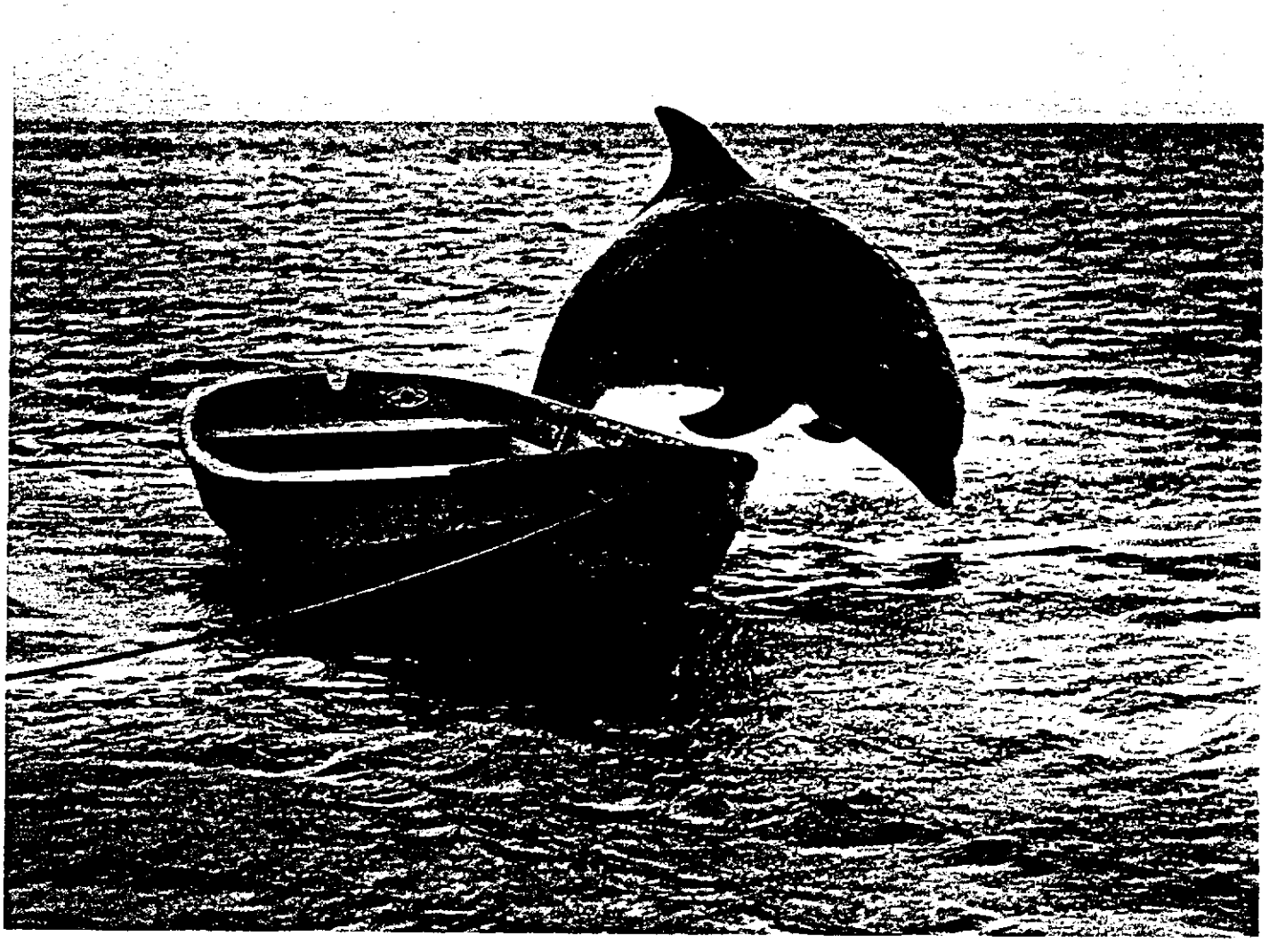
SUMATRAN TIGER
POPULATION AND HABITAT VIABILITY
ANALYSIS WORKSHOP

BRIEFING BOOK

SECTION 3 - DISTRIBUTION AND STATUS OF SUMATRAN TIGERS

CARNIVORE

Carnivorous Mammals Including Man



Volume I Part 1
January 1978

STATUS AND CONSERVATION OF THE SUMATRAN TIGER

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Of the eight tiger subspecies, one, the Bali tiger *(Panthera tigris balica)* is already extinct and three others, the Javan tiger *(P. t. sondaica)*, the Chinest tiger *(P. t. amoyensis)* and the Kaspian tiger *(P. t. virgata)* are close to extinction with little hope of survival. Poaching and habitat destruction all over the range of the other four subspecies, the Bengal tiger *(P. t. tigris)*, the Siberian tiger *(P. t. altaica)*, the Indochina tiger *(P. t. corbetti)* and the Sumatran tiger *(P. t. sumatrae)* threaten their survival.

On behalf of World Wildlife Fund International and the Dinas-Perlindungan dan Pengawetan Alam (Indonesian Nature Conservation Department), I carried out a study on the status and conservation of the Sumatran tiger. This survey was done in connection with World Wildlife Fund's "Operation Tiger" and Project 884, "Sumatran Rhinoceros."

METHODS

From December 1972 to August 1975 I travelled throughout the Island of Sumatra, spending one to two months in each province and working the rest of the time in Aceh and North Sumatra.

Countless interviews were carried out with officers from the Nature Conservation Department, the local Forestry Department, Army, Police, village-heads, hunters, taxidermists, villagers, and many others. Based on these data, survey areas were selected in every province. I searched for evidence of the tiger on expeditions into these survey areas; for instance, scratching and pug marks, feces, remains of kills, and so on. Based on such evidence, an estimation of the number of tigers in Sumatra was worked out.

DISTRIBUTION AND STATUS OF THE TIGER IN SUMATRA

I have found evidence of the tiger in all of the eight Provinces of Sumatra. The tiger is rare in most of these areas and has found its last stronghold in the lowland forests of Central Sumatra and in the heavily forested areas of the Province of Aceh.

Large parts of the Province of Aceh in the north of Sumatra are still covered with primary forests. I have found evidence of tigers in 12 different locations. The tiger population in the large Gunung Leuser Reserve (4,365 km) is relatively low, as the Reserve consists mainly of mountainous areas. In the east and west coast lowlands, the forest is more favorable to the tiger. But it is also in these areas that timber, farming and plantation activities are progressing rapidly. The tiger is bound to conflict with the human population and is hunted frequently. In 1975 I could confirm that at least 10 tigers were killed in the Province of Aceh.

The Province of North Sumatra (Sumatera Utara) is densely populated. Tigers still occur in the northern part of the province, in the Langkat Reserve (2,100 km^2), and at the southern boundary in the lowlands of Torgamba near the Barumun River. Poaching in the Langkat Reserve seems to be rare. No tiger hunting could be confirmed in the last few years.

In the Province of West Sumatra (Sumatera Barat) tigers still occur in the northwestern and southwestern parts which have a low human population density. Poaching is frequent--a taxidermist at Padang-Panjang claims that he receives about two tiger skins a month (1974).

The largest number of tigers is living in the Province of Riau. Most of the still existing lowland forest of this province is under timber exploitation. Due to the abundance of secondary growth in these areas, the tiger's favorite prey species, pigs and deer, are abundant. In these areas the tiger has its optimal habitat. Poaching is frequent. Six tigers were killed in the surroundings of Duri during my 6-week survey in the area in March-April 1974.

A large part of the Province of Jambi is still covered with forests. Most lowland forests are under timber exploitation, and in the mountainous areas of Kerinci shifting cultivation is very active. Evidence of the tiger can still be found in all parts of the province. Two areas will be important for the conservation of the tiger, namely the lowland reserve of Berbak (1,900 km^2) and the mountain area south of Sungei Penuh in the Kerinci-District. Poaching occurs but is difficult to confirm.

The Province of South Sumatra (Sumatera Selatan) has a rather dense human population, and large forest areas can only be found in the northern part of the province. Tigers still occur in several areas; I found evidence around Pendopo. Here the tigers manage to survive in an area that is covered with Alang-Alang grass and only a few patches of forest. The tigers frequently attack domestic cattle and are hunted ruthlessly. Palembang, the main town of the province, is the center for illegal trading and smuggling of tiger skins. At least six taxidermists are working in this city.

Little is known about the status of the tiger in the Province of Bengkulu, although poaching is frequent. I have found evidence of the tiger in the Sungei Seblat area, and it also seems to occur in the northern and southern part of the province.

In the Lampung Province in the south of Sumatra I have found evidence of tigers in the Wai Kambas area in the east and in the Sumetera Selatan I Reserve in the west. The forest cover in this province is shrinking rapidly and poaching is frequent.

Evidence of breeding was found in several places. In Singkil I could observe a tigress with two cubs.

Pug marks of a tigress with a cub were found in the Mamas and Pinus river area of the Gunung Leuser Reserve and in the Utung river area (Aceh), Torgamba (North Sumatra), Sungei Buluhala and Sungei Kubu (Riau). Tiger cubs were offered for sale in Singkil (1 cub), Tapaktuan (2 cubs), Duri (2 cubs) and Bukittinggi (1 cub). Only in Tapaktuan could the origin of these animals be traced--the mother was shot by a plantation manager near Tapaktuan.

ESTIMATION OF NUMBERS

Due to the difficulties of the habitat, the large area surveyed, and the limited time I could spend on the survey, it is very difficult to make an accurate estimation of the numbers of tigers still surviving in Sumatra.

I have found the tracks of at least 39 different tigers. (The average "largest width" of the forefoot was 14.7 cm. and that of the hindfoot was 12.4 cm.) In addition I had direct observation of three more animals. Taking into account the evidence of tigers which I found, the dimension of the area in which tigers still occur, the different density of tiger population in primary/secondary and lowland/mountain forests, local information and information on tiger hunting, I can make the following approximate estimation:

Province	Approximate Number of Tigers
Aceh	100
North Sumatra	50
Riau	300
West Sumatra	50
Jambi	200
South Sumatra	100
Bengkulu	100
Lampung	50
Total	1,000

The total number of tigers still surviving in Sumatra would therefore be around 1,000 animals.

THREATS TO THE TIGER POPULATION

Habitat Destruction

The main prey species of the tiger, pigs and deer are animals mainly of the forest fringe and not of the large primary forests. The densest tiger populations can be found where the living conditions for its prey species are optimal.

Selective timber cutting is therefore not destroying the tiger's habitat. Selective cutting is, on the contrary, inducing the growth of secondary vegetation, which allows a dense population of pigs and deer. The abundance of prey species is a precondition for the occurrence of a good tiger population. It must be stressed, though, that selective timber cutting is disasterous for some species like the orang utan or the Sumatran rhinocerus.

The opening of the remote wilderness areas by timber and oil companies, however, has facilitated the approach to these areas and, consequently therefore, to local hunting. In opening the hitherto unaccessible areas to local farmers the forest is burnt down and the habitat of the tiger completely destroyed. Due to the loss of its habitat and natural prey species, the remaining tigers are forced to feed on the domestic stock of the farmers and are consequently killed.

Hunting

Sport hunting of tigers was introduced by expatriates and was very popular a few years ago. Sport hunting was done quite openly and is therefore relatively easy to control. Under the Directorship of Ir Priyono Harjosentono, the Indonesian Department for Nature Conservation (Dinas PPA) is doing its best to stop this kind of hunting.

In spite of the fact that the tiger has been protected by law since 1972, it was still common in 1973 for tigers to be killed by sport hunters; and the event was often published in local newspapers. The following example may show how things have changed today.

"Siliwangi" is an army unit stationed in Java which has the tiger as its symbol. The commander of this unit, Colonel Sulaya Sutikna, wanted tiger skins for the hats of the unit's drummers. Two tigers were shot on his order in Aceh and the skins were sent to Java. PPA officials reported the tiger killings and consequently the commander was indicted. The case is still in court at the moment. Of the 10 confirmed tiger killings in the Province of Aceh in 1975, only two were carried out by sport hunters.

Foreign tourists, employees of foreign companies, and rich Indonesians pay over $1,000 U.S. currency for an undamaged tiger skin. As a local villager has an income of less than $50 (U.S.) a month, the incentive for poaching is very high.

Groups of three to four local hunters secretly build traps in the forest. Once a tiger is caught in a sling- or box-trap, the animal is strangled or drowned to prevent damage to the skin through shot wounds. Some of these poachers are operating on their own risk, but many receive a regular salary from taxidermists who prepare and sell the skins or smuggle them out of the country.

As this kind of hunting is done very secretly it is extremely difficult to control, especially outside a reserve. At least 70% of all tigers killed today are hunted by such local poachers. I found no evidence that poisoned meat is used to kill tigers.

CONSERVATION OF THE SUMATRAN TIGER

By a decree of the Minister of Agriculture the Sumatran Tiger is strictly protected since 1972.

