# THE DISTRIBUTION AND STATUS

# OF THE

# ASIAN TWO-HORNED RHINOCEROS
# (*Dicerorhinus sumatrensis harrissoni*)

# IN SABAH, MALAYSIA

by

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Many people have contributed information and ideas, dating from 1980 to 1990, which have been incorporated into the report. Most have been noted in the text in the conventional way by referring to their papers, some of which were not published, and as "personal communications". Apologies are tendered to those who have not been mentioned by name.

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ABBREVIATIONS USED IN THE TEXT

| | |
|---|---|
| asl | (altitude) above sea level |
| ha | hectares (100 ha = 1 sq km) |
| PFE | permanent forest estate |
| sq km | square kilometres |
| W R | Wildlife Reserve |

NOTE

Both lesser one-horned Asian rhinoceros (*Rhinoceros sondaicus*) and Malayan tapir (*Tapirus indicus*) occurred in northern Borneo until at least 8,000 to 10,000 years ago (Cranbrook, 1986), but - despite a few unconfirmed and highly dubious reports to the contrary - no evidence of either species has been found in Sabah during the past century.

SUMMARY

This report brings together currently-available information on the status of the Asian two-horned rhinoceros (*Dicerorhinus sumatrensis harrissoni*, commonly known as the Sumatran rhino), in the wild in Sabah, Malaysia.

It is not possible (nor would it be useful for conservation purposes) to estimate the number of rhinos alive within Sabah, because the animals are very rare and patchily distributed through vast areas of forest. Concern over this rhino's status, which has been expressed often during the past few decades, is not exaggerated, however, and this species is indeed highly endangered.

The extinction in Borneo in relatively recent times of the Malayan tapir and Javan rhino, seemingly of natural causes, is noted, along with the implication that the Sumatran rhino may have similarly suffered a natural decline. Evidence is presented which suggests that the natural distribution of this rhinoceros in Sabah is determined largely by the availability in the forest environment of sodium and possibly other essential minerals. It is further suggested that the necessity for mature female rhinos, especially, to visit concentrated mineral sources (often in the form of "salt licks") has been the main reason why hunters have been able to locate and, in may areas, wipe out this normally elusive species. It is believed that the proportion of female and young rhinos in Sabah is abnormally low, an indication of the effects of intensive hunting.

Despite the probability that non-human factors may have led to a decline in the distribution and size of wild rhino populations in Sabah, it is concluded that hunting by native rural people is almost certainly the key factor which has caused the drastic decline observed during the past century. Illegal hunting still occurs and is still the major threat to the species' continued survival.

Only two areas in Sabah contain rhino populations which have good prospects of long-term survival with adequate protection and management. One (the Tabin population) is concentrated in Tabin Wildlife Reserve, an area of 1,225 sq km which contains at least seven salt licks. The other (the Ulu Segama - Kuamut population) is scattered through a vast area of several contiguous Forest Reserves, but probably centered within an area of less than 4,000 sq km in the catchment areas of the upper Segama and upper Kuamut Rivers. This latter area includes the Danum Valley and Maliau Basin Conservation Areas in the Sabah Foundation's 100-year logging concession.

The Ulu Segama - Kuamut population is probably larger than the Tabin population. However, concentrations of rhinos in the former are highly scattered and it is unlikely that free interbreeding occurs. The Kuamut and other large rivers probably form a partial barrier to rhino movements.

The rugged area which forms the north-western side of the Kuamut catchment, the last extensive area of undisturbed dipterocarp forest in Sabah, has yet to be explored to determine the distribution of rhinos. If widespread, they would form an important extension to the known Ulu Segama - Kuamut population.

Two other areas known to contain rhinos may possibly prove to be important for the species' conservation: the Segaliud-Lokan/Deramakot/Tangkulap Forest Reserves and the Muruk Miau area adjacent to the border with East Kalimantan (Indonesia). The latter area will be relevant only if the proposed Sungai Kayan-Mentarang Nature Reserve in East Kalimantan contains a significant protectable rhino population.

Rhinos occur in at least six other separate areas of permanent forest estate (PFE) in Sabah, but it appears that in all of these the forest area is too small and/or the rhino population is too small to be viable in the long-term.

