly-colored, and noisy; they typically move in large social groups in the upper canopy and do not hide in the undergrowth or vine tangles. If they are present at a site they are hard to miss, but we found no sign of them anywhere, and no hunter's report of their current presence was convincing (the hunters giving the most accurate descriptions also reported not having seen the animals for a long time). Even in the 1970s, Bia seems to have been the only forest in Ghana where red colobus could be reliably seen, but Bia has had little effective protection from hunting since around 1980. A game guard who escorted JO and GW into Bia National Park in July 1995 reported that the only monkeys he had seen while stationed there for three years was a mixed group of Campbell's and spot-nosed guenons near the Kumkumso ranger station and visitor center.

Recommendations

Further Surveys

Our surveys of Forest Reserves in southwestern Ghana, as opposed to National Parks and Resource Reserves, so far have been superficial. Further surveys are needed to get a clearer picture of the status of the rarer forest primates. These surveys should devote more time to some reserves which as yet we have visited only briefly (such as Boin River), and they should examine some reserves we have not yet visited at all (such as Boi Tano and Cape Three Points). Recommendations for urgent conservation measures should be made if further surveys find any viable populations of the two monkeys that we have not encountered so far, the red colobus and mangabey.

In addition, surveys are needed in central and eastern Côte d'Ivoire, which shares its primate fauna (including the three locally-endemic monkeys) with western Ghana. Forest destruction and hunting appear to have been as intense, or more so, in Côte d'Ivoire as in Ghana, but surveys on the ground are still needed. Such a survey, to be conducted by Scott McGraw, is being planned

as this is written.

Improved Conservation in Existing Parks and Resource Reserves

Of Ghana's three forest conservation areas (Ankasa, Bia and Kakum), the vegetation at Ankasa is the least disturbed, and the only one in which we have so far encountered any of the primate endemics: the Roloway guenon. If given better protection, Ankasa almost certainly would support a viable population of this monkey. Further surveys in Ankasa are also needed, in an effort to locate primates which we did not see, but which hunters have suggested are still present: black-and-white colobus, mangabeys, and chimpanzees. The Bia forest is heavily degraded and being actively logged; even if it were given better protection, it may be too late to save any populations of the endemic monkeys in Bia, but a protection effort focused on chimpanzees might have some value for that species (although the numbers protected would be very small). Kakum now has relatively good protection, and it is an accessible forest where ecotourism is being developed. Although no viable populations of the endemic monkeys appear to survive at Kakum, it might be considered in the long run as a secondary Roloway guenon conservation area, if a reintroduction or translocation program could be implemented.

To make primate protection more effective and durable in these conservation areas, we recommend staff incentives and trust funds. Following recommendations made after our 1993 surveys, an incentive system was put in place at Kakum under which bonuses were paid to protection staff making arrests leading to convictions. This is said to have further improved protection in this forest (B. Asamoah-Boateng, pers. comm. 1996), although we have not been able to verify this directly. In the wake of our 1995 and 1996 reports to the Wildlife Department, extra staff have also been posted to Ankasa, new patrol bases established, and patrols leading to the arrest of poachers made deep into the conservation area (M. Abedi-Lartey, pers. comm., 1996). However, a bonus system is not yet in place at Ankasa.

Given the reluctance of governments in countries like Ghana to make large financial commitments to conservation, and given the impermanence of foreign-assistance projects, we recommend the establishment of conservation trust funds for sites such as Ankasa and Kakum. These funds would be established by donations from overseas sources, invested internationally, and managed by a board made up both national and foreign members. The trust funds should be sufficiently large that the annual income from the investments would pay for much of the basic protection of the conservation areas, including the payment of staff bonuses. Efforts are already being made by Conservation International to establish such a trust for Kakum, with initial funding from USAID.

Need for a Red Colobus Action Plan

Although some of the further survey work we have planned or suggested may locate a viable population of Miss Waldron's red colobus monkey, on present evidence we are not optimistic that a population will be found. This may be the first documented case of a distinct African primate taxon having becoming extinct in this century. The extinction of this monkey may have occurred less than 60 years after it was originally described (Hayman 1936), based on a type specimen collected by Willoughby P. Lowe in the western Ghana on Christmas Eve 1933 (the subspecies was named after Lowe's companion on his collecting trip).

The plight of this red colobus highlights the threats facing red colobus more generally. Between 14 and 17 allopatric forms of red colobus have been recognized and given at least subspecific status, and some of them should probably be regarded as distinct species (Oates *et al.* 1994). In the recently published revised edition of the *IUCN Conservation Action Plan for African Primates*, most forms of red colobus are listed as of conservation concern, and ten are among the most threatened of African primate subspecies (Oates 1996). In addition to *Procolobus badius waldroni*, these are *P. b. epieni* (a recently-discovered form in the Niger Delta), *P. b. preussi* on the Cameroon-Nigeria border, *P. b. pennantii* of Bioko, *P. b. bouvieri* of the Congo, *P. b. semlikiensis* of eastern Zaire and the Bwamba Forest of Uganda, *P. b. tephrosceles* of western Uganda and western Tanzania, *P. b. rufomitratus* of the Tana River (Kenya), *P. b. gordonorum* of the Udzungwa Mountains (Tanzania), and *P. b. kirkii* of Zanzibar.

In the last ten years, very little attention has been given to the plight of these red colobus (especially in comparison with the African apes), and some now appear to be approaching extinction. Research is badly needed on the genetics and phylogenetics of the red colobus to allow us to make more confident statements on the patterns of diversity in the group. A concerted effort should be launched to protect the populations that remain, before they slide into oblivion. This effort should include the raising of awareness both within and beyond the primatological community about the significant loss of biodiversity that may be occurring. Almost all the endangered forms of red colobus share their habitat with other threatened primates, and action aimed at red colobus conservation will help them too.

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Note Added in Proof

In April 1997, after this paper was written, Michael Abedi-Lartey observed Diana monkeys and white-naped mangabeys in the vicinity of the Draw River Forest Reserve, immediately east of Ankasa (M. Abedi-Lartey, pers. comm.).

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The Mountain Gorilla: Conserving an Endangered Primate in Conditions of Extreme Political Instability

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Introduction

In her book *Gorillas in the Mist* (1983), Dian Fossey worried that the mountain gorilla would become one of "the seven or so rare species both discovered and extinct within the same century". At the time of her writing, Fossey considered human encroachment on gorilla habitat the single greatest threat to their survival (Fig. 1). While the intervening years have witnessed multifaceted, concerted conservation action on the part of governments of the mountain gorilla's range states and non-government conservation organizations, human population pressure on gorilla habitat, coupled with regional political upheaval, still presents the most serious threat to the mountain gorilla's survival into the 21st century.

The purpose of this paper is to provide an overview of the major conservation problems and potential solutions concerning the mountain gorilla. We concentrate on the Virunga Volcano area of Central East Africa (Fig. 2), as civil war in this region has brought the needs of gorillas and humans into stark, sometimes deadly confrontation, presenting formidable challenges both to politicians and conservationists. Our presentation is organized into three sections. We begin with a brief description of mountain gorillas and their distribution. Next, we review the mountain gorilla's conservation status in the light of population/demographic data and threats from human encroachment on park lands, poaching, and military activity. In the final section, we discuss the potential efficacy of both short and long-term conservation programs.

Description and Distribution

The mountain gorilla, *Gorilla gorilla beringei*, is one of three subspecies of gorilla, with a total population size of about 650, divided nearly equally between two geographically separated populations: One in the Virunga Volcanoes region of Central-East Africa, the other in the Bwindi-Impenetrable Forest National Park of Uganda (Fig. 2). Mountain gorillas are large, herbivorous primates that live in bisexual groups of 10 to 20 individuals, usually containing one silverback male, though groups with two or more silverbacks are not uncommon (Stewart and Harcourt 1986). Groups with more than one silverback can get quite large, numbering as many as 38 individuals (Karisoke Research Center records), but groups of that size are less cohesive and likely to split into two groups (pers. obs.).

In the Virunga Volcanoes region, mountain gorilla distribution is restricted to three national parks bordering three different na-

Figure 1. Dian Fossey observing mountain gorillas. (Photo courtesy of The Dian Fossey Gorilla Fund International).

tions: the Parc National des Virunga of the (newly formed) Democratic Republic of Congo (formerly Zaire, hereafter Zaire/DRC), the Parc National des Volcans (PNV) of Rwanda, and the Mgahinga Gorilla National Park of Uganda (see Fig. 2). Collectively, this 447 km² national parks area is commonly referred to as the Virunga Conservation Area. Virtually everything we know about mountain gorilla behavior and ecology comes from research conducted in the Rwanda and Zaire/DRC portions of this area, where the majority of the Virunga gorillas range. Research on mountain gorillas began with the work of Schaller in 1960 and later Fossey, who in 1967 established the Karisoke Research Center in Rwanda's PNV.

The Virunga Volcanoes population is separated by about 30 km of cultivated lands from the population in the 330 km² Bwindi-Impenetrable Forest National Park to the north in Uganda. The Bwindi and Virunga populations probably became separated only a few hundred years ago through the clearing of intervening forest, a prominent reason why researchers have long suspected both to be mountain gorillas, and comparative study of mitochondrial DNA lends strong support to this classification (Garner and Ryder 1996). A recent study, however, indicates that the Bwindi gorillas are morphologically, ecologically, and behaviorally distinct from their Virunga neighbors, and suggests that they should not be classified as mountain gorillas (Sarmiento *et al.* 1995, 1996) (see Fig. 3). Despite the mitochondrial work, the study of Sarmiento *et al.* suggests that some genetic differentiation between the two populations has occurred, and that it is the result of selection for morphological and behavioral adaptations to different ecologies. If so, then interbreeding between the Virunga and Bwindi populations could result in offspring that are maladapted to either habitat, a phenomenon known as outbreeding depression (Pusey and Wolf 1996). Further genetic, morphological, and ecological comparisons between the Virunga and Bwindi populations are needed to help assess fully the conservation implications. If our eventual aim is to preserve the full variety of East African gorillas, then we must be prepared to accept that the world's population of mountain gorillas consists of the estimated 324 remaining in the Virunga Conservation Area (Sholley 1990).

