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Clem Tisdell† and Hemanath Swarna Nantha‡

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† School of Economics, The University of Queensland, Brisbane QLD 4072, Australia
Email: c.tisdell@economics.uq.edu.au

‡ School of Economics, The University of Queensland, Brisbane QLD 4072, Australia
Email H.SwarnaNanth@uq.edu.au

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For more information write to Emeritus Professor Clem Tisdell, School of Economics, iversity of Queensland, Brisbane 4072, Australia.

CONSERVATION OF THE PROBOSCIS MONKEY AND THE ORANGUTAN IN BORNEO: COMPARATIVE ISSUES AND ECONOMIC CONSIDERATIONS

Abstract

Concentrating on their presence in Borneo, the ecology and conservation of two large Southeast Asian primates, the orangutan *Pongo pymaeus* and the proboscis monkey *Nasalis larvatus* are reviewed. The former species occurs only in Borneo and Sumatra and the latter only in Borneo. The comparative threats facing these two endangered primates and their approximate numbers in the wild are put into perspective. The long-term survival of both species is adversely affected by the degradation and conversion of their suitable forest habitat by logging and agriculture, the occurrence of hunting, poaching and forest fires. The effectiveness of measures to conserve these species are discussed and evaluated from the standpoint of economics. It is concluded that informed assessment of the opportunity costs of conserving these species and their habitat is required and better incentives for law enforcement must be created. Properly regulated ecotourism may draw the necessary attention to the plight of these species and may even help fund conservation research. Economics can help identify least, or low, cost opportunities for conserving species as is demonstrated in this article, even if it is not always possible to demonstrate their economic value convincingly.

CONSERVATION OF THE PROBOSCIS MONKEY AND THE ORANGUTAN IN BORNEO: COMPARATIVE ISSUES AND ECONOMIC CONSIDERATIONS

Introduction

Two of the most intriguing primates on the primate-rich island of Borneo (Meijaard and Nijman, 2003) are the proboscis monkey *Nasalis larvatus* and the orangutan *Pongo pygmaeus*. The proboscis monkey is confined to Borneo whereas the orangutan occurs both in Borneo and in Sumatra. Both species have suffered sharp declines in their population (Sugardjito, 1995; Agoramoorthy, 2003) and face possible extinction in the near future (Nijman, 2001a, p. 185; Nellemann et al., 2007).

Borneo, the world's third largest island, is divided politically between three nations: Brunei, Indonesia and Malaysia. During the Pleistocene period when the sea levels were lower, Borneo was connected to the Asian mainland, and it is, therefore, classified as the Sundaic subregion of the Indian and Oriental biogeographical region. Consistently, evidence suggests that in the past the orangutan's distribution covered an area from northeastern India through Burma (Kahlke, 1972) and southern China and Vietnam, and stretching down to Sumatra, Java and Borneo (Delgado and van Schaik, 2000, p. 203). Both ecological and anthropological factors have contributed to the reduction of the orangutan's distribution (Jablonski, 1998; Goossens et al., 2006, pp. 0285-0286).

The orangutan (meaning 'man of the forest') is one of Southeast Asia's more recognisable and charismatic fauna. This shaggy ape's physical characteristics, function and behaviour are humanlike and local inhabitants have thought them to be a mythical race of people (Rijksen and Meijaard, 1999, p. 30; Cocks, 2002, p. 21). According to Rijksen and Meijaard (1999, p. 30), *Homo sapiens* belong to the same taxonomic group as four species of great apes: the African bonobo *Pan paniscus*, the chimpanzee *Pan troglodytes*, the gorilla *Pan gorilla* and the orangutan *Pongo pygmaeus*. They go on to state that,

> "[a]ccording to genetic and biochemical similarities, these Pongids may have evolved from a common ancestor over a time period of less than ten million years (Sarich and Wilson, 1967). There is no scientific justification for designating the human species as a separate family (Margulis and Sagan, 1986)."

The orangutan is in danger because its habitat – fertile alluvial plains and valleys in lowland tropical rainforests – is preferred by humans for timber extraction, agriculture and palm or rubber plantations (Sugardjito, 1995, p. 47; Rijksen and Meijaard, 1999). Orangutans that flee to human-occupied areas are considered pests and are shot. This species is also hunted and poached for the illegal wildlife trade (Rijksen and Meijaard, 1999, pp.109-127).

The proboscis monkey, distinctive for its red, protruding nose (which may be up to 17.5 cm long in males) and pot belly, was felt by the native inhabitants of Borneo to resemble the Dutch colonialists and were called 'Dutchman monkey' (Orang Belanda). As in the case of the orangutan, the proboscis monkey's low-lying coastal, swamp and riverine habitats happen to be areas preferred by humans for settlement, timber extraction and agriculture (Salter and MacKenzie, 1985; Nijman, 2001b, p. 175). As they avoid heavily deforested areas and other areas near human settlements (Salter et al., 1985), they struggle to persist once displaced. This species is also hunted for bushmeat by some local tribes.

Both the orangutan and the proboscis monkey are considered endangered according to the IUCN Red List (Eudey et al., 2000a, 2000b). The species are also listed under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), prohibiting their trade (CITES, 2006).