A few more rhinos still exist in forest areas which are outside the PFE. Most of these animals are doomed to extinction, and should be brought into the planned captive breeding population. Some of these rhinos could usefully remain in the wild state, however, if the PFE is extended.

Pending work to ascertain (as far as possible) the proportion of female rhinos in the main wild populations, it may become advisable in the future to translocate "doomed" females into Tabin or Ulu Segama - Kuamut. For the time being, however, the development of a captive breeding population is very important, to guard against the possibility that the wild populations have declined beyond the stage of feasible protection and management.

Logging of dipterocarp forests as practised in Sabah is believed to adversely affect rhinos by disrupting already limited breeding and by facilitating hunting. However, these factors are fairly trivial; all rhinos appear to move away from logging activity and return several years later, while semi-professional rural native hunters operate in remote forests, away from any feasible *in situ* protection programmes which may be implemented.

Loss of forest through conversion to permanent plantations has led to a significant loss of rhino habitat and rhinos in parts of eastern Sabah during the past decade or so. But, like logging, this is minor in comparison to state-wide hunting pressure.

The development of large-scale monoculture tree plantations for wood in the PFE may prove to be another significant threat to rhinos in the future. This possibility needs to be investigated and, if necessary, acted upon.

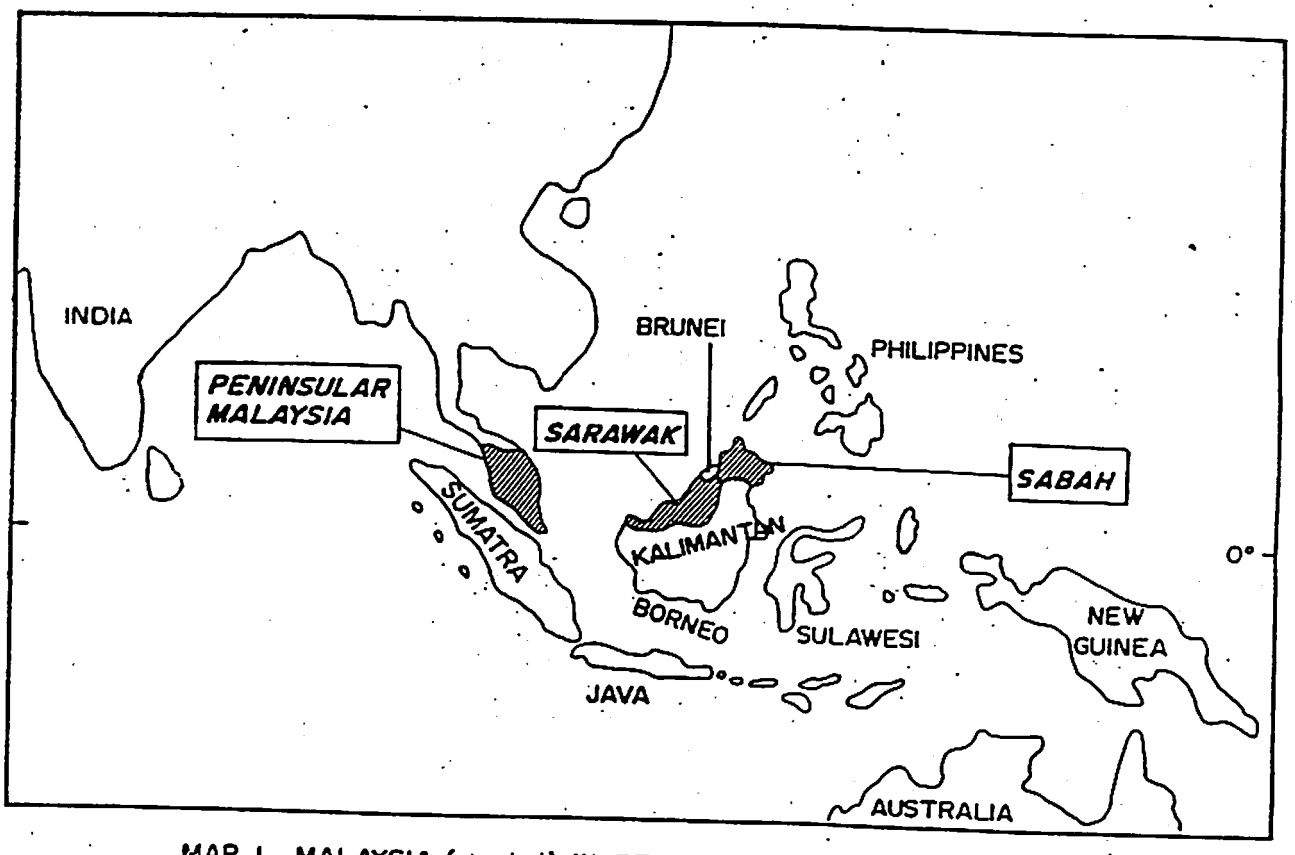
Fire in logged forest is a potentially major long-term threat to Borneo's forests and rhinos alike.