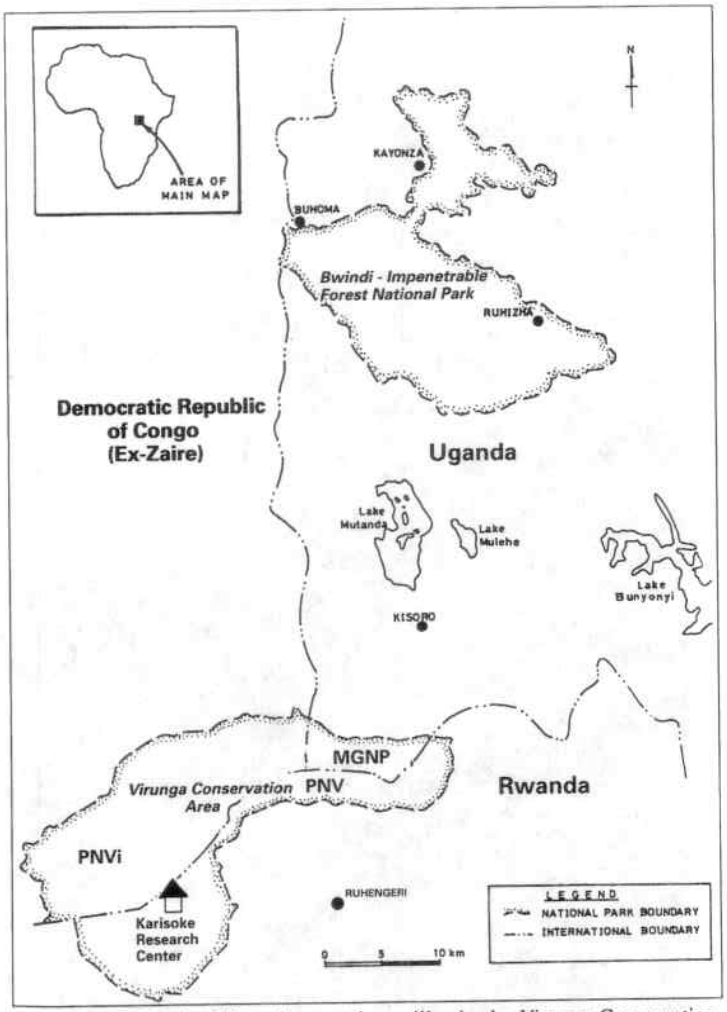

Figure 2. Present location of mountain gorillas in the Virunga Conservation Area and Bwindi-Impenetrable Forest. (Adapted from Sarmiento *et al.* 1996, reproduced with permission from Wiley-Liss, Inc., New York.)

Current Status

Population Size

Whether or not we include the Bwindi population in a count of mountain gorillas, it remains that their total population size is sufficiently small to be classified as "endangered" by IUCN criteria. The Virunga population has been periodically censused since the 1960s. As can be seen in Figure 4, population size reached its lowest point in 1981 and began to increase thereafter. Despite the fluctuation in total number, percent of immatures has remained relatively stable; between 40 and 50%. Although there has been no census since 1989, preliminary results of demographic modeling, using maximum likelihood methods to fit survivorship and fecundity curves to gorilla data from 169 individual records of birth date and death date/last seen estimates (Karisoke Research Center records 1967-1994), indicate that at least the gorilla population that is regularly monitored and probably best protected in the western, Karisoke sector of the Virungas is growing (Pacala *et al.* in prep.). A new census is urgently needed to confirm these results and to determine whether this apparent population growth in the western sector is representative of the population throughout the Virungas.

Habitat Loss

Harcourt (1996) has argued convincingly that although the Virunga gorilla population is small, its viability or persistence for at

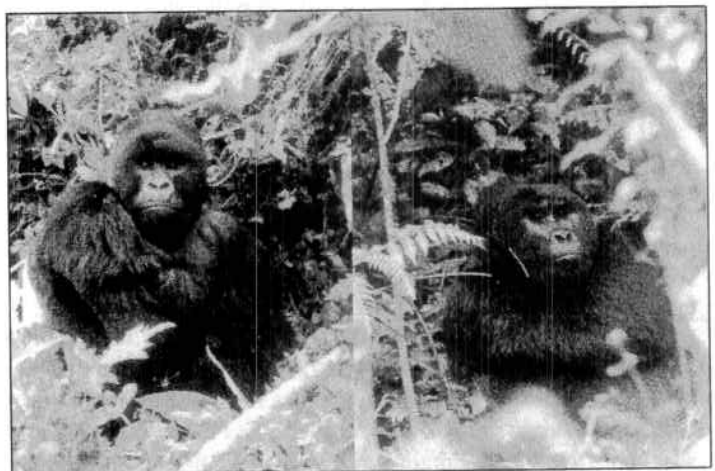

Figure 3. Comparison of Virunga (left) and Bwindi-Impenetrable gorillas. To many observers, the shape of the head and face appear different. (Photo of Bwindi gorilla courtesy of Jane Dewar.)

least several hundred years is not compromised by internal stochastic effects, such as loss of genetic heterozygosity through inbreeding. A far greater threat to the persistence of this population, Harcourt argues, is posed by external influences, especially habitat loss due to increases in human population density outside the conservation area. Destruction of gorilla habitat, he projects, will lead to gorilla extinction long before adverse demographic or genetic effects of small population size are felt. By examining the relationship between human density and rate of forest destruction in African countries, and projecting into the future current rates of population increase in the three countries comprising the Virunga conservation area, Harcourt arrives at the bleak conclusion that the Virunga gorillas will be extinct in well under 100 years. The worst scenario holds for Rwanda, where gorilla habitat should disappear in less than 25 years if present trends continue.

Indeed, the greatest loss of mountain gorilla habitat has occurred in Rwanda, where, between 1968 and 1970, 100 km² of reserve was replaced by pyrethrum cultivation, reducing by nearly one-half the size of the PNV (Harcourt and Fossey 1981). This World Bank financed venture was to yield great economic gain from international demand for the natural insecticide. No such gains were realized, and much of the land intended for pyrethrum has been turned over to the local population for agriculture.

Rwanda is the most densely populated African country, with some 95% of its population dependent on farming for its livelihood. Add to this an annual birth rate of 3-4%, and it becomes easy to see why there is such enormous, continual pressure for arable land, and why, if these trends continue, the future outlook for preserving gorilla habitat in the Virunga region is bleak (Harcourt 1996).

The outbreak of civil war in Rwanda in 1990, and the ensuing refugee crisis in the Virunga region, unfortunately has only intensified the effects of population growth on habitat loss. The 1994 settlement of over half a million Rwandan refugees inside the Parc National des Virunga on the Zaire/DRC side of the Virunga Volcanoes, resulted in significant destruction of bamboo, an important gorilla food, and massive deforestation for wood fuel (as much as 350 tons/day in January 1996; Michel Leusch, UNHCR, pers. comm.). Fortunately, from the standpoint of habitat protection, in late 1996, the rebel alliance movement in (at that time) Zaire ended the deforestation in the Park, of the Virungas by precipitously emptying the refugee camps and repatriating to Rwanda most of the refugees.

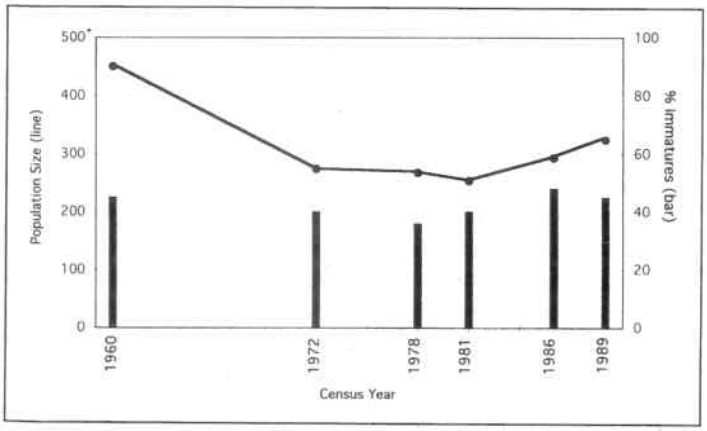

Figure 4. Virunga gorilla population size and composition from censuses conducted between 1960 and 1989. (After Harcourt 1995).

In Rwanda, however, this swell of returnees, in addition to the several million cattle herders who had originally fled Rwanda during the 1959-1960 civil war, continues to place enormous pressure on Rwandan authorities to find suitable land for them and their cattle. For the agriculturalists, the north of Rwanda is particularly attractive with its rich volcanic soils, while many of the returning cattle herders identify politically with the Virunga region. As a result, both farmers and cattle herders seek to repatriate in the same small northern corner of Rwanda, placing unprecedented pressure on the PNV. Not unexpectedly, infiltration of park lands by cattle resulting in degradation of gorilla habitat, a serious problem in Fossey's time, has emerged once again as a threat to gorilla habitat in the PNV and to wildlife elsewhere. In the latter regard, Rwanda's Akagera National Park has suffered the most: The Park and adjacent hunting preserve, once a savanna wildlife home to giraffe, elephant, zebra, kob, lion, and baboons, and a source of income for Rwanda from tourists and hunters, has become home to some 700,000 head of cattle and their herders.

Military operations, particularly along the Ugandan border of the Virungas, have also resulted in gorilla habitat loss. Unbeknownst to the conservation community, large swaths of PNV land were cleared by Rwandan military in 1992/1993 in the eastern sector of the PNV, apparently to better control rebel infiltrations from the Ugandan border. After 1994, these cleared lands were converted covertly by resettled refugees and local residents for agriculture. The clearance and settlement of this eastern portion of the PNV proceeded covertly because prior to 1996 non-military personnel were forbidden to enter this sector, and because it was the last to be cleared of land mines. While the current Rwandan government has taken steps to reclaim these PNV lands, compliance has been difficult to enforce and monitor due to the continuing security problems in the country's north.

Poaching

An increase in poaching, of both gorillas and antelope, is a likely additional consequence of the Virunga region's political instability, insofar as systematic anti-poaching patrols by park rangers have been seriously hindered by military activity inside the Virunga Conservation Area. For the first time since the 1980s, gorillas have been killed intentionally in the Virungas. In July-August of 1995, three gorillas were shot dead in Zaire/DRC Virunga Park, and a fourth was found dead there. In addition, an infant was taken, indicating that abduction of immatures for the black market was the motive for the killings. This seems to have been the motive as well behind the spearing to death of four gorillas just a few months earlier in the Bwindi-Impenetrable Forest National Park, for a total of eight dead adults in 1995 alone. We may assume, though we have no proof, that political instability creates a regional climate favorable to black market transactions.

Poaching of ungulates also presents a significant threat to mountain gorillas since their hands or feet can get caught in the poacher's snare, which may result in the loss of a limb or the gorilla's life. Since 1994, large portions of the western sector near the Rwanda-Zaire/DRC border have not been patrolled by Park rangers from Zaire/DRC nor Rwanda for fear of hostile confrontations with ex-Rwandan military who continue to seek refuge in the Virunga Conservation Area. Further, because Rwandan Park rangers now must

patrol the forest unarmed (prior to 1994 they carried firearms), they are understandably less willing to patrol areas near the international border where they may encounter well-armed poachers.

We do know that ungulate poaching (primarily African buffalo and bushbuck) has increased since the onset of the civil war in October 1990 in areas of the Virungas that are still regularly patrolled. Records of the number of snares recovered by rangers and the associated increases in the number of gorillas caught in them show the rise in poaching activity (Fig. 5). Increased poaching is probably due to the need for protein by a war-ravaged population and the perception that in times of political instability there is a lower chance of apprehension or prosecution.