This article will review the conservation of the proboscis monkey and the orangutan, focusing mainly on Borneo. Review results will include a discussion of the ecology, distribution and size of populations of the focal species, comparative threats to the species, attitudes to the species and conservation measures. The discussion will assess the ecological effectiveness of conservation measures and some economic issues affecting the conservation of these primates.

2. METHODS

A literature survey was carried out of major scientific publications on the orangutan and the proboscis monkey. We compared their ecology, habitat types, the threats they face and their corresponding requirements for conservation. Figures for population sizes of the focal species were collated from various sources and tabulated. The general distributions of the species in Borneo were mapped. The economics of their conservation were explored, taking into account cost efficiency or cost effective factors.

3. RESULTS

3.1 The ecology and life history of the proboscis monkey

This large, odd-nosed monkey is the only species in the genus *Nasalis* and is found in forested areas near water, such as river edges, coasts, mangroves and swamps and sometimes well inland along river systems (Meijaard and Nijman, 2000a, p. 15). Adult males have a head and body length of 660-762 mm and weigh between 16.0 and 22.5 kg (Nowak, 1999, p.154).

The proboscis monkey is a folivore/frugivore: its diet consists primarily of leaves but it also eats fruits, seeds, and flowers and occasionally some invertebrates, such as caterpillars and insect larvae (Kern, 1964; Yeager, 1989). The proportion of leaves and fruits consumed may vary with the season and locality. The species helps to maintain vegetational diversity in areas where it lives because it eats seeds (Yeager, 1989). The species feeds mainly in the early morning and evening (Macdonald, 1982). The stomach of the proboscis monkey is twice as large as that of any other colobine. This leaf-eater relies on bacteria to help digest the cellulose in its food. They do not drink water but get enough water from the leaves they consume.

According to Kawabe and Mano (1972) group sizes range between 11 - 32 individuals whereas Macdonald (1982) observed group sizes of 2 - 63 and stated that larger formations may be temporary foraging parties. Population densities were observed to be 5.93 per km^2 in parts of

Sarawak (Bennett and Sebastian, 1988) and in the Kalimantan average population density was reported to be 63 per km^2 (Yeager, 1989, 1990, 1991, 1992). Their home ranges vary by area and are between 1 and 2.2 km^2 (Kern, 1964; Wolfheim, 1983, p.534; Boonratana, 2000) but are not exclusive. They usually sleep or rest individually on trees over water or at the edge of it (Salter et al., 1985). This means that it is relatively easy for tourists to view them from a boat, particularly in the morning prior to or while they move away to feed and when they return to the waterside in the evening (MacDonald, 1982; Salter and MacKenzie, 1985, p. 121). They swim across rivers on the surface and underwater and are considered to be the most proficient swimmers amongst primates (Kern, 1964).

The proboscis monkey, found most frequently in coastal areas, occur more sparsely inland most likely as a result of hunting by tribal inhabitants (Meijaard and Nijman, 2000a). Their hunting is facilitated because they can be found by accessible waterways. Proboscis monkey habitat has been amongst the most severely affected of any primate by the large forest fires of 1997 in Kalimantan (Yeager and Frederiksson, 1998) and this is likely because the forest fire hotspots were located near rivers (Fuller and Fulk, 1998). The recovery and persistence of this species' populations is very sensitive to hunting pressure and natural disasters because they are a k-selected species with a slow rate of reproduction.

3.2 The ecology and life history of the orangutan

The orangutan has a head and body length averaging 1250 to 1500 mm (Nowak, 1999, p. 175). An adult male weighs between 50 and 90 kg (Rijksen, 1978). The species demonstrates tool use, some basic form of culture and is able to use leafy branches and drape large leaves around itself to protect itself from rain or sunshine (Russon and Galdikas, 1995; Nowak, 1999, p. 175; van Schaik et al., 2003). They are mostly found in alluvial forests in river valleys, floodplain peat forests (Rijksen and Meijaard, 1999, p. 68) riverine forests, low upland hills and other tropical evergreen forests (Meijaard and Nijman, 2003). In Borneo, the orangutan's altitudinal limit is generally observed to be 500 metres above sea level (Groves, 1971) and their choice of habitat is shaped by the availability of their preferred food source (Rijksen and Meijaard, 1999, p. 69).

The orangutan are the most arboreal of the great apes — they spend more time up amongst the trees than on the ground compared to chimpanzees and gorillas (Galdikas, 2005, p. 98). They therefore almost always travel through the forest canopy (MacKinnon, 1974; Rijksen, 1978; Sugardjito, 1995). The orangutan is primarily a fruit eater, but also consumes leaves, bark and insects (see Rijksen and Meijaard, 1999, p. 65). They eat a wide variety of fruits obtained from numerous tree species, particularly large-cropping fruit trees, such as figs, and prefer ripe, soft-fleshed fruits (Galdikas, 1988; Djojosudharmo and van Schaik, 1992; Leighton, 1993). The abundance of fleshy fruit trees can serve as a correlate for the density of orangutan populations in a forest area (e.g., van Schaik et al., 1995; Blouch 1997; Galdikas, 2005, p. 106). Both a reduction in forest canopy and in the availability of fruit trees therefore can adversely affect orangutan population densities (Felton et al., 2003, p. 92). An important food source for orangutans, the strangling fig, relies on stands of the Dipterocarpaceae family of trees – precisely the type of trees most sought after for timber (Sugardjito, 1995, p. 47).