The response of wild rhinos to harmless human disturbance is described and implications for management are discussed.

An outline plan for future surveys and monitoring of wild rhinos in Sabah is provided as an appendix to this report.

# 1. INTRODUCTION

At the beginning of this century, the Borneo form of the Asian two-horned rhinoceros (*Dicerorhinus sumatrensis harrissoni*), commonly known as the Sumatran rhino, was fairly widespread and common in Sabah (Map 1), although there appear to have been regions where the species did not occur (for example, many reports in the British North Borneo Herald, 1883 - about 1920; Weedon, 1906). As examples from those times, at least three rhinos were shot near the town of Sandakan in 1907, two of which were young animals, while in the same year, during an expedition in central Sabah, W H Beech reported seeing many rhinos in the upper Kuamut River, three of which were shot (British North Borneo Herald, 1907). Unrecorded but alluded to in the newspapers of those times are the activities of native hunters, who evidently obtained and freely sold numerous horns in Sandakan town. The government clearly regarded rhino horn as one of various forest products, the harvesting of which was encouraged.




MAP I. MALAYSIA (shaded) IN RELATION TO ASIA AND AUSTRALIA.

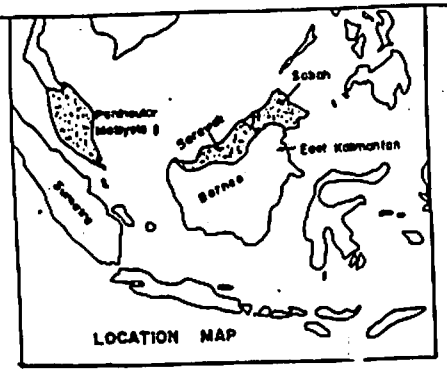
Since those times, the sub-species has suffered a serious decline in distribution and numbers throughout northern Borneo (for example, Burgess, 1961; Davies and Payne, 1982; Andau and Payne, 1982, 1986). By 1979, it was feared that the Asian two-horned rhinoceros was almost extinct in Sabah, but during an extensive survey of large mammals in the state conducted jointly by the Wildlife Section of the Forestry Department and WWF Malaysia, the continuing existence of several small breeding concentrations was confirmed (Davies and Payne, 1982). While prolonged illegal hunting was identified as the major factor which had led to the species' decline, by the early 1980's loss of forest habitat through conversion to permanent agriculture was becoming a significant additional threat. One of the rhino populations under pressure from forest loss was afforded protection by the Sabah government in 1984 through the establishment of the 1,205 sq km Tabin Wildlife Reserve and contiguous 20 sq km of Virgin Jungle Reserve (Payne, 1986a; Andau, 1987; area 40 on Map 2). In the meantime, the extent of another scattered rhino population in the Ulu Segama Forest Reserve (areas 28 and 29 on Map 2) was shown to extend into the Danum Valley Conservation Area (428 sq km; area 27 on Map 2), an area of undisturbed forest retained within the vast (about 10,000 sq km) logging concession of the Sabah Foundation (Clive Marsh and others, personal communication).