Apart from its direct impact on gorillas, the civil war-related increase in poaching also raises the question of the cost to the ungulate population and thus to the Virunga region's overall biodiversity. Preliminary census work in 1996 in the Karisoke sector of the PNV, when compared to ungulate censuses conducted in 1988 and 1989, shows that the populations of black-fronted duiker have increased significantly since 1989, while populations of bushbuck and buffalo have not changed (Plumptre and Bizumuremyi 1996). These results, however, are inconclusive regarding the impact of poaching in the Virunga Conservation Area, in that, for security reasons, only the Karisoke sector could be sampled. As the investigators themselves suspect, the lack of negative impact and actual increase of duiker in this relatively well-patrolled sector may reflect the influx of duiker from less well-patrolled areas. Further censuses of the entire PNV are planned to evaluate more fully the impact of poaching on the ungulate population.

War and Disease

The regular presence of large numbers of soldiers, and actual fighting inside the Virunga Conservation Area, also raises fears about gorillas getting caught in the crossfire. Since 1991 there have been rumors of gorillas killed by landmines placed inside the PNV, but none were ever confirmed. To date, there have been five confirmed killings by military action. The first occurred in May 1992, when the only silverback of tourist group 13 in the PNV was accidentally killed by soldiers' gunfire in the early morning hours. Four more were shot dead in May 1997 in Zaire/DRC's Virunga Park, apparently during a gunfight between the rebel liberation forces and former Rwandan military and Interahamwe

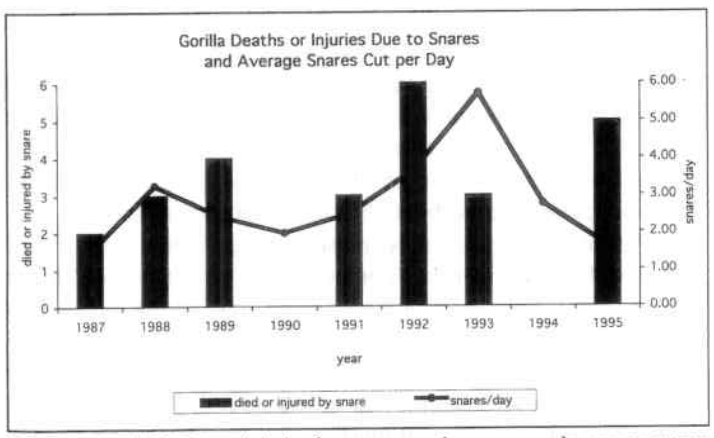

Figure 5. Gorilla deaths or injuries from snares and average number snares cut per day in the patrolled Karisoke sector of the Virunga Volcanoes. No data were available for 1990 and 1994 due to the outbreak of civil war.

(genocidists) still active in the Mikeno sector of the Virungas. This brings the total to 13 adults killed, or 4% of the Virunga gorilla population, as a direct or indirect cause of civil unrest in the region. Moreover, the death of the group's only silverback male (as occurred in the 1992, 1995, and 1997 shootings) may lead to disbandment of the group and death or injury of unprotected females and their infants. This cascade of events, with its transgenerational effects, following the death of a silverback may thus further increase mortality in the population. Urgently needed ground surveys and censuses in the Virunga Conservation Area, while giving us some rough idea of the war's impact on this population, will not likely determine the final toll due to landmines or shootings.

Finally, there is reason to be concerned about disease risks posed to the gorillas by increased contact with humans and their residue. In the first half of 1997, for example, human food remains, feces, and corpses have turned up with alarming frequency in the Karisoke sector (Karisoke Research Center records), serving as potential sources of disease transmission to an immunologically naive gorilla population. Examination of PNV gorilla feces, for example, recently revealed two new parasites also found in humans, suggesting human fecal transmission (Mountain Gorilla Veterinary Project News Service, Summer 1997). The suspected measles outbreak in the PNV gorilla population of 1988, which left six female gorillas dead in its wake before mass vaccination stemmed the spread of the disease (Hastings *et al.* 1988), stands as a clear warning of the deadly potential of human disease transmission for this small population.

Current and Future Conservation Activities

What can be done, both short and long-term, to address the problems we have described for the Virunga Conservation Area?

Civil war in the Virunga region has brought this small subpopulation of mountain gorillas to a crisis point. Never before have gorillas faced the combined onslaught from soldiers, poachers, farmers and cattle herders. More than ever, this situation demands that conservation organizations join forces in working with governments of the gorilla range states to present a united front of support and advice and to put in place well-coordinated action plans. There is also a growing opportunity for conservation organizations to enhance their strength and effectiveness by entering into partnerships with zoological societies that have become increasingly interested in the support of *in situ* wildlife conservation programs (Koontz 1997). At the same time, different organizations have particular strengths and expertise each can bring to bear on the problems at hand.

Gorilla Protection

The recent resurgence of killing of gorillas by poachers and soldiers is particularly alarming and requires immediate action. In Rwanda, following the shooting of the Zaire/DRC gorillas in 1995, the Dian Fossey Gorilla Fund International increased its patrols through the PNV, and increased direct protection of the Karisoke study groups. In Zaire/DRC, the DFGF-Europe joined forces with the International Gorilla Conservation Program (IGCP) in providing radio communications equipment for park staff, while the IGCP funded 24-hour patrols of all habituated groups in the Virunga Park

and outfitted Park guards with bullet-proof vests, should they meet poachers armed with AK-47s.

Unfortunately, these protective efforts were cut short by the late 1996 outbreak of civil war in eastern (then) Zaire. Subsequent fighting in the Virunga Park forced park rangers out, while armed infiltrators, crossing the border from Zaire/DRC to Rwanda through the forest, in response have brought large numbers of Rwandan army into the PNV and severely curtailed PNV ranger patrols. As a result of this political development, the mountain gorillas have been less protected than ever before. It is a geopolitical accident that the mountain gorillas' habitat straddles this volatile border region, and until peace is restored the Virunga gorillas' lives will hang in the balance. In this dire circumstance, in-country conservation organization representatives are virtually impotent; they are often forced to become frustrated witnesses to tragedy and the undoing of all their past efforts. One hope is that political lobbying at the national level in the NGO home countries may lead to greater international participation in brokering a lasting peace and a swift end to fighting in the Virunga region.

Park Service Support and Tourism

In the meantime, we must do all we can to help rebuild the infrastructure of the Park service in Rwanda and in the newly formed Zaire/DRC, so that as soon as conditions allow, Park rangers can resume their protection efforts. In Rwanda, both the DFGF International and IGCP, for example, have financed the rebuilding of the PNV headquarters in Kinigi, where tourists are received and Park employees are lodged. In addition, the IGCP has provided management, equipment, and salary support for the Rwandan park service.

These efforts will also help to restimulate gorilla tourism, which to most local governments provides the strongest, most defensible rationale for protecting and preserving the remaining gorilla habitat. Begun in 1979 in Rwanda, ten years later gorilla tourism generated approximately $1,000,000 in revenue from some 7,000 annual visitors (Weber 1993). After 1991, tourism fell to an all-time low, and at the time of writing this has been suspended in the PNV altogether. There is little question that when security is restored in the Virunga region, gorilla tourism will again return to pre-1991 levels. Some Rwandan government officials forecast even greater demand than ever before, with Rwanda absorbing the "overflow" from Bwindi-Impenetrable Forest National Park gorilla tourism.

The potential for unprecedented levels of gorilla tourism in Rwanda, while positive from the standpoint of economic gain, also has a potential downside. It has, for example, rekindled the desire on the part of some Rwandan government officials to make available for gorilla viewing as much of the Virunga gorilla population as possible, including the Karisoke Research Center research groups. Since Fossey's time, these groups have been set aside for scientific research. Unfortunately, this economically driven strategy can run counter to gorilla conservation efforts. For one, an estimated two-thirds of the total Virunga gorilla population is already well habituated to humans and visited regularly, and thus, despite the normal precautions taken, potentially exposed to human pathogens. Habituation of additional gorilla groups for tourism would further shrink the reservoir of unhabituated (relatively unexposed) gorillas to a point where the population may not be able to recover in the event of a human induced disease epidemic.

It is also questionable whether tourism and research can be mixed without seriously jeopardizing a world-renowned research program. Not only has the research conducted at Karisoke contributed enormously to our fundamental understanding of gorilla biology and behavior, and has guided our conservation efforts, but it has also stimulated wide public awareness and interest in the gorilla, and hence indirectly contributed to revenue from tourism, film crews, and, of course, researchers themselves. Moreover, the scientific programs and tradition established at Karisoke have benefited several generations of Rwandan biologists, mostly from the National University at Butare, who trained and studied at Karisoke under the direction of expatriate scientists.

Unfortunately, Karisoke's research program and its links to the National University were disrupted in early 1993, when the Rwandan Patriotic Front (which a year later toppled President Habyarimana's regime) occupied much of the PNV, and all Karisoke personnel were evacuated. Karisoke was subsequently looted and all buildings destroyed, requiring the relocation of the Center's operation to the nearby town of Ruhengeri. The National University was all but destroyed in the 1994 war, having lost nearly 80% of its faculty and the majority of its educational supplies and equipment. Although it will take time to rebuild the University and the Karisoke Research Center, the DFGF International is a major contributor to the rebuilding of the University in the hope that it will again serve as the wellspring for future generations of Rwandan scientists and conservationists. In the long-term, this partnership should prove the value of scientific research, both for economics and conservation, and place tourism and research on the same national agenda.

Virunga Geographic Information System

One avenue along which research and technology can be highlighted as particularly powerful tools for conservation of gorilla habitat is the development of a Virunga-wide Geographic Information System (GIS). Our initial interest in developing the GIS, was spurned by the alarming rate of habitat destruction by refugees in the Virunga Park. We wanted a means for monitoring and quantifying the refugee impact, and ultimately for assessing the amount of gorilla habitat remaining in the Virunga Conservation Area.

One of the chief difficulties of studying the Virunga Volcano habitat as a single entity has been the division of this region into three national parks in three different countries. For example, our initial attempts to provide a single map for the entire area were frustrated by either the unavailability of topographic maps (e.g., Zaire) or inconsistencies/contradictions presented at national border zones (e.g., Rwanda and Uganda). In addition, there were differences in national languages and land-use classifications.

The application of GIS tools, such as remote sensing, and regional classification analyses, overcomes these and other problems. For the first time, we can treat the three national parks comprising the Virunga Conservation Area as a single afromontane habitat. In addition, use of GIS will enable us to monitor the entire region over time, by periodic satellite imaging, ground-truthing and censuses.

The GIS data base for the Virunga Conservation Area was produced by the Center for Remote Sensing and Spatial Analysis of Rutgers University in collaboration with the DFGF International.

The work was done primarily using the GRASS image processing GIS developed by the Construction Engineering Research Laboratory of the US Army Corps of Engineers. A series of base maps were produced from existing paper maps, Global Positioning System (GPS) receiver data from the field, and Shuttle Imaging Radar (SIR-C), which was provided by NASA in two 1994 flights, and Landsat remote sensing data.