Valuable tiger populations are existing in two established reserves, namely the Gunung Leuser/Langkat Reserve and the Berbak Reserve. The Gunung Leuser/Langkat Reserve consists mostly of

high, mountainous areas. A large part of the Berbak Reserve is swamp forest which is not optimal for the tiger. Consequently, the tiger populations in these reserves are relatively low.

As a consequence of WWF's Tiger Survey, the Indonesian authorities are now establishing a large reserve especially for the protection of the tiger. The reserve will be situated in the Riau Province between Baramun and Rokan Rivers. Selective timber cutting will be allowed in this reserve, but all human settlements and farming activities will be banned. With this concept, the optimal tiger habitat of lowland forests with an abundance of secondary growth can be protected. The reserve will have an area of approximately 5,000 km^2 and harbor a population of about 100 tigers. This great effort of the Indonesian authorities to save the Sumatran tiger from extinction is supported by the World Wildlife Fund. The tiger reserve is situated in the concession area of the Caltex Oil Company which was asked to contribute funds and equipment to this project.

The Indonesian government is facing many problems in enforcing the protection of the tiger. Due to lack of staff, equipment and funds, the protection of the tiger outside of the reserves is extremely difficult.

The WWF Tiger Survey in Sumatra has, together with concerned Indonesian authorities, worked out several proposals to restrict illegal tiger hunting:

All tiger skins already in private possession should be inventoried; newly purchased skins should be confiscated.

All taxidermists should be strictly controlled. Officials, disguised as tourists, should try to locate tiger skins held illegally.

Most tiger skins are smuggled in small boats from Medan, Pekanbaru and Palembang to Singapore. Army and customs officers should be trained especially to control the illegal traffic of protected animals and products of such animals.

In Singapore and Penang tiger skins are still openly sold in curio and leather shops. The Governments of Singapore and West Malaysia should be asked to prohibit the trading of tiger skins.

If it can be proved that a tiger is killing men, it should be shot by trained PPA personnel. As long as there is a demand from zoos with good reputations, such animals could be captured alive.

The hides, teeth and claws of all shot tigers should be destroyed or should belong to the government that could not sell them.

A small sum of money should be paid to local people when they can prove that they have lost a buffalo or goat by an attack of a tiger.

Nature Conservation Education is a precondition for the long-term survival of the Sumatran Tiger. Special campaigns for the tiger should be launched.

People Killed by Tigers

Many horror stories circulate among the people of Sumatra describing tigers who have killed dozens of people. Villagers claim that in 1972 a tiger killed 30 people in a rubber plantation near Batu Radja (South Sumatra). In most cases such stories are only used as an excuse to kill a tiger. I, myself, could confirm only three cases of human beings killed by tigers. During a geological survey of Riotinto Bethlehem in 1972 in the mountains of the Kerinci area, a tiger entered the field camp at Sungei Seblat in the night and killed one local employee. In 1973 a man who was working in his ladang (farmer's field near the forest) was killed by a tiger near Muara Tembesi (Province of Jambi). In 1974, during my survey in Lampung Province, a man was killed by a tiger in Wai Tebu. Other reports about people killed by tigers in Aceh and South Sumatra could not be confirmed.

Remarkably, the three confirmed killings have one thing in common: none of the victims was in upright position when attacked by the tiger. The man from Kerinci was sleeping, the man from Muara Tembesi was working in a squatting position, and the man from Wai Tebu was urinating, also in a squatting position.

Information and my own observations on encounters with tigers seem to confirm that a tiger gives way to a human being approaching upright. A tigress with two nearly full-grown cubs on a timber road in the Singkil Area (Aceh) watched my approach until about 50 meters before walking off into the forest.

It is obvious that tigers sometimes attack men, but such accidents seem to be very rare.

Raiding of Domestic Stock

In areas where the habitat of the tiger is gradually being destroyed reports of tigers killing domestic stock are frequent.

Such reports could be confirmed from all provinces where the tiger still occurs. I have inspected two such kills, one near the Langkat Reserve (North Sumatra) and one near Pendopo (South Sumatra). The tiger kills cows, waterbuffalos, dogs and sometimes goats.

In most cases the tiger is driven away from the kill, just to return for another kill. Several domestic animals killed in the same area mean a considerable economic loss to the native people and the regional Nature Conservation Department (PPA) is pressed hard for a permit to kill the tiger. PPA is looking for alternatives. In December 1975 the Nature Conservation Department of Aceh caught two such notorious cattle raiders and sent them to the Surabaya Zoo.

The Tiger in the Belief of Sumatra's Local Population

The tiger plays an important role in the mythology of the people of Sumatra. It is regarded with great respect and believed to have strong magical powers. It is believed, for instance, to bring bad luck to pronounce his name (Harimau) in the forest. He is therefore respectfully called

"Radja" (King) or his name is expressed with a gesture of the fingers, forming the claws of a tiger.

He is regarded as a messenger of God and the mighty spirits of the forest. He is said to kill only people who have done bad things. When somebody in a village gets killed by a tiger, it is regarded as a punishment of God and the forest spirits and offerings are made to calm the rage of the spirits.

In some areas people believe that the souls of their ancestors are living in tigers. Thus the killing of a tiger can mean the killing of the body of one's own ancestor. That such an act means bad luck for the whole area is evident.

People still believing in the old traditions are therefore not willing to hunt a tiger. If a tiger is harrassing a village, a "Pawang Harimau" or Tiger Magician is called. The Pawang speaks with the tiger, explaining to the tiger how difficult life is becoming for the villagers when all their cattle are killed. He asks the tiger to go back to the forest. If everything fails, the Pawang can give the permission to kill the tiger, but only after he himself receives permission from the forest's spirits to do so. Various ceremonies to calm the forest spirits have to be carried out before a tiger trap can be built. If a tiger is killed accidently in a trap meant for other animals, the enraged spirits of the forest have to be appeased by the Pawang to protect the hunter and the village from the revenge of these spirits.

People born with a harelip are said to be "tiger men." The inhabitants of certain areas of Sumatra believe that these people can be completely normal during day, but that they can change into a tiger in the night. The "tiger people" are much feared for what terrible things that they are able to do in the night.

A strange animal is the "Cegau." It is believed to live in remote mountain areas of the Seblat region in Bengkuli Province. The front half of the "Cegau" is a lion or a tiger, the back half a horse. The animal is said to be extremely ferocious and very fond of human flesh. Today it is still nearly impossible to convince the local villagers to take part in an expedition to these mountains.

The local beliefs about the tiger have proved to be very valuable for the conservation of this species in Sumatra up until now. Unfortunately these beliefs are vanishing rapidly today.

SUMMARY

World Wildlife Fund International has carried out a 2-year survey on the Sumatran Tiger. About 1,000 animals of this endangered subspecies may still survive, scattered over all the Island of Sumatra. The tiger has found its last stronghold in the lowland forests of Central Sumatra, where selective timber cutting is creating an optimal habitat.

Poaching is still frequent, but the Indonesian Nature Conservation Department is making great efforts to save the tiger from extinction. A 5,000 km^2 large reserve was created in the Riau Province to assure the survival of the Sumatran Tiger.

ACKNOWLEDGMENTS

I would like to express my thanks to the Nature Conservation Department and its Director, Ir Priyono, for all the help I received during my stay in Sumatra. I am grateful to L.I.P.I. for arranging my visa. I am most grateful to Mr. Poniran, Mr. Bangun, and all the numerous people who helped me on my survey throughout Sumatra.

APPENDIX:

SHORT NOTES ON THE ECOLOGY AND BEHAVIOR OF THE SUMATRAN TIGER

The World Wildlife Fund Sumatran Tiger Survey was aimed at the collection of data concerning distribution and status of the tiger. Only few data could be collected on the ecology of these animals.

The Sumatran Subspecies of the Tiger

Panthera tigris sumatrae (Pocock, 1929) is smaller than the Indian tiger. Sody (1949) reports the length of the animal, including tail, to be around 250 cm. Two animals shot in Duri during my survey in March 1974 were both males and had a length of 236 cm and 252 cm. Another male tiger, shot just one week earlier, was said to be 3 meters. I could not check this information. Similar to the two other Indonesian subspecies, the Sumatran tiger has a darker coloration than the mainland subspecies (Trap, 1973). This dark color was not very evident in the skins I was able to inspect. The three tigers I could observe myself in the Singkil area, however, were extremely dark colored. The ground color between the black stripes was not yellow or ochre, but dark brown. In diffuse light the stripes were hardly visible.

Of all tracks that were found, the largest width of the pug mark was measured. The average "largest width" of the pug mark of the forefoot was 14.7 cm, of the hindfoot 12.4 cm. The largest prints were found in the Kerinci area (Jambi) where a tiger had forefoot measurements of 16 cm and hindfoot measurements of 13.5-14 cm.

Habitat

Like other tiger subspecies, the Sumatran tiger is adaptable to all kinds of environment. I found evidence of the tiger from sea level up to the mountainridges of the Bukit Barisan at altitudes of over 2000 meters.

The tiger seldom ventures into the mangrove forests of Sumatra's East Coast. It is, however, one of the very few large ground-living animals that use the freshwater swampforest. In the large swamp areas of Riau and Jambi, the tiger prefers regions which are not always flooded and have large patches of dry ground.

Evidence of the tiger was found in the primary lowland, hill, submontane and damp-moss forest. It is able to survive in abandoned and overgrown rubber plantations (Jambi, Riau, Sumatra Utara) and even in Alang-Alang grass areas with only a few patches of forest (Pendopo).

The habitat requirements of the tiger are a good water supply, enough cover, and plenty of prey species. In Sumatra water and cover are plentiful in all tiger areas. Food supply seems to be the restricting factor for a tiger population.

Due to the scarcity of undergrowth in the undisturbed primary forests and therefore of food plants for ground-living herbivores, the population density of the tiger's main prey species, pig and deer, is very low. Secondary forest, created by selective timber cutting, is the optimal habitat for the tiger's main prey species. Wild boar, deer and other ground living herbivores find plenty of food in the soft secondary vegetation. These animals are more abundant here than in undisturbed primary forests where food is sparse.

In these selective timber cutting areas the undergrowth is dense and provides an ideal cover for the tiger. Water is plentiful.

Due to abundance of prey species and dense cover, lowland forest under selective timber cutting is the optimal habitat of the Sumatran tiger. About 70% of the tigers still surviving live today in such lowland forests.

Density of Population

Unlike in India, forest area, water and cover are abundant in Sumatra. The limiting factor to the growth of a tiger population appears to be the availability of prey.

Prey species are more numerous in primary lowland forest than in primary submontane or damp-moss forests. In lowland forests that have an abundance of secondary growth due to selective timber cutting, the density of prey species is higher than in undisturbed primary lowland forest. The density of the tiger population is in direct relation to the density of its prey species.

In the mountainous primary forests of the Gunung Leuser Reserve, the tiger's prey species are rare and, consequently, the density of the tiger population is very low. I have only few data about the size of the tiger's home range in these mountains. Relative identification of tigers based on their footprints and tracking of individual animals suggest that they have a home range well over 100 km^2. I guess that about 50 tigers are living in the 4,400 km^2 of the Gunung Leuser Reserve. That would mean a density of about one tiger/90 km^2.

In the lowlands of Central Sumatra, especially in forests with secondary growth, the tiger's prey species are abundant. The density of the tiger population is higher than in the Gunung Leuser mountains. Tracks of different individuals can often be found close together. The home range is probably smaller than in the mountains. Due to the short time I spent in a single area, I could collect only very few data and can therefore not estimate the area of the home range. I guess that about 100 to 150 tigers are living in the 5,000 km^2 of the newly established Tiger Reserve in the lowlands of Riau. That would mean a density of about one tiger/50 km^2. This population density would still be lower than in the Kanha National Park in India, where Schaller (1967) estimated one tiger/30 km^2 and Sankhala (1974) one tiger/12.5 km^2.

Prey Animals

According to the analysis of feces and kills found, the main prey species of the Sumatran tiger is the wild boar (eaten also by the Javan tiger [Hoogerwerf, 1970]) *(Sus scrofa)*. I found the remains of a wild boar killed by a tiger in the Gunung Leuser Reserve. Wild boar hairs were found frequently in tiger feces. Several times the hair of the sambar *(Cervus unicolor)* was found in feces. A tiger kill in Besitang (Langkat Reserve) was a barking deer *(Muntiacus muntjak)*. Twice the remains of a mouse deer *(Tragulus javanicus* or *napu)* were found in tiger feces. The most remarkable kill I found was in Liwa (Lampung). A Malayan bear *(Helarctos malayanus)* had obviously been killed and partly eaten by a tiger.

