

Tropical forest logging—

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The destruction of tropical forests is perhaps one of the most widely discussed conservation problems of our time. But still scientists know relatively little about the ecosystem as a whole and, more specifically, little about the effects of, for example, selective logging on other forest species. The author, investigating the response of primates to logging in West Malaysia, discovered that, although logging initially causes mortality, the populations of the species he studied all recovered rapidly if the forest was left to regenerate.



Lar gibbon—a relaxed attitude to logging? (Andrew Johns).

Commercial logging is frequently reported as a serious threat to tropical forest animals. In its most destructive form, where whole areas of forest may be clear-felled and the land planted with agricultural crops or single-species tree plantations, few forest animals can survive. However, most commercial logging is selective, designed to remove only the most valuable timber, but even where only a few trees are extracted there is a high loss rate of other trees through incidental damage.

The results of a recent two-year field study in West Malaysia shed some light on the ability of primates to survive severe habitat disturbance. The Sungai Tekam Forestry Concession, where the study was located, is an area of hill dipterocarp forest undergoing selective logging on an estimated 70-year cycle. Forests are theoretically left to regenerate during the intervening period. Logging at a level of 18 timber trees per hectare

resulted in a loss of 51 per cent of the total tree cover. This amounts to random destruction of half the food resources available to primates.

One nocturnal and five diurnal primates occur on the concession. Of these, the crab-eating macaque *Macaca fascicularis*, which is primarily a riverine species (Kurland, 1973), had a rather localised distribution, and the pigtail macaque *M. nemestrina* was rarely observed due to its wide-ranging behaviour. The common gibbon *Hyllobates lar*, banded and dusky leaf monkeys *Presbytis melalophos* and *P. obscura*, and the nocturnal slow loris *Nycticebus coucang* were all relatively common.

The survival of primates in logged forest is influenced by both their ability to tolerate initial logging and their ability to adjust to the different environmental conditions of regenerating forest.

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primates and can they co-exist?

Immediate effects of logging

Logging initially caused major changes in group ranging and activity patterns, mainly concerned with avoiding centres of human activity. Logging also caused a high level of infant mortality; almost all the primate infants previously present in the groups had disappeared by the time logging was completed (Johns, 1981). Few primates were directly killed by felling operations, perhaps only the nocturnal slow loris was susceptible: animals were killed as their sleeping trees were cut down. Mortality of infants probably occurred indirectly through their falling out of trees, either during travel or when the group fled from human disturbance, and their subsequent abandonment. The larger gaps between trees in logged forest made travel difficult and increased the likelihood of infants becoming dislodged from their mothers. In addition to infant mortality, there was a low level of juvenile and adult injury and mortality. In the absence of conflicting evidence this is also attributed to falling out of trees. Though predation might become easier in the more open conditions of logged forest, where primates are more often forced into exposed positions, few of the West Malaysian predators are known to take primates, and predation is an extremely rare event (Chivers, 1980).

Long-term effects of logging

Logged forest might be expected to support fewer primates than primary forest, since many food sources are lost. Most colonising species in regenerating forest do not produce fruits that are eaten by primates, and their leaves carry a high level of secondary compounds making them distasteful. Group density does not, however,

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Ridgetop access road through part of the Sungai Tekam Concession (Andrew Johns).

appear to be less in logged forest; data were not available for the crab-eating or pigtail macaque since these species were rarely encountered and estimates could not be made accurately.

pressure upon certain primates as they become recognised as 'pests'. Hunting for food may represent the single most important threat to primates in many parts of the world, particularly in West

Table 1. Primate density in unlogged and logged forest at Sungai Tekam (groups/sq km)

Species	Mean group size	Primary forest	1-2-year-old logged	3-4-year-old logged	5-6-year-old logged
<i>H. lar</i>	3.3	2.5	2.8	2.5	2.8
<i>P. melalophos</i>	14.0	3.4	2.3	4.5	3.4
<i>P. obscura</i>	14.0	0.5	1.9	2.4	1.4
<i>N. coucang</i>	1.0	25.1	6.0	26.5	5.3

Estimates generated by mapping ranges of groups (diurnal primates) or by censusing (*N. coucang*).

Although estimated group density fluctuates between sites, there is no consistent downward trend with age of the forest since logging. This is also indicated where estimates of overall biomass are made from the density figures. There is a decrease immediately following logging, corresponding to initial mortality within primate groups, but biomass in older logged forest does not appear to be significantly different from that in primary forest.

Africa and in South America, and may be facilitated by improved access following logging. Factors such as these can prevent the re-establishment and continued survival of primate populations in logged areas. Sungai Tekam is unusual in that no secondary cultivation or hunting occurs, either by traditional or modern methods, and this may well account for the successful survival of the primate populations there.

Table 2. Estimated primate biomass in unlogged and logged forest (kg/sq km)

Primary forest	Recent logged	1-2-year-old logged*	3-4-year-old logged*	5-6-year-old logged*
411	317	373	592	419

*Underestimates: *M. nemestrina* occurred at these sites but at unknown density.