The Center acquired SIR-C images of the region, with a spatial resolution of 15 meters. Digital imagery analysis was performed on the Shuttle radar, Landsat, and aerial photographic data to generate a generalized vegetation and land use/land cover data layer for the area (Fig. 6). These data were then integrated with data of the rivers, roads, and elevation. Daily locations of gorilla groups and poaching activity obtained from field staff of the Karisoke Research Center were also incorporated.

This GIS database has the potential for bringing sophisticated quantitative approaches to the temporo-spatial analysis of poaching activity and gorilla ranging behavior in relation to vegetation cover. This kind of inquiry may point to remedies for the causes of poaching and answer questions about habitat carrying capacity, as well as help us examine the potential for sustained use of portions of gorilla habitat. In addition, we are exploring partnerships with the Ugandan Parks Authority to develop a Bwindi-Virunga GIS that will promote comparative study of the habitat of the two gorilla populations. Finally, an arrangement has been made with the Japanese National Aeronautical and Space Development Administration (NASDA), to provide us with two JERS-1 radar images of the region for the foreseeable future. This will allow us to continue to monitor environmental change in both the Virunga and Bwindi-Impenetrable regions.

Although developed in the US, our plan is to give governments of the gorilla range states ownership of this technology, and through training and forging links with national universities and research institutes make nationals familiar with the application of this technology to conservation (Fig. 7).

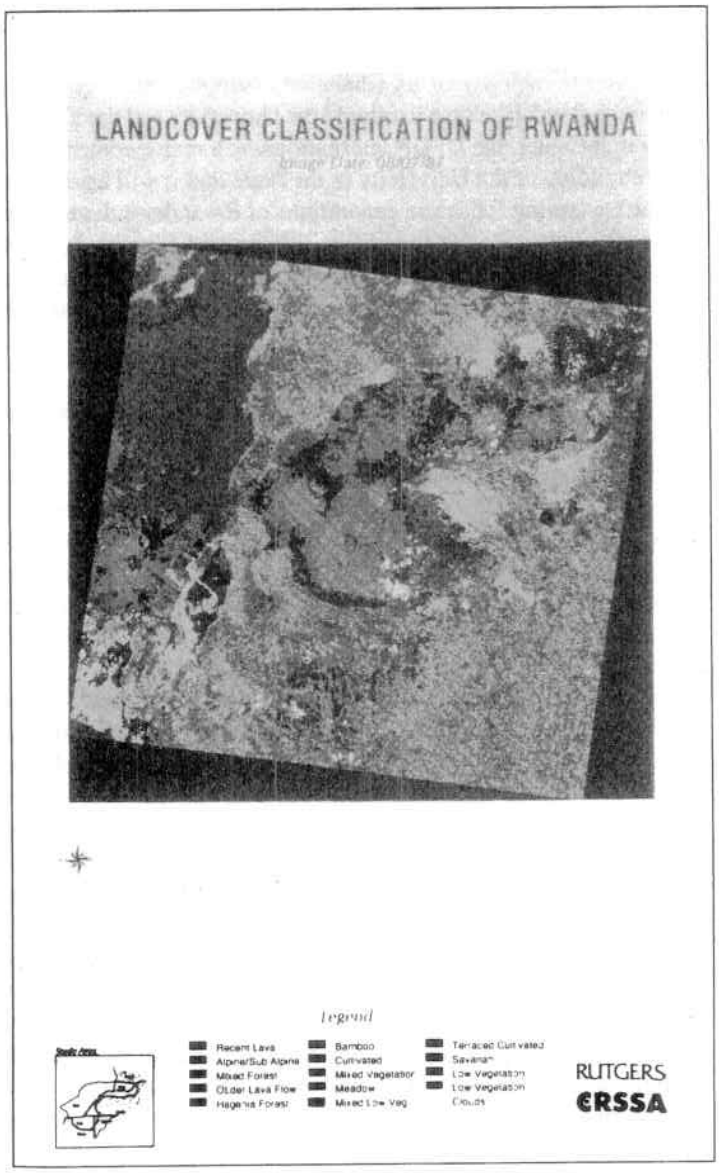

Figure 6. Generalized vegetation and land use/land cover GIS classification for the Virunga Conservation Area, incorporating Shuttle radar, Landsat, aerial photographic, and ground-truthing data.

Conservation Action Plan

Finally, what is urgently needed for both the short and long-term is a regional conservation action plan. In this regard, political changes in the Virunga region may serve as a positive influence. Perhaps for the first time in recent history, the winds of change have brought the political leadership of the gorilla range state countries into close collaboration under a common political agenda. This presents a timely and unique opportunity for a regional assessment of the mountain gorilla conservation status and the formulation of a joint conservation action plan. The Mountain Gorilla Population Habitat Viability Analysis conference, scheduled for December 1997 in Kampala, Uganda, will provide just this opportunity. If security in the region is restored, the PHVA will also facilitate the planning of a much needed census of the Virunga gorilla population. The meeting promises to be a signal event for the collaboration among conservation organizations and national governments in jointly addressing the problems facing mountain gorillas and putting forward a coordinated action plan that hopefully insures the survival of the mountain gorilla well into the 21st century.

Figure 7. N. Gerald-Steklis training Rwandan rangers in the use of GPS equipment. (Photo courtesy of The Dian Fossey Gorilla Fund International and Phil Sirois.)

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Conservation Status and Prospects for the Snub-nosed Langurs (Colobinae: *Rhinopithecus*)[1]

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Introduction

The genus *Rhinopithecus* (Colobinae), commonly known as "the snub-nosed langurs", is comprised of four allopatric species (Fig. 1). The term "snub-nosed" relates to the delicate, upturned nose, the tip of which reaches toward the forehead. Individuals of the four species are, as a whole, relatively large compared with other colobines, and show striking sexual dimorphism in both size and coloration. The taxonomy of the snub-nosed langurs has generated considerable debate (Pocock 1924; Ellerman and Morrison-Scott 1951; Groves 1970; Oates *et al.* 1994). As data on morphological characters have accumulated, however, the most defensible position appears to be the division of the genus into four distinct species: *Rhinopithecus* (*Presbytiscus*) *avunculus*, *Rhinopithecus* (*Rhinopithecus*) *brelichi*, *Rhinopithecus* (*Rhinopithecus*) *bieti*, and *Rhinopithecus* (*Rhinopithecus*) *roxellana* (Jablonski and Peng 1993). Wang *et al.* (1994, in press) have argued further that sub-populations of *R. (R.) roxellana* may be divided into three subspecies (*R. r. hubeiensis*, *R. r. qinlingensis*, and *R. r. roxellana*).

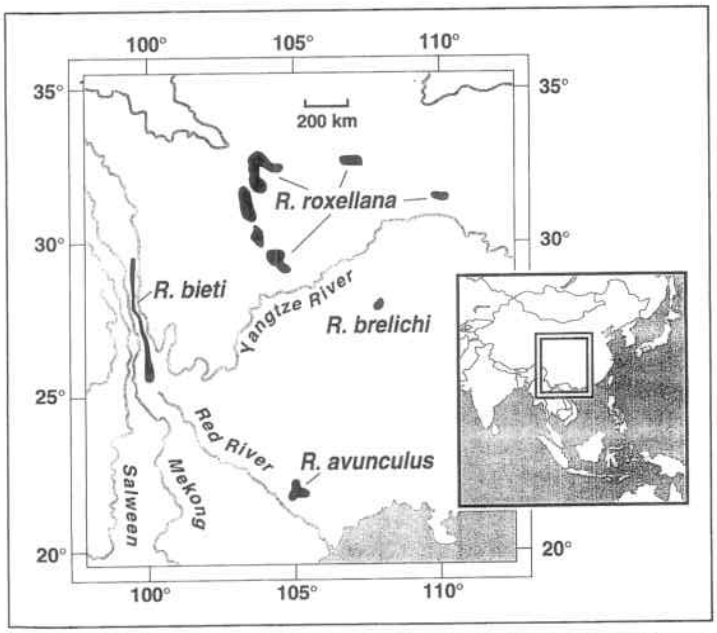

Figure 1. Distribution of the four species of *Rhinopithecus*. The species are allopatric and all have small total distributions.

The four species of snub-nosed langurs represent a phyletic array (Fig. 2). Relative to other members of the genus, *R. (P.) avunculus* is the most gracile, and most similar to *Pygathrix* in its adaptation to an exclusively arboreal existence (Jablonski and Peng 1993). The three Chinese species display a series of more highly derived characteristics of the integumentary and musculoskeletal systems that appear to have evolved as adaptations to colder conditions in temperate, montane forests. The habitats and foraging habits of the animals are such that terrestriality is relatively common in *R. (R.) bieti* and *R. (R.) roxellana*. The Chinese species of *Rhinopithecus* also exhibit larger body sizes and greater sexual dimorphism than the Vietnamese *R. (P.) avunculus*; these characters relate to the Chinese species' adaptation to more highly seasonal environments (Jablonski and Pan 1995).

The distribution range of the genus stretches from latitude 21° to 35°N (Fig. 1), with habitats spanning both tropical and temperate zones. This gradient of habitats has been the key to the development of an adaptive array in close parallel to the phyletic array (Fig. 2). *Rhinopithecus (P.) avunculus* lives in tropical, broadleaf forest in northern Vietnam, and, compared with other *Rhinopithecus* species, has a similar diet and habitat to other Asian colobines. The habitat and behavior of the Chinese taxa become progressively more atypical from *R. (R.) brelichi* to *R. (R.) roxellana* to *R. (R.) bieti*. *Rhinopithecus (R.) brelichi* lives in evergreen and deciduous broadleaf forest at 1500 to 2200 m, *R. (r.) roxellana* lives in deciduous broadleaf and conifer forests 1200 to 3000 m,

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Phyletic Relations	Morphology	Distribution and Ecology
Rhinopithecus (R.) bieti	Sexual dimorphism: extreme. Skeletal adaptations: terrestrial. Body proportions & limb structure: robust.	China, 98°37' to 99°41'E, 26°14' to 29°20'N. Total population: 1000 to 1500 individuals. Habitat: temperate, conifer (3000 to 4500 m). Non-seasonal diet: lichens.
Rhinopithecus (R.) brelichi	Sexual dimorphism: pronounced. Skeletal adaptations: arboreal. Body Proportions & limb structure: robust.	China, 275 km² centering on 108°50', 27°57'N. Total population: 800 to 1200 individuals. Habitat: temperate, deciduous broadleaf (1500 to 2200 m). Seasonal diet: leaves, leaf buds.
Rhinopithecus (R.) roxellana	Sexual dimorphism: pronounced. Skeletal adaptations: terrestrial. Body proportions & limb structure: robust. Seasonal diet: leaves, grasses, lichens.	China, 102° to 111°E, 30° to 35°N. Total population: 8000 to 10000 individuals. Habitat: temperate, deciduous broadleaf/conifer (1200 to 3000 m).
Rhinopithecus (P.) avunculus	Sexual dimorphism: moderate. Skeletal adaptations: arboreal. Body proportions & limb structure: gracile.	Vietnam, 104°54' to 106°03'E, 21°43'to 22°28'N. Total population: 130 to 350 individuals. Habitat: subtropical, evergreen & deciduous broadleaf (<1000m). Seasonal diet: leaves, fruits.
Pygathrix nemaeus	Sexual dimorphism: moderate. Skeletal adaptations: arboreal. Body proportions & limb structure: gracile.	Vietnam, Laos, Cambodia. Habitat: subtropical and tropical. Diet: leaves, fruits.