As a result of concern that these populations might not be viable, and of the fact that a considerable number of non-viable rhinos groupings remained scattered in various unprotected forest areas in eastern Sabah, the government established in late 1985 the Sabah Rhino and Wildlife Conservation Committee (SRWCC; Andau, 1987). The main function of the SRWCC was to initiate and oversee a programme of capture of these "doomed" rhinos for the formation of a captive breeding population. In January 1988, a new Sabah Wildlife Department was established (as an upgrading of the Wildlife Section of the Forestry Department) and the SRWCC was phased out. By mid 1989, one mature male and one immature female rhino were held in stockades at Sepilok Forest Reserve (area 7 on Map 2). At that time, it was felt by the Director of the Wildlife Department that an updating of knowledge on the present distribution and status of wild rhinos in Sabah had become an important priority. This work was started with assistance provided under WWF Project No. 3935 - The Sumatran Rhinoceros in Sabah: distribution and status in previously unsurveyed areas (22 October 1989 to 7 January 1990). It was decided that the first region for investigation should be that between the eastern end of Danum Valley Conservation Area, where rhinos were known to occur at relatively high population density (Ahmad Darus, 1987) and the Maliau Basin Conservation Area (area 18 on Map 2), where the presence of a small number of rhinos had been confirmed in 1988 (Payne *et al*, 1989). The entire region is permanent Forest Reserve, with logging rights held by the Sabah Foundation.

## 2. METHODS

Existing reports on rhinos in Sabah (notably, Ahmad Darus, 1987; Andau, 1987; Andau and Payne, 1982, 1986; Anon, 1986; Davies and Payne, 1982; Payne, 1986b; Payne *et al.* 1989) were used as the basis for this report, together with information derived from surveys conducted in November 1989 to January 1990. A helicopter survey (funded by the Sabah Wildlife Department, with Departmental officers accompanying the author) was done over the region between Danum Valley and Maliau Basin on 10 November 1989 to ascertain location of current logging activities and possible ground access routes. Ground surveys were done in four areas between the Danum Valley and Maliau Basin Conservation Areas later in November 1989. Three survey teams comprised of staff of the Wildlife Department with the WWF project executant, and one of Sabah Foundation staff. Details of these surveys are given elsewhere (Payne, 1990). Various problems prevented additional ground surveys in this region in December, and instead brief surveys were done to the north and east of Danum Valley, and to the south-west of Maliau Basin in early January 1990. In addition, people with knowledge of the forest areas of interior Sabah were interviewed. During November to December 1989, surveys were also done by the Wildlife Department in three areas in eastern Sabah where doomed rhinos had previously existed.

Map 2. MAJOR FOREST AREAS AND OCCURRENCE OF THE ASIAN TWO-HORNED RHINOCEROS IN SABAH




Key

- Rhinos present and part of major breeding population (dots do not represent precise numbers or distribution of rhinos)
- Rhinos outside the permanent forest estate
- Rhinos present in these areas, but numbers and distribution unknown
- Locations where rhinos present in 1960's but now extinct
- International and interstate boundary
- Main permanent roads in regions where rhinos exist
- Boundaries of main Reserves and Parks in Sabah's permanent forest estate
- boundaries between Forest Reserves
- Areas described in text
- Arbitary divisions between areas described in the text
- Rivers which form partial barriers to movement within rhino populations
- Approximate extent of Ulu Segama - Kuamut rhinoceros population, based on available data, February 1990

| | |
|---|---|
| DVCA | Danum Valley Conservation Area |
| DVFSC | Danum Valley Field Studies Centre |
| FR | Forest Reserve |
| MBCA | Maliau Basin Conservation Area |

KOTA KINABALU
SANDAKAN
SEMPORNA
LAHAD DATU
SARAWAK
EAST KALIMANTAN
Sugut area
Ling Kabai FR
Kinabalu Park
Bongaya FR
Ulu Tungud FR
Sepilok FR
Melangking area
Kulamba Wildlife Reserve
Deramakot FR
Tangkulap FR
Tavai
Trus Madi FR
Greater Range National Park
Ulu Kalias FR
Segaliud area
Segaliud-Lokan FR
Gamantang FR
Deramakot FR
Kuamut FR
Matuja FR
Pinangah FR
Sungai
Kuamut R.
Ulu Segama FR
DVFSC
DVCA
MBCA
Gunung Rara FR
Sapulut area
Sapulut FR
Pensiangan area
Kalabakan FR
Sabah Forest Industries
Ulu Kalumpang FR
Tawau Hills Park
Tawau
Lungsang
Tabin Wildlife Reserve
Deer Peninsula
SCALE
0 10 20 30 40 50 Kilometres