The ranging patterns of orangutans are fairly variable (Rijksen and Meijaard, 1999). Orangutans may reside in a single area for most of a year for many years (Rijksen, 1978; te Boekhorst et al., 1990), may frequently return to a particular area for parts of a year, or infrequently visit an area and may never return to it (Rijksen and Meijaard, 1999, p. 80). Studies in Borneo reveal that adult males have home ranges of 2 to 6 km^2 (see Nowak, 1999, p. 175). The average population densities of the orangutan ranges between 0.1 and 3.5 individuals per km^2 in Borneo (and up to 7 individuals per km^2 Sumatra), with flood plains, peat swamps and alluvial/bottomland forests being habitats where they are most concentrated (see Rijksen and Meijaard, 1999, pp. 92-93).

The orangutan has a slow reproductive cycle: a female produces offspring every 7 to 8 years (Galdikas and Wood, 1990). The ability of orangutan populations to rebound from reductions cause by hunting or forest fires is therefore slow. Threats such as rampant logging reduce orangutan population density not only because the habitat's carrying capacity is reduced but also because these habitats then become prone to further exploitation and forest fires. The large forest fires in Borneo during 1996-1997 (which affected an area of 50,000 km^2 (Rijksen and Meijaard, 1999, p. 104)) and more recently the fires of 2006 were in large part caused by arsonists wanting to clear remnant forests that were left after logging operations for agriculture. Orangutans that

fled the fires and took refuge in human-occupied areas such as plantations were considered pests and were killed (Roach, 2006). Some were also eaten by humans (McWilliam, 2001). Poaching and illegal trade in the species also occurs (Sugardjito, 1995, p. 47; Rijksen and Meijaard, 1999). Overall, suitable orangutan habitat is estimated to have declined by at least 80% between the mid-1970s and mid-1990s, and orangutan populations in the wild were observed to have declined by 30 to 50% (Soemarna et al., 1995, p. 123).

3.3 Geographical distribution and population size

The generalised distribution of the orangutan and the proboscis monkey in Borneo are shown in Figure 1. It should be noted that the occurrence of the orangutan within its distribution is patchy and of an uneven density. The occurrence of the orangutan depends, for example, on the availability of their preferred food sources and this in turn is influenced by topography and is affected by the impact of logging operations (van Schaik et al., 1995; Rao and van Schaik, 1997). Further, the distribution of the orangutan is not entirely contiguous but is very fragmented (see Rijksen and Meijaard, 1999). The distribution of the proboscis monkey overlaps considerably with that of the orangutan. Nonetheless, significant populations of proboscis monkeys (consisting of possibly 100 to 1000 individuals) are also found outside these overlapping areas, in unprotected forests such in the southeastern Sarawak-northern West Kalimantan, South Kalimantan and inner East Kalimantan (see also Meijaard and Nijman, 2000, p. 17).