Figure 2. The phyletic and ecological array of the genus *Rhinopithecus*. Compared to other members of the genus, *R. (P.) avunculus* is less derived and more similar to *Pygathrix*. The remaining members of the genus, *R. (R.) roxellana*, *R. (R.) brelichi*, and *R. (R.) bieti*, are more highly derived but individually exhibit numerous autapomorphies which cloud the interpretation of their precise phyletic interrelationships (Jablonski 1992; Jablonski and Peng 1993; Jablonski and Pan 1995; Jablonski in press). An ecological array parallels the adaptive array, with the exception of a reversal of the positions of *R. (R.) roxellana* and *R. (R.)0 brelichi* (Kirkpatrick 1996, in press a).

and *R. (R.) bieti* lives in evergreen broadleaf and conifer forests above 3000 m. Behavioral differences are associated with these forest types. These differences are best illustrated in the progressively atypical diets, which span from the leaf-eating of *R. (R.) brelichi* to the lichen-eating of *R. (R.) bieti* (reviewed in Kirkpatrick in press a).

Description, Distribution, and Ecology of Snub-Nosed Langurs

Rhinopithecus (*Presbytiscus*) *avunculus*

In adult *R. (P.) avunculus*, the pelage of the back, the outer limbs, and the hands and feet is black, while that of the inner limbs, the thighs and head is creamy white. The tail is dorsally black and ventrally white. The animals also have an orange throat patch, and the skin around the eyes and nose is bare and pale blue, deepening to bluish-black around the mouth. Infants and juveniles are gray rather than black, and immature animals display a pale yellow throat patch and have less color around the mouth (Le 1995; Chaplin and Jablonski in press). The orange throat patch and the white hair of the tail are more prominent in adult males than in adult females. Data are sparse concerning the size of *R. (P.) avunculus*: one adult male is known to have weighed 14.5 kg, and three adult females averaged 8.3 kg (Ratajszczak *et al.* 1992).

The distribution of *R. (P.) avunculus* is restricted to between longitude 104°54' to 106°03' E and latitude 21°43' to 22°28'N in northern Vietnam (reviewed in Kirkpatrick in press b). The langurs are found in subtropical forests on steep karst limestone, with plant species ranging from figs and dipterocarps to oaks, magnolias and maples (Cox *et al.* 1994). The forests show substantial seasonality. Between February and May, for example, the forests are flush with young leaves, while between August and October, many of the trees synchronously bear fruits. At present, *R. (P.) avunculus* may be limited to two isolated groups, with a total population size of between 130 (Le 1995) and 350 (Cao 1995).

Rhinopithecus (P.) avunculus appears to follow the colobine tendency to be completely arboreal (Ratajszczak *et al.* 1992; Boonratana and Le in press). Social organization is based on one-male, multi-female units (OMUs), and all-male units (AMUs) are seen as well (Boonratana and Le in press; Le 1995). Different OMUs frequently come together at sleeping sites and feeding trees, and at times they travel together. AMUs also associate with these collections of OMUs. The diet consists primarily of leaves (including the leaves of bamboo) and fruits (Ratajszczak *et al.* 1992; Pham 1994; Boonratana and Le in press), and food choice varies with the season; young leaves are a primary component of the diet in Spring (February to May), and fruits are a primary component of the diet in Autumn (August to October) (Boonratana and Le in press; Le unpubl.).

Rhinopithecus (*Rhinopithecus*) *brelichi*

In adults of *R. (R.) brelichi*, the back is covered with long, fine hair, brown above, grading to gray on the lower body, and there is a bright patch of white between the shoulder blades. The distal limbs, the neck, and the head are black, with the exception of a golden brow. The chest and the inner surfaces of the upper arms are golden as well. The face is bare, revealing white skin, tinged slightly blue. Juveniles are various shades of gray, with the pattern changing with age. Adult males are more brightly colored than adult females, and unlike other species in the genus, adult males have white skin on prominent nipples. As with *R. (P.)*

avunculus, data on the size of *R. (R.) brelichi* are limited. Two male *R. (R.) brelichi* are known to have averaged 14.5 kg, and one adult female weighed approximately 8 kg (Quan and Xie 1981; Qiu 1982).

Rhinopithecus (R.) brelichi occurs only in a small region centering on Mt. Fanjing (108°50'E, 27°57'N) in the Wuling Mountains of China, with the langurs mostly restricted to the 275 km² core area of the Fanjingshan Nature Reserve (Bleisch *et al.* 1993). The langurs generally range in a zone of mixed deciduous and evergreen broadleaf forest between 1500 and 2200 m asl (Bleisch *et al.* 1993); yearly rainfall above 1600 m asl exceeds 2000 mm (Bleisch unpublished). Temperatures fall below freezing during five months of the year, and snows are common in winter. Monthly mean temperatures are never below zero (Celsius), however. Within the forests used by the monkeys, mono-groves of Asian oaks (*Cyclobalanopsis* spp.) and beech (*Fagus longipetiolata*) often occur, while other forest types used by the langurs do not have a dominant tree species. Common canopy trees include cherries (*Prunus* spp.), maples (*Acer* spp.), *Rhododendron* spp., and birch (*Betula* spp.). The world population of *R. (R.) brelichi* is probably fewer than 1200 and may be less than 800, all in a single population (Bleisch 1995).

Descriptions of the locomotion of *R. (R.) brelichi* are similar to those for *R.(P.) avunculus*: *R. (R.) brelichi* is primarily arboreal, characterized by quadrupedal walking, climbing, leaping, semi-brachiation and occasionally by full brachiation (for example, compare Bleisch *et al.* 1993, with Le 1995). The social organization in *R. (R.) brelichi* appears to be based on small groups of 5 to 10 individuals, each with a single male. A large number of these OMUs range together in large, semi-cohesive groups that can hold up to 400 individuals (Bleisch *et al.* 1993). AMUs of 2 to 5 adult or subadult males also are seen on the periphery of these groups. The langurs use a wide variety of food resources, with dramatic changes through the seasons. Preferred foods include young leaves and leaf buds of many species, leaf petioles (e.g., from *Fagus longipetiolata*), flower buds, fruits and seeds (including those of *Prunus* spp. and *Sorbus* spp.), bark and insect larvae (Bleisch and Xie in press).

Rhinopithecus (Rhinopithecus) bieti

In *R. (R.) bieti*, adult pelage is gray-black to black on the back, the head, the distal limbs and the tail (Wu 1993). The flanks, chest, and front of the neck are white. Infants are bright white, becoming light gray over several months, and juveniles are gray, gradually darkening to gray-black. In general, adult males are a darker black than are adult females, and the white flank hair of adult males is longer, relative to that of adult females. Males are also about 50% larger, with adult males weighing 15.3 kg on average (n = 5) and adult females 9.1 kg (n = 7) (Appendix in Kirkpatrick in press a).

Rhinopithecus (R.) bieti is found between longitude 98°37' to 99°41'E and latitude 26°14' to 29°20'N along the Yunling Mountains of China's southwest (Long *et al.* in press. a, b). The langurs are found in high-altitude, evergreen forests, with the canopy composed primarily of fir (*Abies* spp.), spruce (*Picea* spp.), evergreen oak (*Quercus* spp.) and *Rhododendron* spp. The forests are between 3000 and 4500 m asl, making *R. bieti* the non-human primate of the highest known elevations (Long *et al.* in press a). Temperatures average below zero (Celsius) for several months of the year, and snow can accumulate to over 1 m in depth (Kirkpatrick 1996). Recent surveys throughout the distribution of the langurs suggests there are 13 distinct sub-populations of *R. (R.) bieti*, located in five counties in Yunnan Province and Tibet, for a total population size of between 1000 and 1500 animals (Long *et al.* in press a, b).

Compared with *R. (P.) avunculus* and *R. (R.) brelichi*, *R. (R.) bieti* is relatively terrestrial. Estimates of terrestrial activity for *R. bieti* range between 22% and 70% of the day (e.g., Wu 1993; Kirkpatrick 1996). Social organization in *R. (R.) bieti* is two-tiered, as in other species of *Rhinopithecus*. OMUs range together as groups, with their size apparently spanning from less than 50 to over 200 individuals (Long *et al.* 1994, in press a, b). Unlike the groups of other members of the genus, however, those of *R. (R.) bieti* do not show fission-fusion (Kirkpatrick 1996). The primary food of this species appears to be arboreal lichens, supplemented by leaves (e.g., from plants in the rose family and the grass family) and, at certain times of year, fruits and/or seeds (e.g., *Sorbus* spp., *Cotoneaster* spp.). In a recent, year-long, study of *R. (R.) bieti* at Wuyapiya, for example, arboreal lichens composed over 80% of the annual diet (Kirkpatrick 1996).

Rhinopithecus (Rhinopithecus) roxellana

The pelage of adult *R. (R.) roxellana* is brown to black on the back and outer sides of the limbs. Long hairs, bright golden in color, extend from the shoulders like a cape. The inner sides of the limbs, the thighs and elbows are creamy white. Newborn are gray, changing in about one month to creamy white. Adult males have orange/red patches on both sides of the throat, and the golden cape of males is longer and brighter than that of adult females. Unlike other species of *Rhinopithecus*, adult males in *R. (R.) roxellana* also have distinct, enlarged flanges on the corners of the upper lip, looking something like leaf buds. The function of these flanges is unknown; they are present in young males (~2 years old), but small and flaccid; in the oldest males, the flanges likewise appear shriveled. These observation suggest that the flanges are related to male sexual activity or sex hormones. Other dimorphic characters, not only in *R. (R.) roxellana* but in other members of the genus as well, may also relate to sexual activity. As in the other species, adult males weigh substantially more than adult females (males: 16.4 kg, n = 12; females: 9.4 kg, n = 13; see Appendix in Kirkpatrick in press a).

Rhinopithecus (R.) roxellana has the widest distribution of any species of snub-nosed langur, being found between 102° to 111°E and latitude 30° to 35°N in the Qionglai, Minshan, Qinling and Daba Mountains of central China (Liu 1959; Tan 1985). The forests used by the langurs range in elevation from 1200 to over 3000 m asl, and consist of three main types: Deciduous broadleaf forest, conifer forest, and a forest type that mixes both deciduous broadleaf and conifer trees.

The separate mountain ranges inhabited by *R. (R.) roxellana* roughly correspond to provincial divisions. Current population estimates for the langurs are about 4,000 in the Qinling Mountains of Shaanxi Province (Liu and Gao 1995), between 600 and 1000 in the Daba Mountains of Hubei Province (Ren *et al.* in press), and

about 800 in the Minshan Mountains of Gansu Province (Zhang 1995; Li *et al.* 1995). There is no current estimate for the number of langurs in the Qionglai and Minshan Mountains of Sichuan Province, but given the forest available and older reports (e.g., Tan 1985), we estimate there are between 2,000 and 4,000 langurs in Sichuan. We therefore estimate the world population of *R.(R.) roxellana* to be between, 8,000 and 10,000 animals.