Occasionally the tiger catches a monkey. Feces analysis showed that the pig-tailed macaque *(Macaca nemestrina)*, the longtailed macaque *(Macaca irus)* and the leaf monkey *(Presbytis)* (one feces sample each) are prey species. N.van Strien (personal communication) found in the Mamas area of the Gunung Leuser Reserve that even an adult orang utan male *(Pongo pygmaeus)* was killed and half eaten by a tiger.

In addition, nails of birds and hair of unidentified small mammals were found in tiger feces.

In newly populated areas where the tiger's habitat is being destroyed rapidly, the tigers also feed on domestic stock. I have seen two such kills--one was a cow, the other a dog. According to local information, water buffalos and goats are also killed by the tiger.

Schaller (1967) found that in India more than half of the tiger feces contained leaves or earth. Nothing similar could be observed in Sumatra.

After the tiger has killed its prey, it eats the prey in a safe, densely covered place. Parts of the barking deer killed in the Besitang area were eaten in different places. All of these places were in an area of about 200 meters in dense secondary growth near a river. The cow killed in Pendopo was dragged over 100 meters from the Alang-Alang grassland to a small area covered with dense shrub before the tiger started to feed.

Scratching Marks

Probably with its forefeet the tiger makes scratching marks on the ground. Such scratching marks are about 20 to 30 cm wide and 40 to 60 cm long. They can be found along animal trails, near kills and saltlicks. Often they are repeated every few hundred meters.

Scratching with the hindfeet was observed in connection with defecation. The droppings however, are not buried. The tiger scratches with both

hindfeet before defecation. After placing the droppings in or near the scratching mark, the tiger sometimes scratches again, but not burying the feces. Scratching marks on the soil could be part of the tiger's communication system (Trap, 1973).

Scratching marks on trees are much less frequent. Claw marks on trees were found near a kill, near a saltlick, and along a main trail.

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SOCIALIZATION BY INTELLIGENCE:

SOCIAL BEHAVIOR IN CARNIVORES AS A FUNCTION OF RELATIVE BRAIN SIZE AND ENVIRONMENT

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A review of the evolution of sociality in carnivores was given by Eaton (1976), mainly with reference to felids. It seems wise to proceed from that discussion in this paper to avoid needless repetitions. Eaton discussed the evolution of social behavior mainly in terms of natural selection; i.e., social behavior is probably under direct genetical control. Some serious doubts on this assumption arise when social behavior is studied not only in the wild, but in captivity, too. Many species show a broad plasticity of social behavior. There is strong pair bonding in species in which this type of sociality is uncommon in nature; there is help of the male for the female in the care of young, even in the first days after birth, not only in conspecifical pairs, but in heterospecifical ones, too; there is a great variability of social relationships towards man, and so on. Comparative investigations of carnivores in their natural habitat as well as in zoos add to the evidence that many species are capable of a much greater plasticity in social behavior than they usually show in nature. This means that different types of sociality found in different populations of the same species, as is true of the lion and the cheetah (Eaton, 1976), may merely suggest the realization of different behavioral possibilities without specific genetical background but based on a general social plasticity.

The idea that brain size is related to plasticity of social behavior was independently put forward at the same time by Krushinsky (1974) and myself (Hemmer, 1974). Krushinsky found a correlation between the rate of cephalization and the ability for elementary intellectual activity. He concluded on the basis of ethological facts accumulated up to this time that there is a specific relation between the development of animal intellectual activity and the level of complexity in intragroup social relations. He pointed out that mutual help and cooperation are characteristic of the animals with highly developed intellectual activity.

The main problem hindering a much earlier success in the approach to behavioral-brain correlations was how to measure the relative brain size in a truly comparative manner. It was explained in several publications by the author (Hemmer, 1971a, 1971b, 1974a, 1974b) why a reliable calculation of relative brain size has to be based on the intraspecific or intrapopulation allometric relationship between a parameter of the body size, e.g., the body weight, and the brain weight or volume, but cannot result from interspecific relations as it was done by most workers on the evolution of brain and intelligence (e.g., Jerison, 1973). I calculated cephalization constants in form of the value of the allometric equation's integration constant, with the mean mammalian allometric exponent 0.23 for the brain-body relationship.

The only correlations hitherto found with behavioral or other biological parameters are those described by Hemmer (1971a, 1974a) for primates with this cephalization constant. The only other cephalization parameter meaningful in a biological sense is the number of extra neurons as calculated by Jerison (e.g., 1973). As the values of the correlation coefficients for different cephalization parameters show (Table 1), there is a highly significant correlation between the cephalization constant as given by Hemmer and the extra neurons as given by Jerison in Old World monkeys and in apes. The cephalization index as given by Bauchot and Stephan and the cephalization quotient as given by Jerison are also significantly correlated in the monkeys with each other both basing on allometric exponents between 0.6 and 0.7 (0.63 in Bauchot and Stephan; 0.67 in Jerison), but show no correlations at all with the biologically meaningful parameters (Table 2). Although calculating cephalization levels with the interspecific or intergeneric brain-body-allometry with slopes about 0.6 - 0.7 may indeed have some long tradition, it produces less than useful results as shown; for example, in primates by the gorilla ranging below all cercopithecine monkeys and by the chimpanzee, related in all ways to the gorilla, but ranging above the cephalization level of nearly all cercopithecine species except the small *Cercopithecus (Miopithecus)* talapoin.

9

Tiger Numbers and Habitat Evaluation in Indonesia

Charles Santiapillai and Widodo Sukohadi Ramono

INTRODUCTION

Prior to the large scale modification of its habitat by man, the tiger (Panthera tigris) thrived in substantial numbers and had a much wider geographical distribution in Indonesia than it does today, being once found in Sumatra, Java, and Bali. Since the turn of the century, a combination of high human population densities and extensive land-use activities, has led to the extirpation of two of the three subspecies of the tiger, viz. Panthera tigris sondaica and P. t. balica from Java and Bali respectively. Today only the Sumatran tiger (P.t. sumatrae) survives (Fig. 1), but even in Sumatra, the disruptive processes that squeezed the tiger out of Java and Bali are beginning to threaten the species there as well (Santiapillai and Widodo 1985).

Nevertheless, the fact that it is still found in Sumatra indicates that the tiger is an exceptionally adaptable predator, able to survive as long as sufficient prey, fresh water, and ample vegetative cover are available to it (Schaller 1967). If the current disruptive processes are not mitigated, the tiger, like the rest of the Sumatran large mammals is likely to have its range and numbers shrink at an accelerating rate.

NUMBERS OF TIGERS IN SUMATRA

At the turn of the century, the tiger was so numerous in Sumatra that it was considered a serious threat to man in several areas, and so rewards were paid by the East India Company for every animal that was killed. Considerable number of people fell victim to tiger depredations annually and there were even instances of entire villages being depopulated as a result (Marsden 1811).

The question of just how many tigers are present in Sumatra today presents many difficulties. The tropical rain-forest

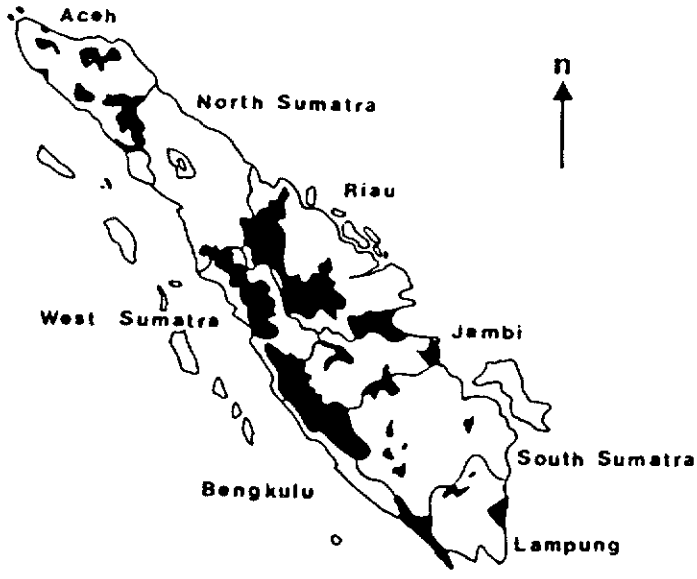

Fig. 1. The distribution of the Sumatran tiger (Panthera tigris sumatrae).

environment in Sumatra coupled with the secretive nature of the tiger, makes it extremely difficult to estimate their numbers.

Borner (1978) found evidence of the tiger in all eight provinces of Sumatra and estimated their population to be about 1,000 individuals. Since then, disruptive and competitive human land-use patterns have further eroded much of the animal's habitat, especially in the lowlands. Whilst it is impossible to be certain about the total number of tigers remaining in Sumatra today, it's numbers can now be measured in 'hundreds'. In the past, their numbers would have been estimated in the 'thousands' (Santiapillai and Widodo 1985).

HABITATS FOR TIGER IN SUMATRA

Sumatra, with a total land area of 473,606 sq. km, represents one of the largest islands in the world. It's topography is dominated by the chain of volcanic mountains - the Burit Barisan - along the west coast (Fig. 1). The lowland evergreen forest formations occur on the narrow alluvial plains between the Burkit Barisan in the west and the extensive swamps in the east (Seidensticker in press).

Sumatra's human population have always been small compared to those of Java and Bali. By 1930 Sumatra had only about six million people, while there were 42 million in Java (Loeb 1972). During the next five decades, while the population of Java more than doubled to 91 million, that of Sumatra increased by over four fold to 28 million. This was largely due to the annual arrival into Sumatra of thousands of transmigrants (both official as well as spontaneous) from over crowded islands such as Java and Bali.

The largest increase in the human population occurred in the southern province of Lampung, where between 1961 and 1980, the numbers increased from 1.6 to 4.6 million - an increase of 177% (Scholz 1983). The aspirations of these transmigrants for a better life style in Sumatra points to an even greater pressure on the remaining undisturbed wildlife habitats.

The most optimistic estimate of the extent of the protected areas in Sumatra is 92,637 sq. km or 20% of the total land area (IUCN 1985). Only a few of these areas are large enough (Fig. 2) to maintain viable populations of tiger, but even these are not completely immune to the effects of environmental disturbances outside their boundaries.

It is the vulnerability of the tiger to man-induced changes in its environment that explains why it has virtually disappeared from the densely populated province of Sumatra Utara (North Sumatra). Tigers overall numbers in the two provinces of Lampung and Sumatra Barat (West Sumatra) also remain low. The stronghold of the tiger in Sumatra seems to be the province of Riau (94,562 sq. km) where 30% of the island's tiger population is thought to be present (Borner 1978). Nevertheless, the existing protected areas in Riau are unlikely to remain viable and self-sustaining in the face of relentless disruptive land-use activities. The only large reserve, Kerumutan, was established in 1968 and is now almost totally destroyed by activities of illegal settlers (FAO 1982).

The area between Barumun and Rokan Rivers in Riau, recommended by Borner (1978) as a viable reserve for tiger, was found to be 50% peat-swamp forest - a poor habitat for large mammals in general (Seidensticker 1986). Furthermore, not only is the area completely blanketed by timber concessions, it is also being exploited for its oil reserves (Seidensticker 1986) and is earmarked for conversion to oil-palm or sugar cane plantations.

The provinces of Aceh, Jambi, Sumatra, Selatan, and Bengkulu account for almost 50% of the island's tiger population (Borner 1978). Tiger depredations on livestock and human beings are still being reported from Bengkulu and Aceh provinces (Santiapillai and Widodo 1985). The limitations imposed by man on tiger in the provinces of Sumatra Utara, Sumatra Bartat, and Lampung are likely to increase in other provinces as well.

The tiger in Sumatra inhabits a variety of habitats, but it is particularly associated with riverine forests, swamp forests, and grasslands. In the Berbak Game Reserve (Fig. 2), which is renowned for its tigers, the main habitats are freshwater swamp forests and river edge forests (Silvius et al. 1984). However, tiger distribution is not solely determined by the amount of suitable habitats or forest cover left. Other factors, such as the availability of suitable and vulnerable prey populations, and other carnivore competition, chiefly from the red dog (Cuon alpinus), are equally important. The principal prey of the tiger in Sumatra is the wild pig (Sus scrofa), followed by the sambar (Cervus unicolor).

Rain forest habitat in general does not support a high biomass of large ungulates (Eisenberg and Seidensticker 1976). Ground living herbivores such as the wild pig and sambar are generally found in low densities in primary forests (Santiapillai

Fig. 2. Major conservation areas in Sumatra.

and Widodo 1985). In view of this and because a large proportion of the conservation areas in Sumatra are mountainous (Fig. 2), the tiger occurs in low numbers.

In the Kerinci-Seblat National Park, the tiger is known from altitudes of over 1,000 m (Blouch 1984). As agricultural pressures and large scale logging operations in the lowland areas in Sumatra increase, mountainous habitats may offer the only sanctuary for the tiger in the future. It is likely that before the end of this century, tigers will survive in Sumatra only in discontinuous populations.