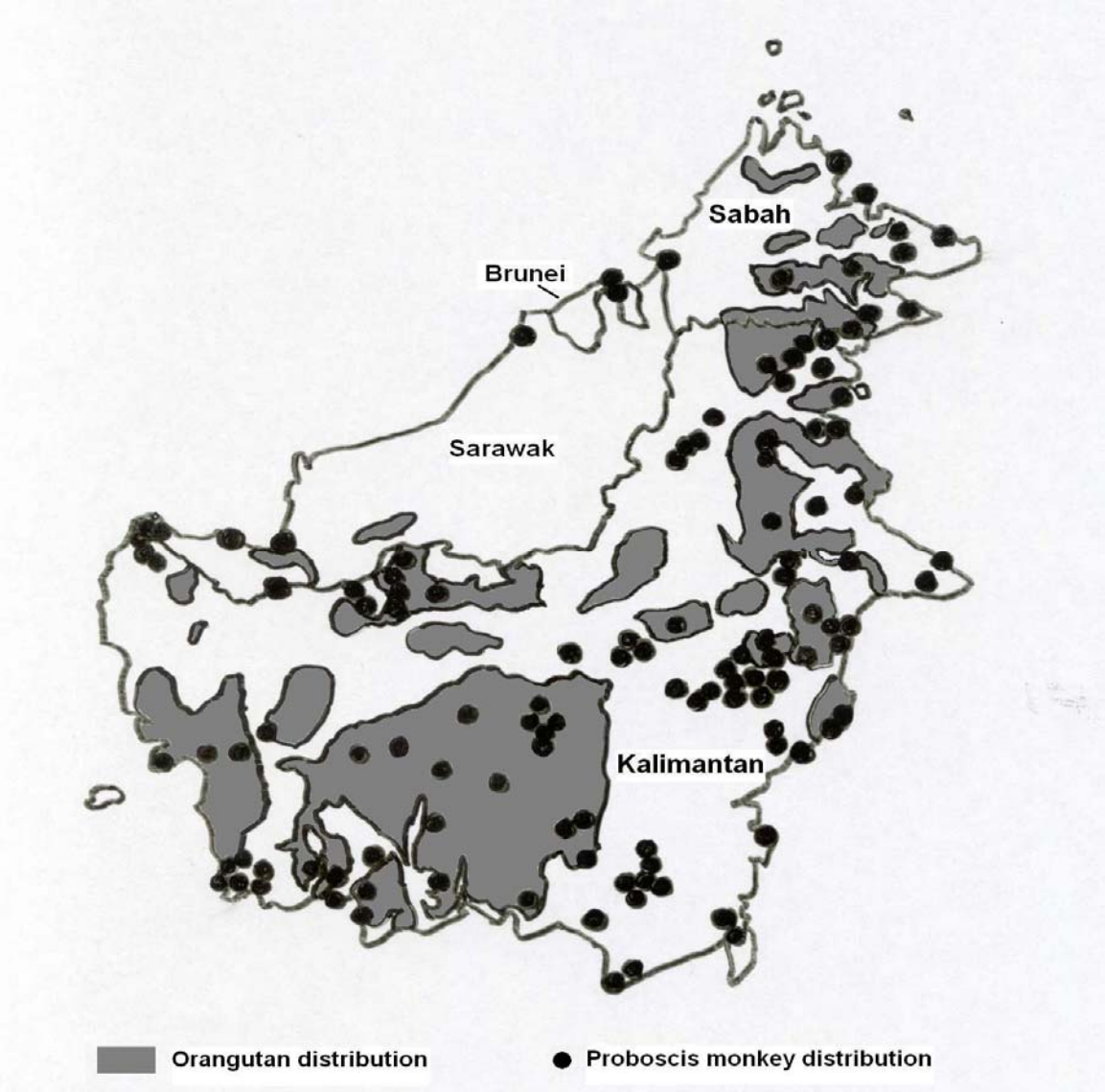

Figure 1: General distribution of the orangutan and of the proboscis monkey in Borneo. Data for the orangutan are based on data up till July 1997 from Rijksen and Meijaard (1999, p. 269). Data for the proboscis monkey are based on observations made by various researchers between 1978 and 1999, as found in Meijaard and Nijman (2000, p. 17).

Accurate, comprehensive and up-to-date estimates of the population sizes of the proboscis monkey and the orangutan are largely unavailable. This is due to, among other things, the vastness of Borneo and the inaccessibility of many of its parts, the difficulty in obtaining reliable maps of its areas, limited feedback from various organisations, and the difficulty in detecting the study animals (the orangutan in particular) (see for example Rijksen and Meijaard, 1999, pp. 179-185). Nevertheless, some estimates are available of the number of these focal species. Tables 1 and 2 contain estimates of population sizes for the proboscis monkey, gathered from the

work of various field scholars, and for the orangutan obtained from a survey done by Rijksen and Meijaard (1999). Most of the estimates of population sizes for the proboscis monkey were made in the 1980s. The estimates for the orangutan were made before the occurrence of major fires and drought in 1997 destroyed a significant amount of proboscis monkey and orangutan habitat. It is highly likely that the size of the populations of these species have since declined further. These estimates also indicate that the present population of proboscis monkeys in Borneo is about half that of the orangutan in Borneo and about a third of the total extant population of the orangutan.

Table 1: Estimates of numbers of proboscis monkeys *Nasalis larvatus* in Borneo

Area	Numbers	Percentage (%)
Kalimantan[1]	7,500	68.7
Sabah[2]	2,000	18.3
Sarawak[3]	1,000	9.2
Brunei[4]	420	3.8
TOTAL	10,920	≈100

Notes

[1] Derived from estimates in Meijaard and Nijman (2000) Table 1, p. 17. A minimum of 2,800 and a maximum of 12,200+ individuals were calculated. The figure presented in the table is an average of these.

[2] Based on Salter and MacKenzie (1985)

[3] Based on Bennett et al. (1987)

[4] Estimate by MacKenzie in 1982-1983. Reported in Salter and MacKenzie (1985, p. 131).

Table 2: Estimated numbers of orangutan *Pongo pygmaeus* in Borneo and Sumatra in mid-1997[1]

Area	Numbers	Percentage (of grand total) (%)
Kalimantan (Indonesia)		
West Kalimantan	6,695	18.7
Central Kalimantan	10,158	28.3
East Kalimantan	4,208	11.7
Sub-total	21,061	58.7
Malaysia		
Sabah	1,687	4.7
Sarawak	385	1.1
Sub-total	2,072	5.8
Brunei	0	0.0
Total Borneo	23,133[2]	64.4
Total Sumatra (Indonesia)	12,770	35.6
GRAND TOTAL	35, 903[2]	≈100

Notes

[1] Estimates derived from Rijksen and Meijaard (1999), Appendix 4; their data were obtained from a survey carried out before the impact of the 1997 forest fires.