Wang *et al.* (1994, in press, see also Wang *et al.* 1995) have argued that *R. (R.) roxellana* can be divided into three subspecies. The subspecies are isolated on separated mountain ranges, and subspecific divisions are based on differences in pelage color and in the skull morphology of a limited number of specimens. The pelage of *R. (R.) roxellana* in the Qinling Mountains is a lighter, brighter gold than that of other *R. (R.) roxellana*, for example. Wang *et al.* (1994, in press) designate the langurs of the Qinling Mountains of Shaanxi as *R. (R.) r. qinlingensis*, the langurs in the Daba Mountains of Hubei as *R. (R.) r. hubeiensis*, and the langurs of the Qionglai and Minshan Mountains of Sichuan and Gansu as *R. (R.) r. roxellana*.

Rhinopithecus (R.) roxellana is both arboreal and terrestrial, spending almost half its time on the ground (Su *et al.* in press). When on the ground, the langurs typically walk plantigrade, but sometimes when running on snow, they run on their knuckles, much like chimpanzees (Ren pers. obs.). The social organization of *R. (R.) roxellana* is similar to other species of *Rhinopithecus*, with the size of groups spanning 100 to 300 individuals or more (Ren *et al.* in press). The basic social unit within the groups is the OMU, although they can have a few (~5%) multi-male, multi-female units; AMUs are also associated with groups. Groups of *R. (R.) roxellana* are characterized by fission-fusion: at times separating into two or three smaller groups during the day, with these smaller groups being separated by 200 to 300 m. It is as yet uncertain if there are distinct daily or seasonal patterns to fission-fusion, however. The diet fluctuates widely across seasons, and consists of leaves, seeds, and, in some locations and at some times of the year, lichens (Schaller *et al.* 1985; Su *et al.* in press).

Conservation Status of the Snub-nosed Langurs

Both the Vietnamese and Chinese governments have taken action to protect snub-nosed langurs. The international conservation community and the international primatological community have also given support to conservation action. Strong laws and a number of nature reserves are in place to protect the langurs, and field research has determined the status of langur populations and the threats to their survival. Despite this strong foundation, however, on the practical level of day-to-day implementation there remain substantial obstacles to the survival of these species.

Progress in Conservation Action

In Vietnam, the national government has listed *R. (P.) avunculus* in the national "Red Data Book" as endangered, and has also issued decrees, the most recent in 1992, to protect endangered monkeys such as these. The Vietnamese government and an international consortium of zoological societies also have established a "rescue center" for threatened primates, including *R. (P.) avunculus*. The Na Hang Nature Reserve in Tuyen Quang Province, designated in 1994 and designed in consultation with the International Union for the Conservation of Nature (Cox *et al.* 1994), is primarily for the protection of *R. (P.) avunculus*, and contains at least 130 individuals of the species (Boonratana and Le 1994). All the guns held by the 200 families within Na Hang N.R. have been confiscated, and hunting appears to have been successfully controlled in the region (Le pers. obs.). The United Nations Development Program (UNDP) has expressed interest in providing major funding for the reserve at Na Hang, although as of July 1996 this funding was not yet secure. Attention to the conservation needs of *R. (P.) avunculus* was catalyzed through a distribution survey funded by the World Wide Fund for Nature (Ratajszczak *et al.* 1992), and through the first long-term field study of the species, funded by the Wildlife Conservation Society (Boonratana and Le 1994) and Primate Conservation, Inc. (Le unpubl.).

The Chinese government has promulgated numerous national laws to protect snub-nosed langurs, and the Chinese Academy of Sciences has supported field research on *R. bieti* and *R. roxellana*. The high priority given to snub-nosed langur conservation was reiterated in 1988 by the inclusion of *R. (R.) bieti*, *R. (R.) roxellana*, and *R. (R.) brelichi* as first-class protected species in the State Council's List of Main Protection Law and the Law Against Hunting of Endangered Animals, both of 1989. The Chinese government has further established numerous national and local reserves aimed to aid in the protection of snub-nosed langurs. The single known population of *R. (R.) brelichi* is protected in the Fanjingshan Nature Reserve, for example, and a substantial portion of the total population of *R. (R.) roxellana* is also protected in reserves. This is due, in part, to the fact that *R. roxellana* is sympatric with the giant panda, *Ailuropoda melanoleuca*, and benefits as a result from conservation action directed toward the panda. Nature reserves that contain substantial populations of *R. (R.) roxellana* include Shennongja (Hubei Province), Baishuijiang (Gansu Province), Foping and Zhouzhi (Shaanxi Province), and Wolong and Baihe (Sichuan Province). The proportion of *R. (R.) bieti*'s total population that is protected within nature reserves is substantially less than that of other *Rhinopithecus* species: Only two of thirteen existent sub-populations are completely within Baimaxueshan Nature Reserve, the only operational reserve to hold *R. (R.) bieti* (Long *et al.* in press a, b).

The international community has helped to document the conservation problems facing the Chinese snub-nosed langurs (e.g., World Wide Fund for Nature support of a comprehensive survey of *R. (R.) bieti*; Long *et al.* in press a, b). International support also has been crucial to develop ecological information on these little-known species. This support has included that of the Wildlife Conservation Society for basic research on *R. (R.) brelichi* (Bleisch *et al.* 1993; Bleisch and Xie in press), support from the L. S. B. Leakey Foundation and the Wenner-Gren Foundation for research on *R. (R.) bieti* (Kirkpatrick 1996), and support from the Zoological Society of San Diego and the U. S. National Science Foundation for current field research on *R. (R.) roxellana*. Training programs run by the Wildlife Conservation Society, the World Wide Fund for Nature, and China's Ministry of Forestry (with support from the World Bank's Global Environment Facility) have all helped improve the professionalism of nature reserve staff, including staff at reserves that contain snub-nosed langurs.

Obstacles to the Conservation of Snub-Nosed Langurs

Although progress has been made in the conservation of snub-nosed langurs, the survival of all the species is threatened by hunting and habitat destruction. This is due, in large part, to a lack of institutional support for the enforcement of regulations designed to protect langurs. This lack of support can be traced, fundamentally, to the lack of financial resources provided by central governments to the agencies charged with wildlife protection.

Rhinopithecus populations live in remote, mountainous areas. People in these areas are poor, and typically are unaware of the laws protecting endangered animals. (Awareness of laws does not assure compliance, however). Residents within the ranges of *Rhinopithecus* continue to hunt them for food and for traditional medicine. Hunting is particularly severe for *R. (P.) avunculus* and *R. (R.) bieti* (reviewed in Kirkpatrick 1995). Langurs are also often caught in snares set for other animals, such as musk deer. This is a particular problem for the two semi-terrestrial snub-nosed langurs, *R. (R.) roxellana* and *R. (R.) bieti*. Although not a problem of hunting *per se*, much attention has been given to captive breeding programs, but poorly planned programs and lack of coordination between agencies actually contributes to the endangerment of the langurs.

The forests of the langurs are used heavily both by local residents and by government-owned logging companies. Local residents cut trees for firewood and for building homes. Forests also are burned to make pasture for free-ranging cattle (mainly in the regions inhabited by *R. (R.) roxellana* and *R. (R.) bieti*), and to produce charcoal (a major source of revenue in the region inhabited by *R. (R.) brelichi*). Local governments are typically dependent on logging as the primary source of revenue. Large-scale logging is technically forbidden in national-level nature reserves in China, but almost all forests outside reserves are slated for clear-cutting. In some reserves, tourism development has destroyed langur habitats (for example, see Su *et al.* in press). The rapacious cutting of forests effects almost every known population of snub-nosed langurs, even those in reserves.

The Fate of the Snub-nosed Langurs: Survival or Extinction?

In our judgment, the conservation problems of the snub-nosed langurs are growing at a faster rate than are the conservation solutions currently being implemented. Particularly in China, the single-minded pursuit of quick money hampers conservation efforts, and short-term profits associated with habitat destruction invariably outweigh long-term consequences. Further, local people see little reason to follow government edicts that prevent them from increasing their standard of living, particularly when local people see ubiquitous media images of a tremendous rise in the living standards of city-dwellers. Resolving this fundamental contradiction – improving the living standards of local people without destruction of local habitats – will be essential if conservation efforts are to succeed. Below, we consider the probable destiny of the snub-nosed langurs over the next two decades, and provide conservation recommendations to halt or at least slow the decline of populations.

Rough Estimates of the Viability of Species

Rhinopithecus (P.) avunculus. The total population of *R. (P.) avunculus* is estimated to be between 130 (Le 1995) and 350 (Cao 1995), and is divided into at least two non-contiguous sub-populations. The species is critically endangered and faces considerable problems of hunting and habitat destruction (Ratajszczak *et al.* 1992; Boonratana and Le 1994). Even with the recent designation of Na Hang Nature Reserve, *R. (P.) avunculus* will probably be extinct in 20 years unless immediate and effective actions are taken. Those that would limit the probability of extinction include support for Na Hang Reserve and additional habitat protection.

Rhinopithecus (R.) brelichi. The total population of *R. (R.) brelichi* is estimated to be 800 to 1200, all in a single population within Fanjinsgshan Nature Reserve. The langurs occupy most of the available habitat and the population could not have been much larger in the past than it is today (Bleisch 1995). This suggests that this population has survived isolation in these mountain forests for several hundred years. Based on a crude analysis using the Generalized Animal Population Process Simulation (Harris and Allendorf 1989), this population is not in great danger from demographic stochasticity or inbreeding depression, and should be able to maintain over 90% of its genetic variability for the next 100 years. The population may be threatened, however, by environmental stochasticity and by catastrophic events. Currently, the most serious threat is continued destruction of its habitat, and unless this is controlled soon, the population is likely to shrink to a dangerously low size within 20 years. Captive breeding is not a priority for this species at the present time, but habitat protection remains critically important.

Rhinopithecus (R.) bieti. *Rhinopithecus (R.) bieti* contrasts with *R. (R.) brelichi* in terms of conservation prospects. As with *R. (R.) brelichi*, it has a low total population, estimated at between 1000 and 1500, which , however, is fragmented into 13 isolated sub-populations, with the two largest holding only about 200 individuals each (Long *et al.* in press a, b). Geographic features make it improbable that there is exchange of individuals between these sub-populations, and it would be almost impossible to connect them through habitat corridors. Local populations of temperate mammals are known to suffer sudden extinctions due to severe swings in climate (Caughley and Gunn 1993), but areas undergoing such local extinctions are subsequently re-colonized by immigration. Within the range of *R. (R.) bieti*, however, habitat fragmentation appears to have disrupted this process, and local extinctions of *R. (R.) bieti* populations may well be permanent. Only the two sub-populations living completely within Baimaxueshan Nature Reserve can be considered well-protected, with all others endangered due to habitat destruction and hunting. Several sub-populations of *R. (R.) bieti* will almost certainly be extinct within the next 20 years, and without strong action this may well be the medium-term fate of the entire species (Long *et al.* in press a, b).