Optimum habitat is provided by sub-climax vegetation. Reproductive success of tigers in successional habitat can be high (Smith 1978, Sunquist 1981, Tamang 1983). Ecotonal areas are especially favorable to tigers. The transition zone between forests and grasslands provides ideal habitats to the tiger's principal prey species, such as the wild pig and sambar, so these 'edges' enhance the tiger numbers too.

In the early stages of habitat alteration by man, the tiger might benefit in so far as it finds such 'edges'. Selective logging can promote prey population build-ups and so could benefit the tiger as well. Sustained yield exploitations of the forest, if carried out carefully, is compatible with tiger conservation (Ashby and Santiapillai this volume). The threat to the tiger comes not from the logging per se, but from the human element that invariably follows such activities. In planning for tiger conservation, it is imperative that tigers and new settlements be kept apart.

In optimum habitat in India such as the Corbett Reserve, tiger densities can be as high as 14 per 100 sq. km (Sankhala 1979). In prime habitat in Nepal, adult tiger densities of 6-7 per 100 sq. km have been recorded, whereas outside such areas, densities are much less, about 1-2 per 100 sq. km (McDougal 1977, Smith 1978, Sunquist 1981). In Sumatra, tiger densities could

be as high as 3.7 per 100 sq. km in the lowland forests of Bengkulu (Santiapillai and Widodo 1985).

In general, tiger densities are much lower. In the lowland Way Kambas Game Reserve (Fig. 2) in Lampung province, tiger densities range from 2.3 to 3.0 per 100 sq. km (Nash and Nash 1985). In the more mountainous habitat as in the Gunung Leuser National Park in Aceh province, the tiger is known to exist at a density of 1.1 per 100 sq. km (Borner 1978). In summary, the tiger is able to maintain a density of 1 per 100 sq. km in montane habitats and 1-3 per 100 sq. km in more favorable lowland areas in Sumatra.

THREATS TO THE SURVIVAL OF TIGER

The most serious threats to the survival of the tiger in Sumatra today are indiscriminate forest clearance, poaching, and poisoning (Santiapillai and Widodo 1985). If the Sumatran tiger is already under some threat from these, then its status is likely to become even more precarious in the future. The tiger is a range-sensitive species (Seidensticker and Hai 1983) and is therefore susceptible to large scale changes in land-use patterns.

Since 1972, the tiger is fully protected in Sumatra by a Governmental Decree (van der Zon 1979). But poaching still goes on. Today, a tiger skin on the black market is worth over US $3,000, which offers a strong incentive for poaching.

Poison has always been a major threat to the tiger's survival in Indonesia. According to Hoogerwerf (1970) it was perhaps the most important direct cause for the decline of the Javan tiger. Chlorinated hydrocarbons like DDT or organo-chlorides such as Toxaphen (used in the control of cattle ticks) are used as poison in the provisioned baits (Myers 1976).

In the 1800's, one method used to kill tigers in Sumatra, was to leave a vessel of water impregnated with arsenic near the bait (Marsden 1811). Because the tiger has had an adverse press in Indonesia, many people view the animal as vermin that should be destroyed. However, attitudes are slowly changing and villagers are now beginning to understand the role of the tiger in reducing the number of wild boar near agricultural areas. Where the tiger does not occur wild boar have become a serious pest to agriculture, second perhaps to the elephant in the scale of its depredations and damage (Santiapillai and Widodo 1985).

THE OUTLOOK FOR THE TIGER IN SUMATRA

Up to now, the conservation measures have largely been limited to the enactment of legislation for the protection of the tiger in Sumatra and setting aside reserves for its survival. Ideally, the emphasis must be on maintaining the highest number of tigers and widest possible distribution if we are to ensure their long-term survival in Sumatra. This is easy to recommend, but difficult to implement in many of the developing countries

where rapid human population growth entails the development of every piece of land to its maximum. Nevertheless, Indonesia has set aside a number of large areas for wildlife and nature conservation, despite its high human population.

The major conservation areas in Sumatra (Fig. 2) are the Kerinci-Seblat National Park (14,846 sq. km), Gunung Leuser National Park (8.025 sq. km), Barisan Selatan National Park (3,568 sq. km), Berbak Game Reserve (1,900 sq. km), and Way Kambas Game Reserve (1,300 sq. km). Because population pressure will continue to increase, the land set aside for conservation must be viewed in this context. Therefore, the best opportunity for the conservation of the tiger in Sumatra lies in some form of multiple use pattern of its peripheral habitats away from the core areas.

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Conservation of Sumatran Tiger (*Panthera tigris sumatrae*) in Indonesia

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Introduction

About the turn of the century, there were three subspecies of the tiger (*Panthera tigris*) in Indonesia: *Panthera t. balica* in Bali; *Panthera t. sondaica* in Java and *Panthera t. sumatrae* in Sumatra. Today however, both Bali and Javan tigers have become extinct and only Sumatran tiger survives. The extinction of the two sub-species of tiger in Indonesia was both rapid and deliberate and it occurred at a time when conservation was already the accepted national policy (Ashby & Santiapillai 1987). This fact underlines the inherent difficulty in conserving a large predator in environments dominated by man. It shows clearly that much more than mere legal protection and reservation of habitat is needed to safeguard the species in the wild. It therefore calls for a more discretionary and selective strategy to replace our current strategy of responding to crisis in the management of carnivores in general and the tiger in particular. The ecological and behavioural factors that restrict the tiger's range in Sumatra likewise make it susceptible to pressures from man's modification of its habitat. Because of its vulnerability to a spectrum of limiting factors, the tiger in Sumatra faces precarious prospects if its present distribution were to be substantially reduced and populations become small, fragmented and isolated from one another. In Sumatra, tiger habitat is shrinking fast and unless prudent policies are adopted to exploit the timber resources on a sustainable basis, by the year 2000, the tiger will almost certainly be confined to a few large and well protected reserves.

Distribution of the tiger

Sumatra prior to 1900 was largely covered in primary forest from Aceh in the north to Lampung in the south. Up to that time, the tiger, although its population density would have been low, was more or less continuously distributed throughout the entire island. Less than a century later, as a result of conversion of primary forest to agricultural holdings, the tiger distribution has become fragmented and substantially reduced (Fig. 1). However, tiger is found in all the eight provinces although in highly populated areas such as the provinces of North Sumatra and Lampung, the animal has been squeezed out of much of its former range.

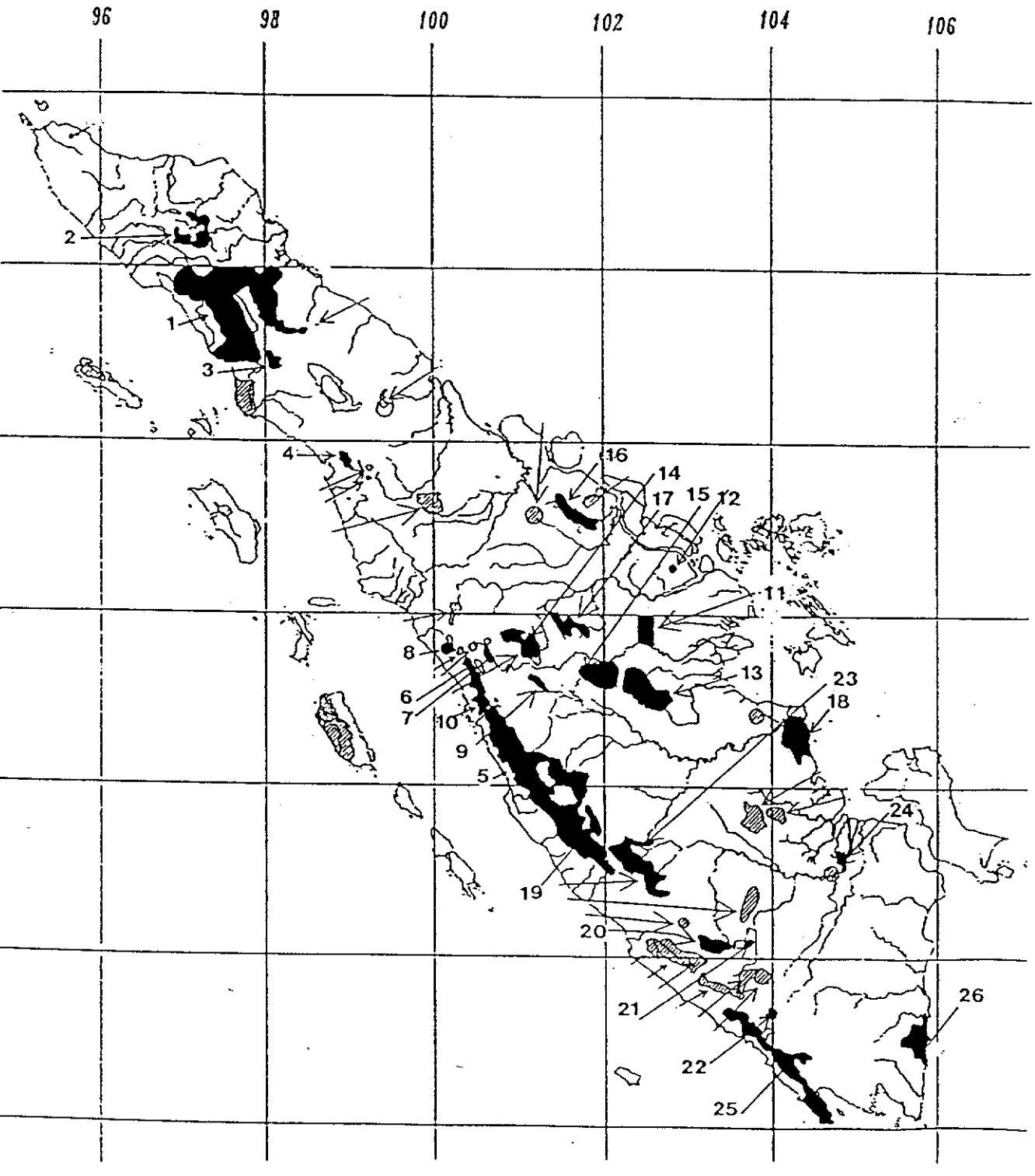

Fig. 1 Distribution of Sumatran tiger (Panthera tigris sumatrae). Solid shading: positive evidence of presence of tiger. Cross hatching: extent of additional suitable habitat but where positive evidence is not available. Numbers refer to the areas indicated in Table 1.

The fact that the tiger still survives in all the eight provinces in Sumatra points to its adaptability and versatility. However, there are strict limits to its versatility: what is probably particularly important is a variety of mammalian herbivore species being available as prey, fresh water and ample vegetative cover (Schaller 1967). These requirements are largely met within the network of protected areas in Sumatra.

There is definite evidence for the presence of the tiger in 26 protected areas in Sumatra (Table 1). These areas total 4,564,121 ha or 45,641 km2 and account for about 9.63% of the total land area of Sumatra. Within these areas, the tiger inhabits an altitude range from sea level to over 1,000 m (Blouch 1984). In addition, tigers are also known outside the network of protected areas, especially in rubber plantations where much of the tiger attacks on man and livestock has been reported.

Rainforest habitat in general does not support a high biomass of large ungulates (Eisenberg & Seidensticker 1976). On the other hand, lowland forests support a greater biomass of ungulate prey such as wild pig (Sus scrofa), sambar (Cervus unicolor) and barking deer (Muntiacus muntiak) which are among the species preferred by tiger in Sumatra (Santiapillai & Widodo 1987). But it is precisely such lowland forest habitats rich in prey species that are fast disappearing in Sumatra as a result of a host of development programmes. It is estimated that between 65 and 80% of the forests in the lowlands of Sumatra have already been lost (Whitten et al. 1984). The mountain areas to date have been less seriously affected, but disruption of continuous cover is already substantial in some cases, and perhaps 15% of their total area may tentatively be estimated as already removed on the evidence avalable.

Optimum habitat is provided by sub-climax vegetation. Ecotonal habitats are particularly favourable to tiger, as such transitional zones between forest and grasslands support a higher density of tiger's principal prey species.

Number and density of tiger

The dense and tangled vegetation of the tropical habitats in Sumatra makes it extremely difficult to arrive at even working estimates of the tiger number and density. As the animal is rarely encountered in the forest, much of the data regarding its presence and number must come from information obtained from people living in or around the areas inhabited by tiger and also from the study of the pug marks (McDougal 1977; Panwar 1979).

Borner (1978) estimated the number of tiger in Sumatra to be about 1,000. He based his estimate on an island-wide survey he carried out. Since his study, Sumatra has undergone much development and subsequently, the extent of prime tiger habitat too has become much smaller. Subsequent survey of the Sumatran tiger in 1984/85 put the number not in the thousands but in "hundreds" (Santiapillai & Widodo 1985; 1987).