[2] Rijksen and Meijaard (1999, p. 286) estimate that a third of the orangutans in Borneo may have perished as a result of the 1997 forest fires, and revise the total number of orangutans in Borneo to 15,000. Thus, overall, there may have been only 27,770 orangutans left in the wild after the 1997 forest fires.

In 2004, the IUCN/SSC Conservation Breeding Specialist Group (Singleton et al., 2004) conducted a population and habitat viability assessment (PVA) for the orangutan. In their study, the orangutan population sizes that were used as the basis for the PVA are much larger than those of Rijksen and Meijaard (1999). This underlines the fact that estimates of orangutan populations are still uncertain. Some of the reasons for this were mentioned above. There is, however, no disagreement that orangutan population levels are falling rapidly, especially with the reoccurrence of forest fires in Borneo.

3.4 Attitudes to the focal species

According to Inskipp and Inskipp (2000, p. 167), "unlike in India and Indo-China, there have been no long-term feelings of sympathy for wildlife based on religious beliefs. So in some of these countries [Indonesia and Malaysia], animals are suffering even more severe persecution as well as habitat loss." Many tribal people in Borneo still kill primates to eat or to use in other ways, even though this is illegal. Although Muslims are forbidden to eat primates, this does not mean that they are forbidden by religion from killing them (Sugardjito, 1995). In addition, countries such as Malaysia and Indonesia are still developing and so environmental awareness may not be widespread or a priority amongst the populace. This is especially so in rural regions where incidences of poverty are high and subsistence living is the rule. While rapid economic growth in these Southeast Asian countries is claimed to have only led to greater selfish consumerism, there are also signs that affluent youths in urban areas are increasingly interested in working for or contributing to NGOs involved in humanitarian and nature conservation work (Wehrfritz, 2006). However, at present, most of the political pressure and funding to conserve proboscis monkeys and orangutans come from NGOs outside Borneo and Sumatra. These include the World Wide Fund for Nature (WWF), Orangutan Foundation International and numerous nature societies and foundations for nature conservation based in Western Europe and North America. This suggests that the conservation of these species is not a high priority for local inhabitants of Borneo.

3.5 Comparative threats to the focal species

The orangutan and the proboscis monkey face similar threats. Meijaard and Nijman (2000, p. 17) list in their Table 1 the threats to the proboscis monkey in Kalimantan in 16 priority areas. The following are the frequencies with which the threats are mentioned: logging (including illegal logging) (15), hunting (4), fire (3), shrimp farming (2), mining (1), and swamp reclamation for agriculture (1). Whether or not these relative frequencies give a sound indication of the comparative threats to these species is unclear. For example, plantation agriculture is not specifically mentioned, nor is the scale of the disturbance consequent to these threats considered.

Similarly, in the case of the orangutan, Rijksen and Meijaard (1999) gave most coverage to logging and hunting as major threats to this ape as well as forest fires. But it is the closer human settlement and the development of agriculture and forest plantations which appear to seal eventually the fate of many lowland species in Borneo. This development often takes place following logging of an area. As pointed out in Payne (2000, p. 5):

> "Some species need lowland forests to survive in the long term as wild breeding populations. The Orang-utan, a species which in Borneo is concentrated mainly in forests below 150 metres (500 feet) altitude, is an example. During the past two decades, the natural habitat of several thousands of Bornean Orang-utans has been converted to planned agricultural schemes and plantations. Some of these apes have been taken to 'rehabilitation centres' in protected forests and some may have moved into adjacent areas. Others, however, will have either died or been exported illegally to destination areas."

Indonesia's transmigration program of people from over-populated Java to Kalimantan and policies for the economic development of Borneo inevitably threaten the survival of forest-dependent wildlife.

3.6 Conservation measures

Within Borneo and globally, several conservation measures have been adopted to protect proboscis monkeys and orangutans. The killing and the capture of these species is illegal in all the countries where they occur. Internationally, trade is banned under CITES but poaching of the species continues due to inability or unwillingness to enforce the laws.

Protected areas have been established in Borneo that favour proboscis monkeys and orangutans, but these are often too small, fragmented or degraded to ensure ecologically the survival of the species, particularly in the case of the orangutan. Some protected areas are largely mountainous and so contain little suitable habitat for the orangutan or the proboscis monkey.

In developing countries, many protected areas — nature reserves and declared national parks — are only 'paper parks'; their protected status in reality is not enforced nor are these areas effectively policed. As with the orangutan, the proboscis monkey is far from safe in the existing reserves established for it, especially in Kalimantan. A documented example is the local extinction of the proboscis monkey in Pulau Kaget Nature Reserve, Indonesia as a result of encroachment and illegal agricultural development (Meijaard and Nijman, 2000b). Wildlife is therefore at risk even in protected areas in Borneo.

Rijksen and Meijaard (1999) suggest that 10,000 km^2 of suitable forest area is required, with some suitable corridors for connectivity, for the long-term survival of an orangutan meta-population (see Rijksen and Meijaard, 1999, p. 175, 377). The required area suggested by them for successful conservation of the orangutan *in situ* is, therefore, quite large (see Rijksen and Meijaard, 1999, pp. 276-278). Furthermore, the economic opportunity cost of conserving the area is likely to be high from the point of view of humans because lowland areas very often have the best forest stands and are most suited to agriculture and human settlement.