Rhinopithecus (R.) roxellana. The total population of *R. (R.) roxellana* is estimated to be between, 8,000 and 10,000. These animals are distributed in a number of sub-populations in which contiguous ranges are shared by several groups. The relatively large population and the contiguous nature of groups implies that the prospects for survival of *R. (R.) roxellana* are better than those for other species of snub-nosed langur. In addition, many sub-populations occur in protected areas designated for giant pandas. Conservation problems are not lacking, however, and a number of sub-populations are likely to be extinct in 20 years, primarily due

to habitat destruction.

Recommendations for Conservation Action

Conservation action could halt the decline of snub-nosed langur populations and prevent the extinction of any members of the genus. Large-scale projects, such as the expansion of nature reserves or the shift in culture from a lust for quick-money to a love of nature, are beyond the scope of the primatological community's expertise and financial resources. The international primatological community can, however, provide the leadership and technical advice necessary to catalyze such large-scale changes.

1. Provide international leadership in the expertise and funding necessary to save critically endangered *R. (P.) avunculus* in Vietnam. Na Hang Nature Reserve needs technical and financial support from both government and conservation organizations to ensure the survival of this species. UNDP should be encouraged to provide the funding necessary to staff the Na Hang N.R. A full program for the species must include habitat protection, continued rigor in the enforcement of bans on hunting and trade, and increased scientific study to understand the precise limits to population size and distribution, as well as to develop information on diet to aid in captive breeding. Captive breeding is premature at present, however, because all captives thus far have died (Le, unpublished). Distribution surveys should continue to investigate the ecological and technical feasibility of linking the nature reserves of Babe and Na Hang.

2. Focus world attention on the snub-nosed langurs, informing people of the beauty and fascinating biology of the genus, and making people aware of the langurs' plight. This long-term project is needed to increase the awareness of both city-dwellers and residents within monkey habitat of the importance for their conservation and the magnificence of snub-nosed langurs. A recent publicity campaign, lead by Z. N. Xi and conducted through a variety of media channels, has produced a year-long moratorium on logging in the range of the Guomorong group of *R. (R.) bieti* (Anon. 1995; Tang 1996; Wen 1996). Although the forests of Guomorong are not yet secure over the long-term, this example shows that conservation dialogue in China is not always biased toward habitat destruction, and that communication of the conservation needs of langurs is an important component of langur protection. Continued work with China Central Television, All-China Radio, the Ministry of Forestry's Green Weekend, and other media in China, to encourage and assist in the production of informational programs and reports will help increase awareness of the conservation needs of the snub-nosed langurs.

3. Organize an International Society for the Conservation of Snub-Nosed Langurs. The mission of this Society would be to produce comprehensive recommendations for the conservation and management of the *Rhinopithecus* species. (We would suggest that primatologists in both Vietnam and China organize independent divisions of this Society.) Membership would include in-country and foreign primatologists, officials from forestry divisions, and the staff of donor organizations. As a first action, a workshop might be held to exchange information and views on the conservation of the snub-nosed langurs. Additionally, this Society might organize (and fund) teams of monitors for periodic, brief trips to langur habitats in order to conduct distribution surveys and discuss options with local people to improve protection of the langurs. The best candidates for such teams would be undergraduate and graduate students interested in wildlife biology and forestry administration. One such team, lead by X. Y. Tang, recently traveled to the Baaimaxueshan Nature Reserve, to assess the impact of the moratorium of logging in the Guomorong area.

4. Based on research results and science, make recommendations to forestry administrators and nature reserve staff for conservation measures. Such recommendations may well include more attention to, and funding for, nature reserves, as well as the enforcement of existing laws. The biggest obstacle to the implementation of such recommendations will be the lack of funds: government agencies concerned with nature conservation are almost certain to support such recommendations, but they typically do not have the financial support from central government to implement such recommendations. In China, for example, it is regularly said that close to 30% of the country's nature reserves are without a budget or staff. Recommendations for increases in the size and number of nature reserves, as well as increased enforcement, will be in line with government policies, however. An example of the use of research to provide the basis for langur protection can be seen in the recent work of Y. C. Long and colleagues (in press a, b), who have provided extensive recommendations for modifying and strengthening the reserve network for the protection of *R. (R.) bieti.*

5. Continue support for research on snub-nosed langurs. Over the past ten years, the international primatological community has rallied to support basic research on this little-known genus. Gaps in our knowledge still hamper conservation efforts, however. The distribution and conservation status of *R. (R.) roxellana* in the Qionglai and Minshan Mountains of Sichuan remain unknown, for example, and yet the Qionglai and Minshan may well hold over half the word population of the species. Research support must be broad enough to include the study of langur and human interaction. Site-specific information must be developed on alternative fuels, the impacts of grazing, and how resource use can be reduced through support of local educational and religious structures. This information will be essential to ensure than langurs and humans will continue to co-exist.

The snub-nosed langurs form a monophyletic clade, with ecological adaptations that grade from those of the tropical, arboreal leaf-eater *R. (P.) avunculus* to the temperate, semi-terrestrial lichen-eater *R. (R.) bieti.* The distribution area and total population of each of the four species of the genus is limited, and all the species should be recognized as quite vulnerable to extinction. The governments of Vietnam and China have implemented measures for protection of the snub-nosed langurs, and the international community has joined in conservation action. The pace of forest destruction in snub-nosed langur habitats, however, coupled with continued hunting, results in the species still being threatened with extinction. In particular, it appears that both *R. (P.) avunculus* and *R. (R.) bieti* have a greater chance of extinction than of survival over the next 20 years. The loss of any member of this unusual, monophyletic clade would be a serious loss to the diversity of the Order Primates.

Acknowledgments

The conservation actions detailed in this paper are being lead by a strong, if young, community of Chinese and Vietnamese citizens concerned with the future of their respective countries. It is to these people that we dedicate this paper. In particular, Tang Xiyang and Xi Zhinong have been inspirational in their vanguard action for the conservation of the snub-nosed langurs.

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Conservation of Japanese Macaques in Yakushima: The Effectiveness of UNESCO's Natural World Heritage Designation

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Introduction

The Japanese macaque (*Macaca fuscata*) is not currently a critically endangered species, but is one which faces mounting pressure from habitat fragmentation and other forms of human disturbance throughout its distribution. While it is unlikely to become extinct in the next ten or twenty years, much of the surviving population lives in conditions which have been radically altered, and continue to be influenced, by humans. The long-term consequences of habitat fragmentation, degradation and increasing contact with humans are unknown, but potentially disastrous. There is an urgent need, therefore, to identify sizable populations which are still living under relatively natural conditions, and to take whatever action is necessary to ensure that both the monkeys and their habitat are adequately protected. The macaques of Yakushima are important candidates for such action, as they represent the largest population of Japanese macaques living in continuous distribution.

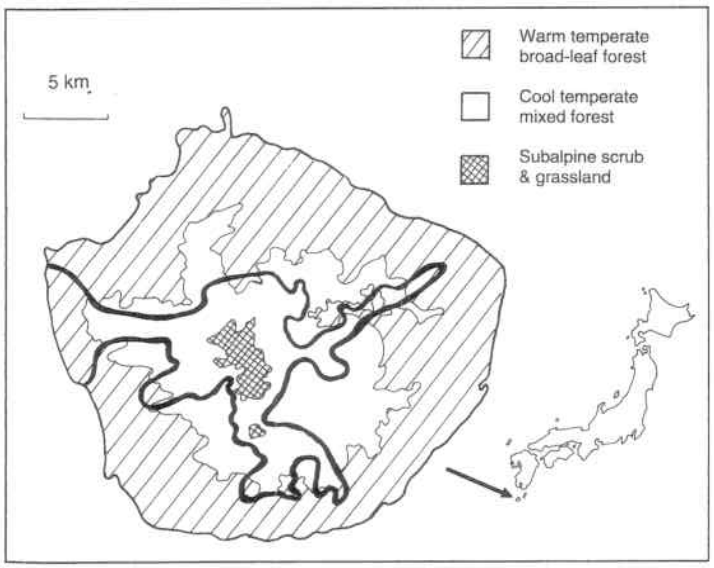

Figure 1. Vegetation zones and protected areas in Yakushima. The 800 and 1,700 m contours are given as approximate boundaries of the vegetation zones. The bold line encloses the area of highest grade National Park, where logging is prohibited or severely restricted.

In 1993 Japan ratified the Convention on the Protection of World Cultural and Natural Heritage. In the same year two areas of Japan were formally designated as Natural World Heritage Sites. One of these was the Shirakami Mountains, in the north of Honshu. The other was part of the island of Yakushima, in the south of Japan. Both sites are important monkey habitats, although this was not a major factor influencing their selection for designation. The Shirakami Mountains support one of the northernmost natural populations of nonhuman primates in the world. The island of Yakushima is the southern limit of the distribution of monkeys in Japan, and the population there is classified as an endemic subspecies, *M. fuscata yakui*, also known as the yakuzaru, or Yakushima macaque.

In recent decades the Yakushima macaque has come under mounting pressure from human impact (Sprague 1986). Initially the main problems were habitat loss and degradation through logging and reafforestation with conifers. In more recent years the macaques have been trapped and hunted in an attempt to control escalating crop damage by the monkeys. These problems were outlined in a paper presented at the International Primatological Society (IPS) Congress in Nagoya in 1990 (Hill 1992). At that time the main conclusions were that two measures were required to ensure the long-term survival of a viable population of Yakushima macaques. The first was an effective, non-invasive method of crop protection. The second was more extensive and more effective protected areas. Although crop-raiding is still a problem, significant advances have been made on the first measure. A system of long electric fences, planned and promoted by Dr. Manda, of Kagoshima University, has reduced levels of crop-raiding in areas where it has been implemented. In theory, designation as a Natural World Heritage Site should represent significant advances on the second measure. The aim of our paper is to outline how local and national government bodies have responded to the designation, and how relevant these responses are to the conservation of the macaques, their habitat and other wildlife.

Site and Protection Status Prior to World Heritage Designation

Yakushima is a mountainous island of about 500 km² with a human population of around 14,000 people. The traditional occupations are fishing, forestry and farming. The major cash crop is oranges, which are also the main crop raided by monkeys. Apart from forestry and recreation, human activities are largely confined to coastal areas, because the interior of the island is too steep to farm or settle.

The natural vegetation of Yakushima can be broadly classified into three main types which correspond more or less to altitudinal zones (Fig. 1). Warm temperate forest extends from sea level to about 800 m, cool temperate forest from 800 to 1,700 m, and then subalpine grassland and scrub around the mountain peaks which reach 1,935 m (Tagawa 1980; Maruhashi 1980). The Yakushima macaque has been observed at all altitudes, but the highest densities are found in warm temperate forest on the lower slopes. This is also a major habitat for the Yakushima deer (*Cervus nippon yakushimae*), another endemic subspecies.