Protected areas having tiger in Sumatra

No:	Reserve/Park/Forest	Prov.	Status	Area (ha)	Alt. (m)
1	Gunung Leuser	Aceh	NP	792,675	0-3419
2	Lingga Isaq	Aech	HR	80,000	800-2823
3	Dolok Sembelin	NSum	PFo	33,910	150-1604
4	Sibolga	NSum	NR	20,100	200-1230
5	Kerinci-Seblat	WSum	NP	1,484,650	500-3800
6	Lembah Anai	WSum	PFo	96,002	600-1811
7	Lembah Harau	WSum	PFo	23,476	600-1256
8	Maninjau	WSum	PFo	22,106	600-1724
9	Bkt.Sebelah/Pangean	WSum	PFo	22,803	600-1078
10	Bajang Air Tarusan	WSum	PFo	81,865	500-2000
11	Kerumutan Baru	Riau	GR	120,000	0-0
12	D. Pulau Besar/Bawah	Riau	GR	25,000	0-0
13	Seberida	Riau	NR	120,000	150-830
14	Bkt. Rimbang/Baling2	Riau	NR	146,000	200-1090
15	Peranap	Riau	HR	120,000	120-492
16	Siak Kecil	Riau	NR	100,000	0-20
17	Air Sawan	Riau	GR	140,000	100-176
18	Berbak	Jamb	GR	190,000	0-20
19	Merangin Barat	Jamb	PFo	64,600	1000-1931
20	Gumai Pasemah	SSum	GR	45,883	200-1776
21	Isau-Isau Pasemah	SSum	GR	12,114	500-1431
22	Gunung Raya	SSum	GR	39,500	300-2232
23	Rawas Hulu Latikan	SSum	GR	213,437	300-2384
24	Padang Sugihan	SSum	GR	75,000	0-50
25	Barisan Selatan	Ben/Lam	NP	365,000	0-1964
26	Way Kambas	Lamp	GR	130,000	0-50
	Total			4,564,121	

NB: NP = National Park; NR = Nature Reserve; HR = Hunting Reserve; GR = Game Reserve; PFo = Protection Forest. Underlined areas refer to lowland reserves/forests.

Provinces, 1. Aceh, 2. North Sumatra (NSum), 3. West Sumatra (WSum), 4. Riau, 5. West Sumatra (WSum), 6. Jambi (Jamb), 7. Bengkulu (Ben). & 8. Lampung (Lam)

Fig. 2: The extent of forest cover in Sumatra

In the optimum habitats in India, tiger densities can be as high as 14 per 100 km2 (Sankala 1979). In prime habitat in Nepal, adult tiger densities of 6-7 per 100 km2 have been recorded, whereas outside such areas, densities are much lower, about 1-2 per 100 km2 (McDougal 1977, Smith 1978, Sunquist 1981). In Sumatra, tiger densities could be as high as 3.7 per 100 km2 in such prime tiger habitat as the lowland forests in Bengkulu province (Santiapillai & Widodo 1985). But this is exceptional and in general, much lower densities are the norm in Sumatra. The tiger in Sumatra can maintain a density of 1 per 100 km2 in mountainous areas and 1-3 per 100 km2 in more favourable lowland habitats (Santiapillai & Widodo 1987).

Of the 26 areas where tiger is positively known to occur (Table 1), 14 represent lowland forests (underlined in Table 1) and these account for 1,339,488 ha or 13,395 km2 while the remaining 12 montane forest habitats make up 3,224,633 ha or 32,246 km2. Taking the maximum density of 3 per 100 km2, the lowland habitats could support a maximum of 400 animals while, at a density of 1.5 per 100 km2, the montane areas could support about 484 tigers in Sumatra. On such flimsy estimates, the network of protected areas in Sumatra could support about 800 tigers.

Conservation implications

The tiger finds itself with its back against the wall in Sumatra. The tiger's prospects for long term survival appear to be grim in a number of protected areas given their small size. Only 12 areas out of the 26 tiger reserves in Sumatra are larger than 1,000 km2. The smaller reserves are unlikely to support viable tiger populations in the future. Such small populations of tiger currently occurring in these reserves are very vulnerable to local catastrophes. Random changes in the populations, such as marked fluctuations in the sex ratio, have proportionately more impact in smaller populations (Bertram 1986). One way of avoiding some of the propblems associated with managing small populations of tiger would be through the establishment of forest corridors to link smaller reserves with the larger ones - if this is still feasible.

Reserves also need to be zoned and managed. Strict protection must be given to the core areas where the tiger and its prey populations could survive without any interference from man. Multiple-use zones around protected areas are an important feature of the Indian tiger reserves (Bertram 1986). Our objective is to maintain viable populations of tiger in Sumatra in as many areas as possible without leading to unacceptable conflicts with livestock and human settlements. This is the difficult management goal facing us: how to increase the number of tiger in the wild at the sametime reduce the conflicts such an increase will have with man and his livestock? Tigers being territorial animals, they will eventually space themselves out in any area thereby force the surplus animals into outlying areas such as buffer zones and multiple-use zones. Conflicts between such transient tigers and man are inevitable in heavily populated areas.

Given the size of the human population in Sumatra, the number of people killed by tigers is indeed very small. Motor cars and snakes kill more people than tiger but attacks on people by tiger however rare they may be are given prominence in the press. More common however are attacks on cattle. Such tiger depredations on livestock must be reduced and the farmers and stockmen who suffer such losses must be compensated otherwise the tigers will forfeit acceptance by the local people and without local people's support, no conservation programme will achieve its desired goal in the long run. If the losses of livestock are exceptional and sustained, then they should be offset by some sort of compensatory adjustment on the part of those who benefit from the predator's survival viz, the society at large (Myers 1976)

Problem tigers such as "man-eaters" and chronic stock raiders could be captured and accommodated in Zoos, where they could be bred and maintained as an insurance against extinctions in the wild. But already, there are far too many tigers in the zoos - so numerous are they that many are on contraceptives to prevent over population!

Recommendations

In spite of losses of habitat to date, there is still time for substantial tiger habitat to be maintained, provided that it is not fragmented into inviable units (Ashby & Santiapillai 1987). Given this situation, we suggest the following strategy:-

1. Strengthen the protection of the five key areas in Sumatra such as Kerinci-Seblat NP, Barisan Selatan NP, Gunung Leuser NP, Berbak GR and Way Kambas GR. These key conservation areas must be divided into core and buffer zones. Intensify the anti-poaching efforts of the guards.

2. Adopt a policy aimed at maintaining as much forest cover over large areas, uninterrupted by human settlements and roads where remoteness, difficulty of terrain and density of cover can provide natural protection.

3. Adopt a policy to keep as much unfragmented habitat outside the protected areas as is practicable on a long-term basis, as a multi-purpose forest where sustainable timber extraction is practised that is compatible with the survival of the tiger and its prey.

4. Identify areas chosen for new settlements in terms of compatibility with nature conservation as well as agricultural suitability to minimise conflicts.

5. Survey additional areas in Sumatra and determine the whereabouts of viable tiger populations. This applies particularly to the remaining unfragmented lowland forests where the species may be present.

6. Strictly control the use of poison especially around the tiger reserves. The critical element in the decline of the Javan tiger in Ujung Kulon reserve in West Java was poisoning by nearby pastoralists (Hoogerwerf 1970).

7. Design land-use patterns in the vicinity of tiger reserves in such a way as to make them compatible with tiger conservation and thus minimise human-wildlife conflicts. Adopt measures to improve the living standards of the people living along the periphery of tiger reserves.

The farmers and herdsmen must be convinced that the conservation measures being taken are in their long-term interests, for without the support of the local people, all current efforts to conserve the tiger in Sumatra, whether in the wild or in captivity are unlikely to succeed.

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RANGING PATTERNS AND DENSITY OF SUMATRAN TIGERS IN GUNUNG LEUSER NATIONAL PARK.

M.Griffiths

BACKGROUND

General description of Leuser National Park

Leuser National park has an area of about 800,000 ha and lies in the Northern part of Sumatra between latitudes of approximately 2° 54' N and 4° 2' N. The area is divided into two approximately equal halves by the Alas river which runs southwards and flows into the Indian ocean at Singkil.

With the exception of the Kluet extension (12000 ha), Sekundur (40000 ha) and the upper Alas valley(1500 ha), the entire area is mountainous and there are at least six mountains exceeding 3000m altitude. East of the Upper Alas valley there is an extensive area of highland with moderate topography but for the most part the the park is rugged and, particularly in the west, is almost impassable for man.

Vegetation

For those regions of the park that lie below 1000m the vegetation cover is mixed dipterocarp forest. With increasing altitude oak forest predominates and finally at the highest elevations pines and rhododendron forests are typical with open alpine meadows covering the exposed areas.

In the Upper Alas valley most of the land on moderate topography has been converted to cultivation - bananas , candlenut, coffee and some rice. In places where the fertility of the soil has been depleted, beluka scrub and alang alang grass *Imperata cylindrica* has recolonised the previously cleared land.

Issues

Although Leuser is large most of it is mountainous and thus unsuitable for many species. Of the species of fauna recorded in the park 70% live in the lowlands - which account for less than 20% of the Park's total area. These are the areas that are also the most threatened and in many cases are already modified. In 1981 most of the Sekundur was selectively logged on the justification of 'habitat improvement'. The Kluet is under constant threat and some was logged in the 1970's. The region of Upper Alas inside the park has been allowed to be settled illegally, although their are discussions at

present about reversing this trend. All these areas are on topographically benign land below 500m - the richest of all the habitats. Almost no land like this still exists in its pristine state in the Park.
If Gunung Leuser National Park is to have a chance of surviving in the long term lowland areas additional to the the ones already gazetted will have to be incorporated into the park.

Tigers in the park

Tigers are found throughout the park to elevations at least as high as 1800m. With increasing altitude however the frequency of tiger sign gets progressively less (van Strein, 1970). It appears that the highest densities are around the periphery of the park. In these flatter well watered areas, sambar deer thrive and the wild pigs, another staple of the tigers diet, reach high densities on account of the abundant food in the gardens and farms of local villagers.

Tiger inventory as a part of photo survey of GLNP

From 1985-1990 the writer carried out various camera trapping projects in GLNP. Initially these were self funded, but during the period from 1986-1988 the work was sponsored by Mobil Oil. Subsequently, during 1989-90, the author carried out a photo survey of the park as part of WWF's renewed involvement in the protection of the area Although the primary aim of the projects was to identify and record rainforest animals for basic knowledge and publicity purposes, much useful information was obtained on several species, particularly the large cats which frequently passed the various remote camera locations. This work allowed the author to both estimate the minimum number of animals in the areas covered and to get an approximate minimum measure of their home ranges. The majority of the work was carried out in two study areas - The Bengkung river system and the Upper Mamas valley (rf Fig 1)
The Bengkung river drains an area roughly 800 sq km and ranges in altitude from the river basin at 100m to the northern watershed at 1700m. Much of the southern half of the catchment is on moderate topography with a highest altitude 600m approx. The underlying rock types include basalts and limestones as well as some sedimentary deposits . There is a high diversity of plant species and the area is well watered.
The Upper Mamas valley is smaller in area than the Bengkung (about 230 sq km) and is on average higher - ranging from 1100m

on the valley floor to 2200m on the western watershed. Plants are less varied, the canopy is generally lower than the Bengkung, but all the prey species found in the Bengkung (Barking deer, Wild pig, Serow, Sambar deer, and porcupine) are present here.

METHODS

Two methods were employed to gather data on the tigers in the two study areas - camera trapping and the study of tracks .

TRACKING simply involved following tracks of an individual tiger that had recently passed by a camera location. The idea being that by noting the approximate date of passing it would be easy to identify the individual tiger when films were subsequently processed. Following tracks allowed a more comprehensive understanding of tiger movements in areas not covered by cameras.

CAMERA TRAPPING used cameras which were set up beside game trails. The cameras were equipped with a simple triggering device such as a pressure mat placed on the path and when an animal passes a camera location, it triggered the camera and an exposure (photo) was made. Electronic flashes were used so that the passage of nocturnal animals could be recorded.

Indexing the films.

After each camera was set up the film was indexed by taking an exposure of a man holding a card (showing the name of the location) and a survey pole (for later use in measuring the animals photographed at that location).
Films were collected every 4-6 weeks and, after processing , the rolls were analysed .

Analysis of the films

The highest priority in analysing the films was to identify the individuals. Accurate identification was essential before any conclusions could be made regarding home ranges and frequency of use of trails by individuals etc.
Because of the importance of accurate identification, considerable effort was been spent on this part of the analysis.

Identification of Individuals

Identification of tigers was based almost solely on stripe patterns but, where applicable, body measurements could sometimes be used to differentiate individuals.

1. Size - This was gauged by comparing the size of the animal with the measuring pole photographed on the index exposure on the same roll of film. Care had to be taken to ensure that perspective errors were taken into consideration. For instance the shoulder height of a tiger might vary as much as 3%.