An alternative response to logging might be the reduction of average group size rather than a decrease in group density. However, the sizes of the few groups that were counted accurately in logged forest were comparable with those of primary forest groups.

Secondary effects of logging

Logging roads open up an area to further disturbance not related directly to logging itself. Ribbon development of secondary agriculture can occur along access roads and this both destroys regenerating forest and may increase

Can primates persist in logged forest?

The main effect of selective logging is to reduce the resources available to primates. Certain trees may be either selectively avoided or selectively cut, but the overall effect is close to random destruction of, in this study, half the trees. Of course, where a rare tree is sought after as a valuable timber its numbers may be greatly reduced in logged forest and this will affect primates if the species is an important food resource. In Malaysia, the majority of commercial timbers are not of tree species used as food sources by



Aftermath of selective logging (Andrew Johns).

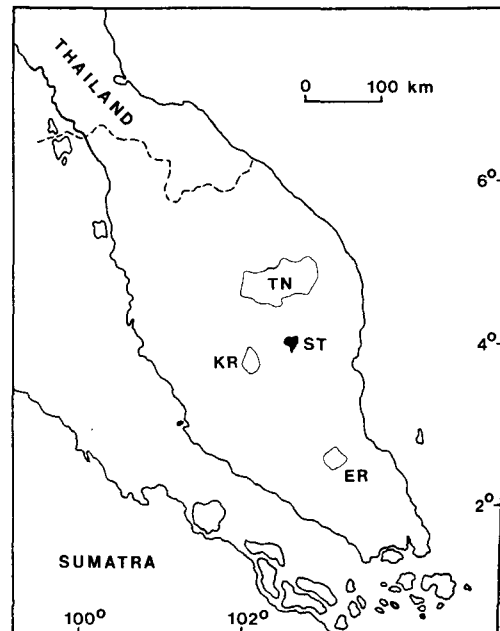
primates: food trees are lost only through incidental damage during logging.

In Africa and South America commercial timbers are frequently also important food trees. Lost food sources are not compensated for by colonising tree species, which are rarely useful to primates as food sources.

The ability of primates to persist in logged forest at Sungai Tekam is probably largely due to dietary flexibility. Two species were studied in depth, the common gibbon and the banded leaf monkey. Both showed a significant shift towards folivory in logged forest, feeding especially on young leaves, the production of which increased as a response to increased light.

Not all primate species, however, will be flexible to changing conditions of environment and food supply following logging. Specialist feeders are particularly vulnerable. Recent surveys by the Sabah Forest Department have demonstrated that the orang-utan *Pongo pygmaeus* declines

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West Malaysia showing Sungai Tekam Concession (ST), Taman Negara (National Park) (TN), Endau Rompin National Park (ER) and Kerau Game Reserve (KR).

severely in numbers in logged forest (Payne and Davies, 1982). Also in Borneo, the proboscis monkey *Nasalis larvatus*, which lives only in riverine and mangrove forests and feeds primarily on only a few tree species, is severely affected by disturbance of the habitat (Salter and MacKenzie, 1981). In Amazonia, primates such as the common woolly monkey *Lagothrix lagotricha*, spider monkeys *Ateles* spp. and the endangered bearded sakis *Chiropotes* spp. do not persist following habitat disturbance, perhaps because of a reduction in available food resources, but more likely because they themselves are a preferred food of the local people (Ayres, in prep.; Hernandez-Camacho and Cooper, 1976).

Small primates, which feed opportunistically on a variety of foods, including insects, frequently survive in some numbers, or even thrive in disturbed forest habitat (e.g. tamarins, *Saguinus* spp. in South America (Bernstein *et al.*, 1976; Hernandez-Camacho and Cooper, 1976); talapoin monkeys, *Miopithecus talapoin* in West Africa (Gautier-Hion, 1971)). These species are frequently adapted to exploit edge habitat or clearings within primary forest, which may pre-adapt them to survive in disturbed forest conditions.

The extent to which selective felling will influence primates depends on the intensity of cutting and the consequent availability of food resources in logged forest, whether or not the primate has a sufficiently variable diet to make use of the different array of food resources available following logging, and the degree of hunting pressure experienced. Selective logging in itself may not critically deplete primate populations. Primates may possess the *ability* to survive but not the *opportunity*. Restriction of secondary agriculture or hunting in areas of regenerating logged forest may thus have an important role in primate conservation: a forest should not be 'written off' merely because it has been logged.

Faced with the continuing exploitation of tropical

forest, efforts should perhaps be directed at determining which species are incapable of surviving in logged forests and thus require protection in national parks or equivalent reserves, and which species are able to co-exist with the timber industry. Perhaps more attention should be paid to possibilities for the integration of timber exploitation and wildlife conservation: the two are not always mutually exclusive. If commercial exploitation of tropical forest is unstoppable, at least we can try to lessen its effects.

Acknowledgments

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