While prospects for conserving the proboscis monkey *in situ* may however appear better than they are for conserving the orangutan *in situ*, the opposite is the case for *ex situ* conservation. Unlike the orangutan (see Cocks (2001) on orangutans at the Perth Zoo, Australia), the proboscis

monkeys rarely survive for long in captivity. However, progress in conserving proboscis monkeys at the Singapore Zoo has been made by providing them with food that matches the nutritional content of their varied diet in the wild (Agoramoorthy et al., 2004).

In Borneo, several rehabilitation centres have been established for orangutans. The main ones are Sepilok in Sabah, Semenggoh in Sarawak, Camp Leakey and Wanariset Samboja in Kalimantan (Rijksen and Meijaard, 1999, pp. 155-156; McWilliam, 2001).

Their purpose is to take in orangutans that have been displaced by logging and other developments, illegally captured, or are young and have lost their mothers due to hunting, and care for them with a view to re-introducing them eventually to the wild. Such centres are also normally tourist attractions, although Rijksen and Meijaard (1999) argue that this sort of use is counterproductive to the long-term aim of conserving the orangutan in the wild. Rijksen and Meijaard (1999) point out that orangutans often fail to survive when released to the forests from such centres because they have become dependent on care and therefore are unable to cope with an independent way of life in the wild. There may also be a tendency in their view not to release orangutans from rehabilitation centres but to keep them to attract tourists from whom the centres gain commercially, or even to seek more confiscated orangutan for tourist purposes when the ultimate goal should be to eliminate the need for having a rehabilitation centre. These authors therefore maintain that the rehabilitation centres are more of a palliative than a positive means for the conservation of wild orangutans. However, they suggest that strictly controlled and regulated ecotourism that minimises exposure of orangutan to disturbing contact with humans can serve to educate people about the plight of the orangutan (Rijksen and Meijaard, 1999, p. 176, 377).

4. DISCUSSION

Populations of both the proboscis monkey and the orangutan continue to decline due to multiple threats. While logging (legal and particularly illegal) is most frequently cited as the main threat, other important threats include the hunting of these species and fires which are often associated

with logging activities and subsequent farming of deforested areas. While appropriately managed forestry can be compatible with these species, possibly at reduced carrying capacities (see for example, Johns, 1983, 1988; Rijksen and Meijaard, 1999, p. 187), the severe habitat change brought about by agricultural development generally results in their local extirpation. Not only do farmers convert former forests to crop fields, but also many agriculturalists regard remaining orangutans in the surrounding area as pests.

While agriculture does not seem to be compatible with the survival of these primates, there is evidence that rotational forestry is compatible with the survival of local orangutan populations. For example, the IUCN/SSC Conservation Breeding Specialist Group (Singleton et al., 2004, p. 173) reports that the Deramakot Forest Reserve, a part of the Upper Kinabatangan forests uses a rotation system of reduced impact logging and this system

> "has resulted in a mosaic of lowland habitats at different stages of exploitation and regeneration. Deramakot supports one of the highest orangutan densities in Sabah with a population of over 1000 individuals and is considered to be a good model for combining logging practices with orangutan conservation."

However, the ecological adaptation of the local orangutan population is not yet fully understood. Furthermore, the costs of these changed forest management practices require study. It is possible that the costs may not be high, especially if the practices support long-term sustainable natural forest utilisation. The challenge, however, is to formulate well-targeted economic incentives to forest concessionaires to adopt such practices or propose economic penalties for not doing this.

Given that illegal logging (even in protected areas) is still rampant in parts of Borneo, an urgent priority is to police logging more effectively. Without stronger governance, wildlife will continue to suffer.

Both the population of proboscis monkeys and orangutans reproduce slowly, the rate being slower for the latter. Small annual reductions in population size can result in the extirpation of their populations. Therefore hunting in some parts of Borneo is a significant threat to these

species. In relation to the orangutan the IUCN/SSC Conservation Breeding Specialist Group reports:

> "Low rates of hunting (more than 1% per year) could destabilize and threaten the persistence of even initially large populations in extensive areas of habitat. The impacts are most severe when hunting occurs in lower quality habitat, where the potential population growth rate is low at best, but even in the best habitats, the slow breeding rates of orangutans cannot compensate for hunting at rates of 2% and higher." (Singleton et al., 2004).

Hunting is difficult to prevent especially by groups such as the Dayaks who have traditionally hunted primates for food. In the absence of other economic opportunities, their incentive to use forest resources remains strong, and stronger law enforcement is problematic politically.

Conversion of forests to agricultural use such as for oil palm production, rice growing, soybean production permanently eliminates forest habitat and is a growing long-term threat to the survival of proboscis monkeys and orangutans in Borneo. There is a need to more carefully assess the economic returns and social impacts of such developments. Economic returns should be based not just on private economic returns from such developments but should also take account of social economic returns. The latter returns can often be much lower than private returns because private development can give rise to adverse environmental spillovers. For example, plantations often are a major source of forest fires and the elimination of swamps for agriculture may adversely affect secondary forests because of changes in hydrology. Forests usually die as a result of these hydrological changes. Extensive alteration of forested landscapes can also consequently result in undesirable changes in local rainfall patterns and climate.