To get the best measurements, the placement of the front paws should straddle the point at which the foot of the measuring pole was placed at the time of the index exposure.

Body length proved an unreliable parameter to use because of distortions inherent outside the central part of the photograph and because of apparent shortening when the animal was not exactly parallel to the plane of the film.

2. Pelage - The most useful areas on the body for identifying individuals were the sides of the abdomen, the face and the outside of the upper rear legs. The stripes here showed most variation between individuals and least distortion as the animals moved. Since many photos were taken from the side problems could arise in deciding whether two patterns of stripes (from the left side and the right side) represented one or two animals. As it turned out there was in most cases a sufficient range of camera angles and animal orientations to allow positive identifications to be made in all except one case.

Identification of Sexes

Male tigers were positively sexed by the presence of external genetalia .

Females were identified when no external genitalia were present when viewed from angles that should have shown a clear view of the same. If a positively identified male was seen in the company of another adult , that adult was assumed to be a female if no other evidence was available.

Female tigers had a less pronounced ruff around the face. Conversely males photographed in the Leuser region almost invariably had a short mane of hair on the back of the neck.

Activity times

Examination of the photographs would frequently reveal what time of day the exposure was taken. For simplicity the daily activity periods were divided into diurnal, nocturnal and crepuscular. In

reality there were many occasions when the time could be determined more accurately by using the direction and angle of the sun light, the pattern of shadows and even the build up of condensation on a camera lens in the early morning.

Miscellaneous information

Other things noted were the frame number of the exposure, the direction in which the animal was travelling, the number of individuals in a frame, and the time period in which the exposure was taken. Additional notes were made of anything thought to be significant - the condition of the animal, unusual activities when photographed etc.

DATA

After analysing the photographs the data was entered in a tabular data base and set out as shown in Table 1 (for the Bengkung study area) and Table 2 (for the Mamas study area)

DISCUSSION

Limitations of the data set

Since the cameras were not specifically set out with the aim of delineating range sizes of tigers the information gained gives a picture of home ranges only of only a few tigers. In other cases tigers would appear at just one or two locations and visits would be rare.

Logistics also restricted the number of camera locations that could be located in the field. A typical camera set weighed 25 kgs and it would take up to two weeks to reach certain locations. Ten cameras covering the two different study areas representing a total area of about 140 sq km were utilised . Because of this paucity of data it was impossible to get unambiguous information on the amount of overlap between adjacent home ranges.

Although in most cases all the tigers could be positively identified there were some cases where this was not possible and no name was given to the individual. In one case two tigers indicated as different individuals (Barb and Skinny) may have been the same individual tigress. Both these animals had similar build and dimensions and were in the same area for the same period - but in absence of positive proof to their being the same individual they were considered as two separate animals. This however had no bearing on any of the calculations regarding densities and range sizes.

Interpretation of minimum home range size

Where there were records of an individual tiger having passed four camera sites of more, the area described by imaginary lines joining those locations was calculated and was noted as a measure of the minimum home range of that individual. This in all cases was clearly an underestimate. Even in the case of the male tiger named Rajah, tracks made by this individual passing by Location Barat were followed well to the west of the area confined by the lines connecting the camera locations. Similarly the tracks of Rope in the Mamas river area were tracked along the edge of the Mamas river for at least 12 km. This would effectively double the home range size calculated by the straight line method. Other observers (van Strein, 1985) noted that the lower regions of the Upper Mamas valley (90 sq km) might itself be only part of the territory for a large male tiger. Van Strein reports that large tiger walked the entire length of the Upper Mamas valley in just a few days and left at the southern end.
An estimate of home range size calculated by the straight line boundary method gives a figure of approximately 80 sq km for the male, Rajah. If the area known to be covered by Rajah using both camera information and fresh tracks is calculated then the number is closer to be 90 and similarly the area for Rope the most commonly photographed tiger in the Mamas would be about 36 sq km.
The home range sizes drawn of the Map (fig 1) give the home ranges of tigers based on the both the photographic data and tracks where an individuals tracks passed a camera location and the identity of that individual could be later positively identified by examination of photographs.

Range comparisons between two male tigers

Name	Study area	Range size (sq km) (cameras only)	Range size (sq km) (cameras + tracks)
Rope	Mamas	8	36
Rajah	Bengkung	80	90

Of the two individuals above the figures given for Rajah are more reliable. For one there were more camera locations in the area (6 in the Bengkung, as opposed to 4 in the Mamas), and secondly the arrangement of the cameras in the Mamas was almost linear Hence although the the distance between the furthest two cameras in the Mamas was 10km the area calculated using the straight line method

gives no impression of the actual area probably covered by this tiger. On the other hand the the cameras in the Bengkung were arranged in a rough semicircle with a diameter of 22 km. This arrangement not only gave a better spatial coverage but was also extensive enough to include a greater part of the total home range of the individual being studied.

Frequency of use of trails

By calculating the frequency with which an individual tiger passed the various camera locations it was possible to gain an insight into how the area was used and where the core area was.
The frequency was calculated as the number of passes per an elapsed number of camera weeks (the time during which the cameras were operating)

Location	No. passes.	Cam. wks.	Passes/year (approx).
Barat	1	27	2
Lokasi A	1	19	3
Lokasi B	2	15	7
Rambung	2	29	4
Suntik	4	26	8
Timur	5	32	8

A study of the frequency of passes in the above would suggest that the core of the area is centered around Timur ,Suntik and Lokasi B but that locations as far away as Rambung (12 km from Suntik and 20 km from Timur) were regularly visited about every 3-4 months.

A possible error could be produced here because the quality of the camera location could also influence the frequency of passes - eg the probability of a tiger passing over a given square meter of trackless forest is far less than over a square meter patch on a typical game trail, (as demonstrated in other work in the Bengkung by the author in 1986-87) . However since all of the camera locations were on the dominant game paths in any area it can be assumed that this influence would not be significant in the final calculations.

Male v females range sizes, and overlap

In only one case did a female (Flame) positively pass by more than one camera location. It is thus very difficult to get an accurate idea of home range size for females from the camera trap data.

From the data it can also be seen that of the animals whose sex could be positively identified, 84% of the passes were made by males. Since many of these passes were made by just a few individuals the unequal ratio of passes may be a reflection of the greater ranging effort expended by the males. Many writers (Schaller, 1965) have noted this difference in ranging between the sexes and and it appears to be confirmed by the camera trap data in a rainforest environment the best way to economise on the energy expended in covering large distances is achieved by following well developed game trails which themselves have resulted from animals, particularly elephants and formerly rhinos finding the easiest routes through the uneven terrain.

It is also significant that on 3 out of 7 times(43%) females were photographed they were closely followed by males (either in the same exposure or in the immediate subsequent one). It may be that the females use the trails more when in oestrus and avoid them at other times.

This same effect has been noticed with the Leopards of Ujung Kulon National Park in work currently being carried out there by the author using camera traps.

Similar biases have also noticed by the author regarding clouded leopards in Gunung Leuser National Park at the same time as the tiger data was collected.

Relevance of the whole park.

Although the hills surrounding the Mamas and bordering the Bengkung to the North are high they are not as steep and as dissected as in many other regions of the park. Additionally the valley floors are fairly flat and are support good numbers of the preferred prey of the tiger - Sambar deer *Cervus unicolor*, pig *Sus scrofa*, and barking Barking deer *Muntiacus muntjak*. These areas would thus be considered ideal for an unmodified rainforest environment .

Taking into account topography, availability of water, and prey animals, there would be roughly 1700sq km of area in the park that is comparable to the Bengkung and Mamas. Most of the remainder is higher and more rugged and the tiger would rely mostly on Serow *Capricornis sumatrensis* and Barking deer for prey.

It is important to note that in examining data on other species from the camera surveys that a relative value of tiger habitat can be arrived at by comparing the frequency with which prey species pass

camera locations in two different altitudinal ranges in the Bengkung study area

Species	100-600m	600-1700m
Sambar	4	0
Kijang	13	14
Pig	14	1
Porcupine	11	3
Serow	2	1
Totals	44	19
Total Camera weeks	89	59
No of prey animals/yr	26	17

It can be seen that the higher altitudes are both poorer in prey species diversity (the sambar is absent and the pig almost so) and in density of suitable prey species (based on the frequency of camera passes).

If we now assume that the density of prey species is no greater in the even higher and more rugged parts of the park than 17 animals/year/ game trail, then for a course guess we can say that if the range size of the tigers in Leuser is proportional to the density of prey species then the minimum home range range size at higher altitudes would have to be larger by a proportionate amount

Minimum range size at higher regions = 26/17 x 90 sq km
= 137 sq km

Although this is an over simplification , it does at least give a guide to the sizes of home ranges in the less the optimum habitats. If anything the figure is too small . For one thing the minimum range size for Rajah does not represent the full range of that individual. Also other aspects such as rugged topography in the higher regions of the park would create a reduction in habitat quality - i.e. a tiger would be largely restricted to travelling along ridge tops and would have difficulty gaining access to the more rugged slopes where the prey species such as serow could thrive.

CONCLUSIONS

Population estimates

There are three broad tiger habitat types in Leuser National Park. The mountainous regions above 600m, the lower regions with extensive river valleys and benign topography, and the edge of the park.

Of the three it is possible that the park edge is potentially richest in tigers. The author noticed that densities of wild pigs were almost four times as high (based on frequency of camera passes) in gardens and farms on the parks edge as they were in the primary rainforest. Locke (1954) who studied tigers in similar forest fringe habitats in Malaysia calculates an average of one tiger per 26 sq km. Similar figures would no doubt pertain for the forest edge habitats for Leuser.

However since 1986 there has been extensive poaching of tigers around the park especially in the west where the animals have been killed using poisoned baits. Estimates vary as to how many tigers have been killed in this period - but second hand accounts from the leading poacher indicate as many as 50 tigers were secured between 1986 and 1990. The author went to a site in South Aceh where one tiger had died in this manner and where another, having eaten the bait had regurgitated the poisoned food and struggled away.

Tiger numbers on the parks edge have definitely dropped off and now pig numbers that used to be controlled by the tigers have rapidly increased with subsequent loss of crops, especially rice. Probably the densities of tigers of the parks edge are now no higher than in the primary forest of the park itself.

For purposes of population estimates it can be assumed that the forest edge and the lowland areas are a single unit.

Using the home range sizes already derived and for the the moment assuming no range overlap the following population estimates can be given

Habitat type	area sq km	No/sq km	Popn (males)
Park edge and primary forest up to 600m	1700	90	19
Mountains above 600m	6300	140	45
Total population of male tigers			64

Since no information is available on the relative sizes of male to female home ranges it is difficult to draw any conclusions here. Schaller (1967) gave figures for the male to female home ranges of Indian tigers as 30/25 sq miles. If this ratio holds true in general for all tigers then it might be guessed that the minimum home range sizes for female tigers in Leuser area 75 sq km and 116 sq km for lowland forest and highlands respectively.
This would give estimates for the females of the park as follows

Habitat type	Area (Sq km)	range(sq km)	Popn(females)
Park edge & Primary forest to 600m.	1700	75	23
Mountain areas Above 600m	6300	116	54
Total population of female tigers			77

according to the figures given above the total population of adult tigers in Leuser National Park would be 141.
Undoubtedly there is considerable overlap of home ranges especially among the males, and no doubt the actual home ranges would be bigger than so far recorded. These two factors might partially cancel each other out
However for the sake of argument if it is assumed that there is an average of 50% overlap of all home ranges and that the home range sizes quoted are a maximum.Then the new estimate for the population of adult tigers would be:-

Total Popn = 141/8000 x1/2
= 0.0352
Total = 282

If on the other hand there was no overlap but the size of the actual home ranges were in fact 50% larger (it is unlikely to be much bigger since none of the males at the northern periphery of the Bengkung study area reached into the Mamas study area, and visa versa).
Then the population would be = 141 x 0.5 = 71

Thus a best guess for the population of is 176 +- 106 or, for practical purposes,

The adult tiger population for Leuser National Park would be about 180 +- 100.

The only other figure for the Park is given by Kurt (1970) who estimated a tiger density in the park of around 3/100 sq km, giving a probable population of 240 individuals.

MANAGEMENT ISSUES.

The main threat to the tiger in around Leuser at the moment is poaching. Almost no local villagers poach the tiger. Partly this is for spiritual reasons, but there are also economic reasons (it is better to let tigers control pig populations than to build expensive fences around rice fields). Therefore almost all the poaching is done be outsiders. They know it is illegal and they do it for profit. The concern is that when tigers are poisoned on the parks periphery tigers from deeper within the park move in to the vacated and preferred areas. If the tigers are continually poached, the population of tigers deeper inside the park could be depleted- even though no poaching is actually done in the interior. Such an effect was found to occur when cat eradication was carried out on some of New Zealand's offshore islands in the 1980's.(Little Barrier Ranger. Pers Comms. 1983)

A more sinister aspect of this poaching is that it reduces the genetic diversity and may even work preferentially by taking out dominant individuals that utilise the best habitats on the edge of the park .