Much of the forest has been influenced by human activity. Most natural vegetation on the narrow coastal plain was cleared or fragmented long ago. Also many areas of the warm temperate forest on the lower mountain slopes were heavily logged in the 1960s and 70s. Some of the logged lots were replanted with conifers, but many of them were abandoned to natural regrowth, and these areas now support secondary forest.

Even before its designation as a Natural World Heritage Site, Yakushima had a great variety of protected areas and conservation designations. Table 1 gives a simplified summary of the main ones. At the local level there are six Wildlife Protection Areas and one Special Wildlife Protection Area designated and administered by the Prefectural Government. At the national level two government agencies have their own overlapping designations. Most of the interior of the island is owned by the National Forestry Bureau. Included within this are several areas designated as Conservation and Research Forests. In addition 40% of the island falls within the Kirishima-Yaku National Park. Only half of this area is officially protected, however, in that logging is prohibited or restricted in it. Finally, at the international level, Yakushima is the site of a Man and the Biosphere (MAB) Reserve, as designated by UNESCO.

The various designated areas overlap extensively with one another. In most cases the boundaries are poorly signposted or not signposted at all (Table 1). The Wildlife Protection Areas, designated by the prefectural government, have no staff and so are not patrolled. The National Forestry staff carry out routine maintenance of forestry roads and some footpaths, but do not patrol conservation areas. The National Park has only three Rangers and they do not patrol conservation areas on a regular basis. The MAB Reserve is perhaps the most ethereal category of all, in that there are no signs, no personnel and no office for the reserve. Casual interviews indicated that local people in Yakushima do not know what a MAB Reserve is, and certainly do not know that parts of their island are supposed to be one.

Wildlife Protection Areas are partially effective in that they reduce hunting pressure on the macaques and deer. All hunting in Yakushima is officially classed as 'Nuisance Animal Control', and requires a permit issued by the local government. The permit specifies an area within which hunting may take place. Permits have occasionally been issued which allowed hunting within Wildlife Protection Areas, but this is rare.

In summary, none of these areas can considered to provide effective, long term protection for macaques or other wildlife. This is because their locations are poorly marked, few people know what regulations apply to them, and little effort is made to patrol the area or enforce regulations. An additional shortcoming as far as the macaques and deer are concerned, is that all of these designations concentrate on areas of primary vegetation, or those which have sustained only minimal disturbance, and this generally means high altitude. The higher grades of National Park provide a good example (enclosed by the dotted line in Fig. 1). With the exception of one area on the west coast, and a few bits and pieces, the protected areas exclude almost all of the warm temperate forest, and therefore most of the primary habitat of the macaques.

World Heritage status

The area designated as a Natural World Heritage Site is more or less the same as that of the higher grades of National Park. So the vegetation types most strongly represented within it are the subalpine grassland, scrub and the cool temperate forest of higher altitudes. Again, the only sizable area of warm temperate forest included is on the west of the island, where the designated area reaches the coast. This is also the only part of the World Heritage Site that is directly accessible by road.

The warm temperate forest is of great conservation value in its own right. Once widespread in southern Japan and eastern China, most of East Asia's warm temperate forest has now been destroyed or severely fragmented. That of Yakushima is the largest remaining tract in the East Asian region. Although much of it has been disturbed at some point, there are now extensive areas of mature secondary forest. Our surveys have shown that the population densities of Yakushima macaques and deer in these areas are comparable to those found in the primary forest on the west coast (Hill *et al.* 1995; unpubl. data). These areas of mature secondary warm temperate forest are not under immediate threat of logging, because it is cheaper for Japan to import timber from tropical countries than to harvest its own. However, this situation is certain to change, and these areas need to be protected. World Heritage designation was an opportunity to recognize the importance of these areas, but one which was missed entirely.

Even within the designated area there is little evidence that World

Table 1. Main categories of protected areas in Yakushima and their effectiveness.

Level	Category	Clear signs?	Patrolled	Effective for conservation?
Regional	Wildlife Protection Area	Yes	No staff	Partially
National	National Forest	No	Rarely	No
National	National Park	No	Rarely	No
International	Man & Biosphere Reserve	None	No staff	No

Heritage status will improve the conservation situation. There are no specific regulations governing what people may or may not do within the World Heritage area and it is not patrolled. The World Heritage designation has been used more as a public relations exercise than for any kind of practical conservation action. There is little sign of money being used for practical conservation work and no rangers or field staff have been employed. The government's main response to the designation has been to inject huge amounts of money into construction, notably of a special museum called the 'Yakushima Island Environmental and Cultural Village Center'. The museum is housed in an extravagant new building and is more obviously aimed at promoting tourism than conservation or education. It was jointly funded by the prefectural and national governments at a total cost of over US$ 14 million. About US$ 1.8 million of this was spent on producing a 22 minute giant-screen movie spectacle on the island's nature, with narration by a national celebrity. The staff consists of bureaucrats seconded from other government departments, and a team of receptionists, none of whom has any special knowledge or experience of Yakushima, or of wildlife conservation. Worst of all, much of the information given in the museum is misleading, painting a rosy and inaccurate picture of co-existence between man and nature. It ignores the enormous damage done by clear cut logging in the 60s and 70s and dismisses the annual trapping and hunting of thousands of monkeys and deer in recent years (Hill and Sprague 1991; Hill 1992) as 'minimal' nuisance animal control.

World Heritage status may also contribute to the growing tourist boom, as it is used to advertise the island as a holiday destination. The number of tourists visiting Yakushima has been increasing for some time (Fig. 2). Over the eight years from 1989 to 1996 the estimated number of tourists visiting the island increased by 60%. By 1996 the number of tourists visiting the island per year was more than ten times the number of people living there. Little provision has been made to protect the environment from the negative effects of the boom. Footpath erosion, increased litter and sewage are all major problems in the mountainous interior.

Increased tourist pressure is also apparent from the numbers of vehicles passing along the western coast road. Comparing the summers of 1993 and 1995, before and after designation, the numbers of private and rental cars increased by 33% (Sugiura *et al.* 1997). Despite warnings and notice boards forbidding the practice, tourists feed monkeys from their cars. This problem, once confined to specific tourist areas, is now increasing along the western coast road, which passes through the only part of the monkeys' major habitat which is protected against logging. It is very difficult to monitor tourist feeding of monkeys, but one indirect way of assessing its effects is to test their reaction to the presentation of a food that they would not normally be familiar with. In the National Park area along the west coast there are no orange orchards and ten years ago monkeys in this region did not respond to oranges as food (Hill unpublished observations). A survey conducted by Sugiura *et al.* (1997) in 1993 examined the responses of monkeys to an orange presented in the researcher's hand at various locations on the western road. In several groups they found that some monkeys approached the researcher when shown an orange. Furthermore, when trials were repeated two years later they found an increase in response rate at several locations.

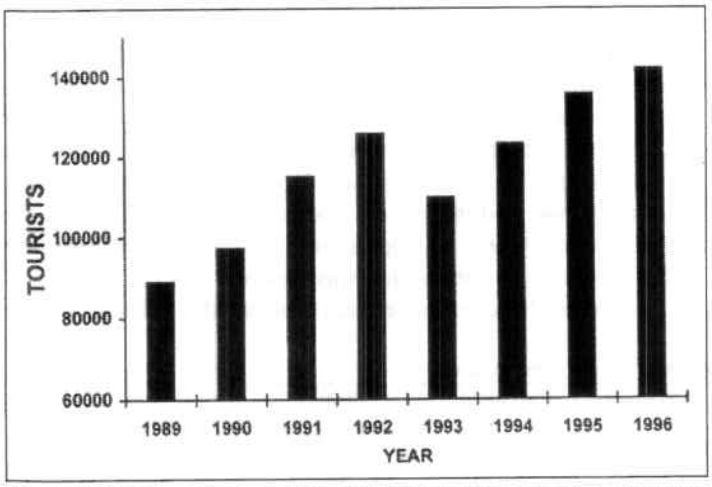

Figure 2. Number of tourists visiting Yakushima each year from 1989 to 1996 (based on government figures).

Circumstantial evidence from numerous locations around Japan suggests a link between tourists feeding monkeys and the problem of crop-raiding. It would be very difficult to test this idea, but at an intuitive level it makes sense. As the monkeys lose their fear of humans they become more likely to enter fields and orchards and more difficult to scare away from them. If this is the case, then feeding by tourists not only disrupts the behavior and ecology of the monkeys, but also contributes to the extermination of hundreds of monkeys each year in the name of pest control (Hill 1992).

Priorities for the future

Yakushima has no shortage of conservation designations, but none of them are adequate for effective protection of the macaques or other forest wildlife. There is a definite need to increase the effectiveness of the various designated areas for the conservation of wildlife, not only for their protection from hunting and habitat loss, but also for the prevention of undesirable activities such as feeding of monkeys. They need to be well signposted and regularly patrolled by rangers.

Protected areas should be extended to include more mature secondary forest, which is an important habitat for a wide range of organisms, including the macaques. Warm temperate forest should be recognized as an endangered vegetation type in East Asia, and protected as such. Also, efforts should be made to promote tourism which is not harmful to the environment, and to educate tourists about the wildlife and their potential impact on it.

A greater effort should be made to actively involve the local people in conservation efforts and developments relating to the World Heritage designation. More resources from prefectural and national government should be allocated to resolving conflicts between the local people and wildlife in ways which consider the needs of both. Problems such as crop-raiding present real threats to conservation and can only be solved by strong, long-term commitment.

Finally, it seems that the procedure adopted by IUCN/UNESCO in the designation of parts of Yakushima as a World Heritage site could be improved. Representatives visited the site, the designation was made and guidelines were issued. There is a plan to re-

turn to assess the effects of the designation several years later (Thorsell, IUCN, pers. comm.), but no plans for monitoring in the interim. Surely it would be better to make designation itself contingent upon a demonstration by the authorities responsible for the site that they have a management plan, that they are taking action which will improve or at least maintain the conservation status of the site and its wildlife, and that plans for development are in keeping with the spirit of the World Heritage Programme.

Conclusion

To date the designation of parts of Yakushima as a World Heritage site has had mixed implications for conservation on the island. The main response of the prefectural and national governments has been to construct an expensive new visitor center and to staff it with people who are not familiar with Yakushima or its wildlife. The number of tourists visiting the island continues to increase, but provisions to protect the environment from these tourists have been inadequate. This is leading to deterioration in terms of increased litter, sewage, footpath erosion, disturbance of wildlife and increased risk of fires. Although feeding of monkeys is officially discouraged, it continues to proliferate. This practice was once largely confined to one part of the island but is now spreading. These problems could be alleviated by recruiting rangers and field guides from the local populace to regularly patrol protected areas, to enforce regulations, and to educate tourists about the island and its wildlife. Investment in trained field staff, rather than in new roads, buildings and entertainment, would help to protect for future generations the unique environment and wildlife that earned the Natural World Heritage designation for Yakushima.

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