Furthermore, bureaucrats often seriously overestimate private returns from agricultural development. The Mega-Rice Project in Kalimantan provides an example. The IUCN/SSC Conservation Breeding Specialist Group (Singleton et al., 2004, p. 170) points out:

> "… the disastrous Mega-Rice Project, perhaps the largest and most destructive agricultural conversion project in the world in recent times, demonstrated how rapidly areas of orangutan habitat can be destroyed. In a bid to boost the country's rice production, one million hectares of peat-swamp forest was partly cleared and drained during 1995-1997 in preparation for conversion to rice fields. Most of this land is covered in highly acidic, deep peat and is useless for agriculture. The construction of a network of massive canals completely drained the peatland during the dry season, and even when it became apparent that rice wouldn't grow and the project was abandoned, the drainage of the proposed rice field areas also drained vast tracts of the surrounding forests. Dead wood and dry peat became a tinderbox, flaring into uncontrollable fires that raged for six months during 1997-1998. Over 400,000 hectares of forest burnt (Page et al., 2002) and virtually no forest remained for orangutan to seek refuge in. IN any case, the canals, rivers and farmland largely prevented orangutans from moving into remnant forests. If we estimate an approximate orangutan density for the area of 2 individuals per square kilometer, that equates to 8,000 individuals that perished in the fires. A wasteland is left where before there was diverse rainforest."

This development project yielded negative private returns and has had much larger negative social returns.

From an economic viewpoint, an important consideration in conserving species is the opportunity cost of doing so. The opportunity cost of conserving a species for example setting aside sufficient area of habitat to ensure its survival, is indicated by the highest economic return foregone by not using the area in another way, for example for agriculture or logging followed by agriculture. From the above, it can be deduced that no opportunity costs are involved in preserving peat swamp areas for the conservation of orangutans and proboscis monkeys.

Views differ about how large an area of habitat need to be set aside to conserve the orangutans. Rijksen and Meijaard (1999, p. 175, 377) suggest that a minimum viable meta-population of 5,000 adult orangutans requiring an area of suitable habitat of about 10,000 km^2. This implies

that the habitat on average has a carrying capacity of one orangutan per 2 km^2. The area required is sensitive to the level of carrying capacity of the habitat conserved. In Borneo, habitat carrying capacities for orangutans are estimated to range from 0.1 - 3.6 adults per km^2. Even if the average carrying capacity of the conserved area is two adults per km^2, the required conservation area would be 2,500 km^2. Nevertheless, given such a large area, the opportunity cost in terms of foregone economic development would potentially be high. However, this would vary with the areas involved. For example, as pointed out above, forest swamps have very little sustainable potential for commercial development, and therefore the opportunity cost of conserving this habitat is low. On the other hand, conserving production forests slated for logging would imply a high opportunity cost.

The findings of the IUCN/SSC Conservation Breeding Specialist Group (Singleton et al., 2004) give a smaller minimum viable population of adult orangutans than stated by Rijksen and Meijaard (1999) because Rijksen and Meijaard are considering a meta-population whereas Singleton et al. (2004) consider single populations. This group states on p. 154:

> "Our initial exploration of some scenarios representing typical populations on Borneo suggests that orangutan populations restricted to habitats capable of supporting only about 50 animals can persist for a considerable number of years, but are unstable and vulnerable to extirpation. Habitats capable of supporting more than 250 orangutans appeared necessary to ensure good demographic and genetic stability."

They go on to conclude that populations of at least 500 orangutans would be sustainable and genetically stable in the long run (Singleton et al., 2004, p. 169).

Therefore, according to this view, even if a habitat has a carrying capacity of two adult orangutans per km^2, an area of at least 125 km^2 is needed for long-term viability of orangutan populations and 250 km^2 is desirable. Clearly the minimum required protected area for the viability of orangutans populations will vary with the carrying capacity of the area conserved which will differ with locality and the availability of food tree species.

The area required for conserving a minimum viable population level of orangutans are likely to be larger than that needed to conserve a minimum viable population of proboscis monkeys because proboscis monkeys are more adaptable general feeders compared to the fruit-eating orangutan and are smaller in size. Therefore, since these species can often be found in similar areas, the economic opportunity cost of conserving a minimum viable population of the proboscis monkey appears to be much less than for the orangutan. Also while the orangutan can be an agricultural pest, the proboscis monkey is not.

Economists often try to value a natural resource, such as a wildlife species in terms of its total economic value. This is envisaged as consisting of non-use or passive values such as existence and bequest values and of use values, comprising consumptive use value, for example for meat, and non-consumptive use value, for example for tourism. In Borneo, most local communities are possibly only or primarily interested in the use values of the species involved. On the other hand, the prime interest of conservationists in higher income countries is in the non-use values of wild species.