Fragmentation

In the longer term the problem of minimum populations needs to be addressed. If the corridor linking the Bengkung and the Singkil swamp is severed and the roads are completed between Blangkejeren and the east and west coasts then Gunung Leuser will become to many animals an island. Although tigers are very tolerant of man and can cross large open areas there is a limit and the Leuser Population will one day become isolated. If the the total number of tigers in the population is left at the lower end of the estimates given in this article then the long term future for the species in one of its last strongholds will be critical..

Wildlife corridors.

In order to mitigate against such an outcome there is a need right now to secure the critical corridors linking GLNP to the large wild areas to the north and to the Singkil swamp to the south. There is a good chance that this can be achieved within the framework of Indonesian conservation law. Wildlife corridors are recognised for their importance and merit special consideration in regional planning.

Tigers , livestock and man

It is true that tigers attack livestock and on rare occasions people. Livestock can be well protected form Tigers by being properly penned at night. In areas of Sumatra where tigers are frequently encountered , livestock pens are a common feature near homes. Maneaters should be eliminated as. having lost their natural fear of man, they could easily repeat the act. killing further people and increasing antipathy towards the many other tigers that prey exclusively on wild animals.

It is worth pointing out here that for many hundreds of years until recently the tigers living in and around the Leuser region left the people largely alone and the people did the same to the tiger. Efforts should be made to encourage the continuance of this relationship. In doing so the tigers, given sufficiently large areas, should continue to live and sustain their numbers.

With proper design of habitat and integrating this with the other needs of development there is no reason why the tiger will not have a long term future and contribute to the welfare of the farmers, to the nations tourist industry and to perpetuating a balanced ecosystem in the forests of Gunung Leuser National Park and beyond.

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TABLE 1

DATA ON TIGER PASSES OF CAMERA TRAPS IN THE BENGKUNG STUDY AREA

Film in	Film out	Location	Fr#	a/s	c	sex	dir	Di/Nc	N/pass	name
Sep-88	Oct-88	Suntik	14	ad		m?	tow	d	1	????
Feb-88	Apr-88	Lokasi A	6	ad		f	lr	d	1	Barb
May-88	Jun-88	Lokasi A	11	ad		f	lr	d	1	Barb
Sep-88	Oct-88	Lokasi B	2	ad		m	away	n	1	Hammer
Sep-88	Oct-88	Lokasi B	4	ad		m	away	n	1	Hammer
Sep-88	Oct-88	Lokasi B	8	ad		m	away	n	1	Hammer
Jan-89	Feb-89	Suntik	9	ad		f?	away	n	1	Jan
Sep-86	Oct-86	Rambung	10	ad		m	rl	d	1	Kaiser
Oct-86	Nov-86	Rambung	24	ad		m	lr	d	1	Kaiser
Nov-86	Dec-86	Rambung	23	ad		m	rl	d	1	Kaiser ?
Nov-88	Dec-88	Barat	2	ad		m	away	d	1	Rajah
Sep-88	Oct-88	Lokasi A	3	ad		m	rl	n	1	Rajah
Sep-88	Oct-88	Lokasi B	6	ad		m	away	crep	1	Rajah
Jan-89	Feb-89	Lokasi B	3	ad		m	tow	crep	1	Rajah
Sep-88	Oct-88	Rambung	19	ad		m	rl	d	1	Rajah
Jan-89	Feb-89	Rambung	11	ad		m	rl	d	1	Rajah
Jul-88	Aug-88	Suntik	7	ad		m	away	d	1	Rajah
Sep-88	Oct-88	Suntik	17	ad		m	away	crep	1	Rajah
Nov-88	Dec-88	Suntik	3	ad		m	tow	n	1	Rajah
Dec-88	Jan-89	Suntik	5	ad		m	away	n	1	Rajah
Dec-87	Mar-88	Timur	13	ad		m	away	n	1	Rajah
Dec-87	Mar-88	Timur	25	ad		m	tow	n	1	Rajah
Nov-88	Dec-88	Timur	4	ad		m	away	n	1	Rajah
Feb-89	Mar-89	Timur	1	ad		m	tow	crep?	1	Rajah
Apr-89	Jul-89	Timur	16	ad		m	away	d	1	Rajah
Dec-87	Mar-88	Timur	18	ad		f+m	away	d	2	Ratu and Satria
Jan-88	Mar-88	Barat	11	ad		m	away	d	1	Satria ?
Jul-88	Aug-88	Lokasi B	6	ad		?	tow	d	1	Skinny
May-88	Jun-88	Suntik	8	ad		?	tow	d	1	Skinny
May-88	Jun-88	Suntik	5	ad		?	tow	d	1	Skinny

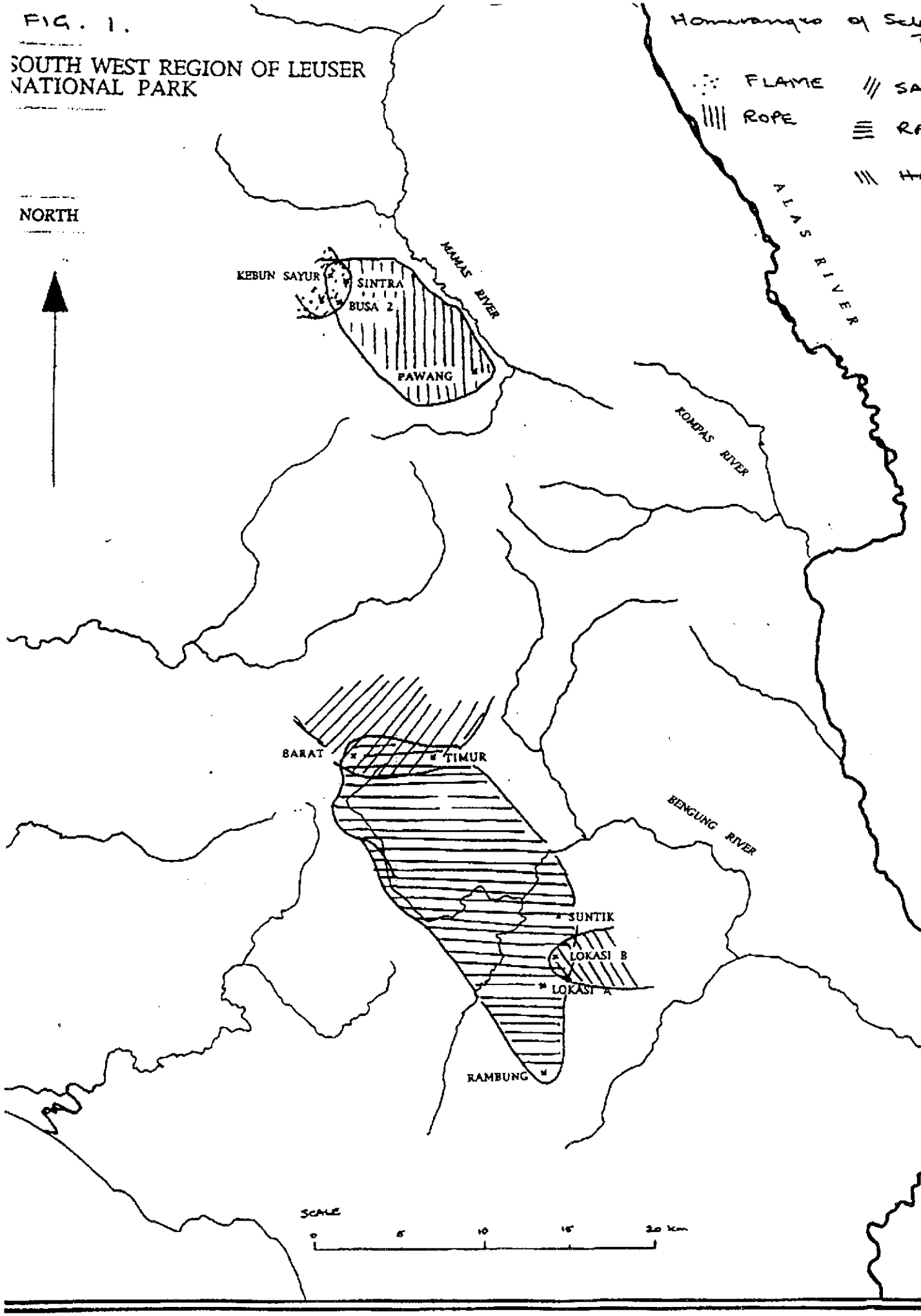
TABLE 2

DATA ON TIGER PASSES OF CAMERA TRAPS IN THE MAMAS STUDY AREA

Film in	Film out	Location	Fr#	a/s	sex	dir	Di/Nc	N/pass	name
Nov-90	Dec-90	Kebun Sayur		adult	m	lr	crep	1	??
Jun-90	Aug-90	Busa Dua	21	adult	f	rl	d	1	Flame
Nov-90	Dec-90	Kebun Sayur	10	adult	f?	lr	n	1	Flame
Oct-90	Nov-90	Sintra	19	adult	f	rl	d	1	Flame
Jun-90	Aug-90	Busa Dua	19	adult	m	rl	d	1	Rope
Jun-90	Aug-90	Busa Dua	22	adult	m	rl	d	1	Rope
Sep-90	Oct-90	Busa Dua	6	adult	m	lr	n	1	Rope
Sep-90	Oct-90	Busa Dua	8	adult	m	rl	n	1	Rope
Sep-90	Oct-90	Busa Dua	10	adult	m	rl	d	1	Rope
Jun-90	Aug-90	Kebun Sayur	11	adult	m	lr	n	1	Rope
Jun-90	Aug-90	Kebun Sayur	22	adult	m	rl	d	1	Rope
Jun-90	Aug-90	Kebun Sayur	30	adult	m	lr	d	1	Rope
Nov-90	Dec-90	Kebun Sayur	7	adult	m	lr	n	1	Rope
Nov-90	Dec-90	Kebun Sayur	13	adult	m	rl	n	1	Rope
Sep-90	Oct-90	Sintra	10	adult	m	lr	n	1	Rope
Jun-90	Aug-90	Pawang	30	adult	m	rl	d	1	Rope.
Jun-90	Aug-90	Busa Dua	14	adult	m	lr	n	1	Titan
Apr-90	Jun-90	Kebun Sayur	3	adult	m	rl	n	1	Titan

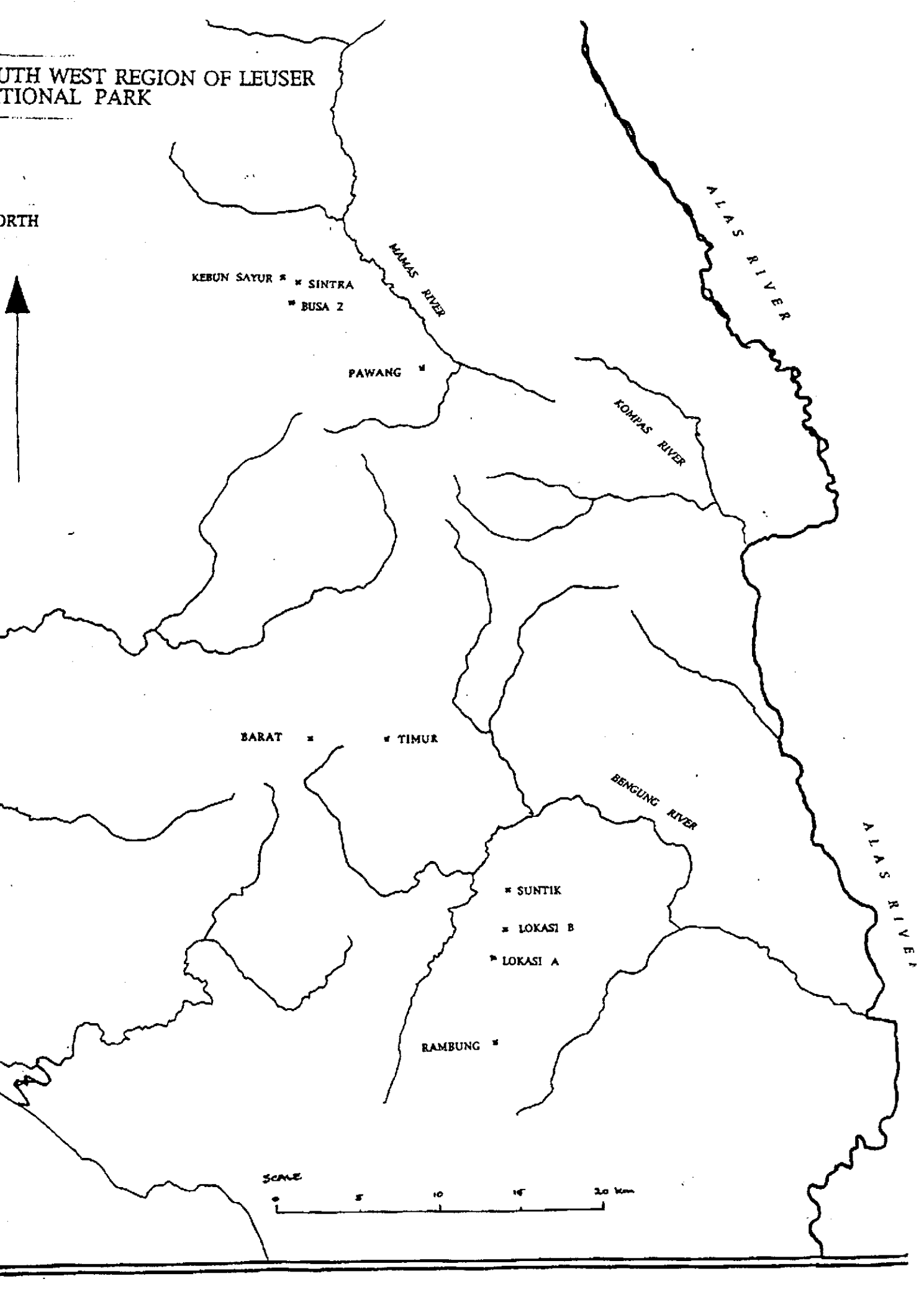
FIG. 1.