The proboscis monkey appears to have a higher use value in the wild for tourism than the orangutan. They are conspicuous, not as cryptic as the orangutan and are easily spotted in their natural riverside setting. The Klias Peninsula in Sabah, about 120 km southwest of the state capital of Kota Kinabalu, has become a popular tourist attraction for its proboscis monkeys. A recent news report claims that "the popularity of the Klias proboscis monkeys has gradually surpassed that of the orangutan in the Sepilok sanctuary in Sandakan," (Kamarudin, 2006). This may be due to the fact that visitors are able to view the proboscis monkeys in natural settings. Conversely, it is well-known that the orangutan is difficult to spot in the wild even for an experienced field ecologist. Nevertheless, some well-regulated ecotourism ventures that cater wild viewing of orangutans are in operation in Sabah, such as the community-based Red Ape Encounters and Adventures in the Sukau area of the Kinabatangan Valley. Ecotourism ventures such as these could provide an economic incentive for conserving proboscis monkey and orangutan populations in addition benefiting their conservation in the wild.

In carrying out economic assessments of the conservation of potential areas, it is also appropriate to adopt a holistic approach rather than assess the value of saving a particular species. Often, conservation of a forest conserves multiple species and preserves a variety of ecosystem services. These all need to be included in the economic assessment of conserving a biome. In effect, such multiple benefits reduce the costs of conserving a forest or similar areas to protect a particular species or set of species. Bennett and Reynolds (1993) observe that the conservation of the mangrove habitats of the proboscis monkey, for example, yields multiple economic benefits.

As Bennett and Reynolds (1993) point out:

> "It is not always easy to justify the conservation of rain forests using economics alone, however, and other reasons such as wider environmental effects, aesthetics and life style values often need to be considered as well. On the other hand, in the case of mangrove forests, the economic values of the intact habitat vastly outweigh those of cutting the trees."

It seems likely, that there are other rainforest areas in Borneo where this is also the case. On available evidence, this seems to be so for Borneo's rainforests located in peat swamps. These forests support proboscis monkeys as well as orangutan and other wildlife species. Further research along the lines suggested by Bennett and Reynolds (1993) would be desirable.

The loss of forests in Borneo, causing loss of wildlife and biodiversity there, has been attributed by some to the progress of globalisation. This process extends the market for timber and for the products of plantation agriculture, such as palm oil, and it facilitates foreign investment in forest conversion and habitat change. The results can be devastating for nature conservation, particularly when open access to natural resources occurs due to the widespread practice of illegal business operations. On the other hand, growing globalization also can be supportive of nature conservation. It facilitates international wildlife-based tourism which, if appropriately managed, can provide economic incentives for nature conservation. Secondly, it fosters the involvement of international conservation bodies (NGOs) in promoting nature conservation in developing areas, such as Borneo. Thirdly, well-developed global communication networks

provide the residents of higher income countries with more information than ever before about environmental issues in developing countries. It may result in their being more willing to support actions to address these problems. Nevertheless, it seems that in recent times, the latter forces have been weaker than the forces of economic growth favouring habitat change and conversion. Therefore, globally biodiversity in the wild has continued to decline alarmingly and primates, such as the orangutan and the proboscis monkey in Borneo, have become increasingly endangered.

Although the available evidence indicates that the extant population of the orangutan in Borneo is much larger than that of the proboscis monkey, the former seems to be at greater risk of extinction in the wild. This is because it requires a much larger sized habitat for its survival than the proboscis monkey and is considered by many agriculturalists to be a pest. Therefore, the opportunity cost of conserving the orangutan is considerably higher than for the proboscis monkey. Moreover, the proboscis monkey has considerable potential for attracting tourists to view it in the wild whereas the orangutan is difficult to find in the jungle and less attractive for tourism in natural areas. The tourism potential of the proboscis monkey means that local communities may be able to earn income from tourists who come to see it. This provides an economic incentive for its conservation.

At present no reliable estimates exist of the overall size of the populations of the proboscis monkey and the orangutan. Further, it is doubtful if reliable and socially acceptable estimates of their total economic value (for example, contingent values) can be calculated. Nevertheless, if it is decided that these species should be conserved, there is still a role for economics. The economist can contribute to a study of the costs of their conservation and to the search for means to minimise or limit this cost (Tisdell, 2005, Ch. 1). In searching for cost-effective or cost-efficient conservation strategies, account needs to be taken of the opportunity cost of conserving natural land areas for the survival of the focal species. In Borneo, one of the habitats in which proboscis monkeys and orangutan occur is peat swamp land. The opportunity cost of conserving these areas is low and so they can be economically included in nature reserves. In addition, the cost of modifying forestry practices so as to sustain some suitable habitat for the focal species may be relatively low, as suggested by experience in the Deramakot Forest Reserve. This should

be explored further. Finally, it should be borne in mind that conserving a biome is likely to conserve several valued species (the biodiversity involved should be a part of the rational decision making process) and in some cases, the biome preserved provides humans with several valued environmental services. Bennett and Reynolds (1993) found in relation to mangrove areas in Sarawak containing proboscis monkeys that the economic value of their environmental related services warranted their preservation. Thus, economic considerations should play an important role in strategies to conserve the proboscis monkey and the orangutan. Economics can help identify low cost or least cost opportunities for conserving such species.

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