SOUTH WEST REGION OF LEUSER NATIONAL PARK



UTH WEST REGION OF LEUSER
TIONAL PARK

ORTH



FACSIMILE TRANSMISSION COVER SHEET

TO: FAX # 612/432-2757

Dr. Ronald L. Tilson
Sumatran Tiger PHVA Coordinator
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Minnesota Zoo
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United States of America

FROM: FAX # 62 251 325755

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Jawa Barat
INDONESIA

DATE: ~~02~~ 5 November 1992

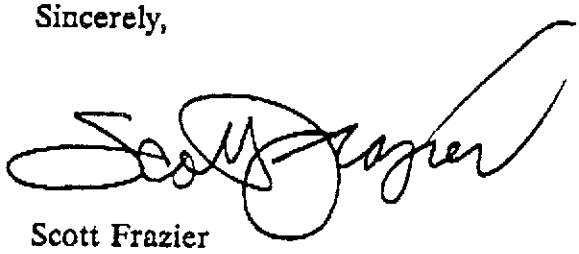
Number of pages 8 (inclusive)

Dear Dr. Tilson,

Thank you for your prompt response to my FAX; I'm sorry my reply has been somewhat delayed. Following this coversheet is a *PRELIMINARY* table of *Wetland Data Base* (*WDB*) tiger observation data. I fully expect to have additional data entered by the time the meeting comes around. Likewise I just haven't had time to go over the existing data with a fine toothed comb but I do not expect any major changes. Observations with the code "**+Memo**" means that there is a memo field (remarks) accompanying this observation in *WDB*. And lastly the date used to define an observation is, when known; the fieldwork date.

I look forward to meeting you in Padang.

Sincerely,



Scott Frazier
Manager, *Wetland Data Base*
Asian Wetland Bureau-Indonesia

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WETLAND DATA BASE TIGER SITES WITH ROUGH COORDINATES - Prelim. Data Asian Wetland Bureau]

CODE	SITE NAME	LATDEG	LATMIN	LAT	LONDEG	LONMIN	LONG
SUM04	Blok Kluet, T.N. Gunung Leuser	3	0	N	97	27	E
SUM09	Dolok Sembelin	2	50	N	98	5	E
SUM17	Giam-Siak Kecil	1	6	N	101	39	E
SUM19	Danau Bawah and Pulau Besar	0	37	N	102	11	E
SUM23	Kerumutan Baru	0	5	S	102	29	E
SUM28	Rimbo Panti	0	22	N	100	5	E
SUM29	Danau Maninjau Utara / Selatan	0	15	S	100	10	E
SUM31	Kerinci Sablat	2	5	S	101	25	E
SUM32	Lunang	2	20	S	101	0	E
SUM38	Taman Nasional Berbak	1	23	S	104	20	E
SUM45	Banyuasin Musi River Delta	2	30	S	104	50	E
SUM46	Padang Sugihan	2	55	S	105	10	E
SUM47	Ogan-Komering Lebaks	3	35	S	104	45	E
SUM48	Taman Nasional Sumatra Selatan I	5	15	S	104	15	E
SUM51	Way Kambas	5	0	S	105	45	E
SUM65	Lematang River Peatswamps	3	0	S	104	0	E

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WETLAND DATA BASE TIGER SITES AND SOURCES - ASIAN WETLAND BUREAU PRELIM. DATA (left half)

REC.	SITE	NAME	DATE*	SOURCE
1	SUM04	Blok Kluet, T.N. Gunung Leuser	08/1991	Rusila, Y. and Enis Widjarnati H. Survey Pendahuluan Areal lahan basah di Taman Nasional Gunung Leuser Blok Kluet, Aceh Selatan.
2	SUM04	Blok Kluet, T.N. Gunung Leuser	08/1991	[as above]
3	SUM09	Dolok Sembelin	1987	Silvius et al. The Indonesian Wetland Inventory. A Preliminary Compilation of Information on Wetlands of Indonesia. Vol. II.
4	SUM17	Giam-Siak Kecil	1987	[as above]
5	SUM17	Giam-Siak Kecil	11/1991	Giesen, W. and B. van Balen. The Wetlands of Giam-Siak Kecil Wildlife Reserve, Riau, Sumatra. FINAL DRAFT REVIEW COPY ONLY.
6	SUM17	Giam-Siak Kecil	09/1992	Martin, Keith. (pers comm)
7	SUM19	Danau Bawah and Pulau Besar	1987	Silvius et al. The Indonesian Wetland Inventory. A Preliminary Compilation of Information on Wetlands of Indonesia. Vol. II.
8	SUM23	Kerumutan Baru	1987	[as above]
9	SUM23	Kerumutan Baru	09/1992	Martin, Keith. (pers comm)
10	SUM28	Rimbo Panti	1987	Silvius et al. The Indonesian Wetland Inventory. A Preliminary Compilation of Information on Wetlands of Indonesia. Vol. II.
11	SUM29	Danau Maninjau Utara / Selatan	1987	[as above]

WETLAND DATA BASE TIGER SITES AND SOURCES - ASIAN WETLAND BUREAU PRELIM. DATA (left half)

REC.	SITE	NAME	DATE*	SOURCE
12	SUM31	Kerinci Seblat	1987	[as above]
13	SUM31	Kerinci Seblat	04/1991	Giesen, Wim and Sukotjo. Lake Kerinci and the Wetlands of Kerinci Seblat National Park, Sumatra. FINAL DRAFT REVIEW COPY ONLY.
14	SUM32	Lunang	1987	Silvius et al. The Indonesian Wetland Inventory. A Preliminary Compilation of Information on Wetlands of Indonesia. Vol. II.
15 38.	SUM38	Taman Nasional Berbak	1981	de Wulf, Robert, Djoko Supomo and Kurnia Rauf. Berbak Game Reserve: Management Plan 1982-1987. FAO Field Report
16	SUM38	Taman Nasional Berbak	11/1983	Silvius, Marcel J. and Wim J. M. Verheugt. Soils, Vegetation, Fauna and Nature Conservation of the Berbak Game Reserve, Sumatra, Indonesia.
17	SUM38	Taman Nasional Berbak	11/1983	[as above]
18	SUM38	Taman Nasional Berbak	11/1983	[as above]
19	SUM38	Taman Nasional Berbak	11/1983	[as above]
20	SUM38	Taman Nasional Berbak	1987	Silvius et al. The Indonesian Wetland Inventory. A Preliminary Compilation of Information on Wetlands of Indonesia. Vol. II.
21	SUM38	Taman Nasional Berbak	08/1991	Himpunan Mahasiswa Biol., Universitas Padjadjaran. DRAFT Laporan Sigi Fauna Di Suaka Margasatwa Berbak Propinsi Jambi.

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WETLAND DATA BASE TIGER SITES AND SOURCES - ASIAN WETLAND BUREAU PRELIM. DATA (left half)

REC.	SITE	NAME	DATE*	SOURCE
22	SUM38	Taman Nasional Berbak	08/1991	[as above]
23	SUM38	Taman Nasional Berbak	08/1991	[as above]
24	SUM38	Taman Nasional Berbak	08/1991	[as above]
25	SUM38	Taman Nasional Berbak	09/1991	Rusila, Y. (pers comm)
26	SUM38	Taman Nasional Berbak	09/1991	[as above]
27	SUM38	Taman Nasional Berbak	01/1992	Zech, Ben (pers comm)
28	SUM45	Banyuasin Musi River Delta	1987	Silvius et al. The Indonesian Wetland Inventory. A Preliminary Compilation of Information on Wetlands of Indonesia. Vol. II.
29	SUM46	Padang Sugihan	10/1985	Nash, S.D. and A.D. Nash. The Large Carnivores, Primates, and Ungulates in the Padang-Sugihan Wildlife Reserve, South Sumatra. WWF/IUCN.
30	SUM47	Ogan-Komering Lebaks	08/1990	Giesen, Wim. Conservation and Management of the Ogan-Komering and Lebaks South Sumatra. FINAL DRAFT REVIEW COPY ONLY.
31	SUM48	Taman Nasional Sumatra Selatan	1987	Silvius et al. The Indonesian Wetland Inventory. A Preliminary Compilation of Information on Wetlands of Indonesia. Vol. II.

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WETLAND DATA BASE TIGER SITES AND SOURCES - ASIAN WETLAND BUREAU PRELIM. DATA (left half)

REC.	SITE	NAME	DATE*	SOURCE
32	SUM51	Way Rambas	1987	[as above]
33	SUM65	Lematang River Peatswamps	08/1990	Giesen, W. and Sukotjo S. Lematang River Peatswamps South Sumatra. FINAL DRAFT REVIEW COPY ONLY.

* Date = fieldwork date if known. Not applicable for Compiled Lists / Sec. Sources.

WETLAND DATA BASE TIGER RECORDS - PRELIMINARY DATA (ASIAN WETLAND BUREAU) (right half)

REC.	SITE	#	TYPE	EVIDENCE	CONFIRM	HABITAT	REMARKS
1	SUM04	-	O,I	T,OV	Y	Coastal dryland woodland	+Memo
2	SUM04	1	O	OTC	Y	Lake shoreline, non-aquatic trees/shrubs	+Memo
3	SUM09	-	L		?		
4	SUM17	-	L		?		
5	SUM17	-			U		
6	SUM17	-	I	O?T?	U	Peat swamp forest	+Memo
7	SUM19	-	L		?		+Memo
8	SUM23	-	L		?		
9	SUM23	-	O,I	A,OTV	Y		
10	SUM28	-	L		?		+Memo
11	SUM29	-	L		?		
12	SUM31	-	L		?		
13	SUM31	12	I	O?T?	Y	Topogenous peat swamp woodland	+Memo
14	SUM32	-	L		?		
15	SUM38	-			Y		
16	SUM38	1			Y	Marine or Estuarine Nipa woodland, flooded daily	
17	SUM38	2			Y	Riverine forest	
18	SUM38	2			Y	Non-peat Swamp forest	
19	SUM38	2			Y	Non-peat Swamp forest	
20	SUM38	-	L		?		
21	SUM38	3	O	T	Y	Peat Swamp forest	+Memo
22	SUM38	2	O,I	T,O	Y		+Memo
23	SUM38	2			Y	Riverine	
24	SUM38	3	I	O	U	Freshwater Swamp	+Memo
25	SUM38	1	O,I	T,O	Y	Peat Swamp forest	+Memo
26	SUM38	1	I	O	Y	Perennial Riverine	+Memo
27	SUM38	-			Y		

WETLAND DATA BASE TIGER RECORDS - PRELIMINARY DATA (ASIAN WETLAND BUREAU) (right half)

REC.	SITE	#	TYPE	EVIDENCE	CONFIRM	HABITAT	REMARKS
28	SUM45	-	L		?		
29	SUM46	-			Y		
30	SUM47	-			U	Seasonally flooded (unknown tidal), (non-peat) swamp, grasses	+Memo
31	SUM48	-	L		?		
32	SUM51	-	L		?		
33	SUM65	2			U		+Memo

KEY

A = ARTIFACTS (BODY PARTS)
C = CLAW MARKS
I = LOCAL INFORMANT
L = COMPILED LIST (SECONDARY SOURCE)
O = OBSERVED/OBSERVATION (VISUAL)
T = TRACK(S)
U = UNCONFIRMED
V = VOCALIZATION
Y = (CONSIDERED) VALID
# = NUMBER OF OBSERVATIONS
, = to be interpreted as "respectively" for the TYPE and EVIDENCE columns