## 3. DISTRIBUTION OF RHINOCEROS IN SABAH

It is not possible with available information to completely describe the present distribution of the rhinoceros (*Dicerorhinus sumatrensis*) in Sabah. Even for regions in which the species does occur, there appear to areas rarely or never entered by rhinos. For this report, the description of rhino distribution is based on a map of Sabah showing (a) the main legally-protected forest areas and (b) additional areas where rhinos occur. To facilitate description, these are divided into forty-one areas (Map 2). Some of these areas are clearly-defined (for example, Tabin Wildlife Reserve), while others are based upon a combination of factors but are to some extent arbitary (notably, the interior Forest Reserves). For areas not numbered on Map 2, there is no evidence that rhinos exist, nor is it likley that they occur.

The areas are as follows (refer to Map 2):

1. *The border area between south-western Sabah and the neighbouring state of Sarawak (Malaysia) and province of East Kalimantan (Indonesia).* This is still predominantly under forest cover, on very rugged terrain, with scattered settlements of communities which hunt wild animals for meat. Most of the area labelled 1a. is within the Sabah Forest Industries concession, and under undisturbed montane forest, much of which is scheduled for future logging. There are a few scattered, small villages within the area. The last report of rhinos adjacent to the Sarawak border, from local hunters, dates from the mid 1960's (Davies and Payne, 1982). Both sides of this border region have been opened up by logging operations since then, and the total lack of any recent reports there suggests that rhinos are now extinct in the Sabah-Sarawak border range. However, hunters from Long Pasia, in the heart of area 1a, reported in early 1989 that they had found signs of rhino a few days' walk to the east of that village in area 1b (Laurentius Ambu, personal communication), which incorporates a mountain peak (Muruk Miau, 6,835 feet asl) and territory in East Kalimantan. There is a joint Malaysian-Indonesian encampment on the international boundary here, which is used as a base for setting marker stones. The people involved are not local, however, and do not stray far from the boundary, so they are unable to provide much information about the area generally. Area 1c, the Pensiangan district, contains many scattered communities which practise shifting agriculture and hunting. In the past, there were more human inhabitants than now, and much of the vegetation is old secondary forest. The area was gazetted as Forest Reserve in 1984. Brief verbal surveys in early 1990 indicated that rhinos were present in former times but are now probably extinct.

8. *The Melangking area*, land owned by the state and private individuals. More than half the area is still under heavily-logged forest. Footprints of a rhino were found here by local residents in the mid 1980's (Forestry Department file report), indicating the presence of one or a small number of remnant, doomed individuals.

9. *The Gomantong area*, consisting of a Forest Reserve (for the protection of the Gomantong Caves and edible birds' nest industry) and extensive contiguous seasonally-flooded forest. An old local resident shot a rhino in this area in the 1960's (personal communication to J. Payne), but there have been no records since then.

10. *The Batu Putih - lower Pin area*, consisting of a rattan plantation under natural forest (9,300 ha) and Supu Forest Reserve (4,500 ha), together with extensive land under heavily-logged forest owned by private individuals and by the state. Much of the land is being converted to agricultural plantations. There are at least two isolated, doomed rhinos in this area (Shim P. S. and land survey team, personal communications; approximate locations of these animals shown on Map 2).

11. *The Segaliud-Lokan-Labaung area*, land owned by the state and by private individuals. About a half is still under heavily-logged forest, but agricultural development is proceeding. The presence of rhinos here was reported intermittently, including several cases of illegal hunting, during the 1960's until 1988. A Wildlife Department survey found no evidence of the species on the fringes of this area and area 12 in November 1989 (Ambu, 1989), but it is possible that a very few still exist.

12. *Segaliud-Lokan Forest Reserve*, logged and proposed for conversion to fast-growing tree plantation. The presence of rhinos here was reported intermittently by logging workers and hunters from the late 1970's until 1988. One or two rhinos living on the north-eastern periphery of this region were tracked in 1988, with a view to capture using pitfall traps. No sign of any rhinos was found in that area in November 1989 (Ambu, 1989). It is likely, however, that a very small number remain in the Reserve.

13. *Deramakot Commercial Forest Reserve*, entirely logged during the 1960's to early 1980's, and contiguous with Segaliud-Lokan. Rhinos were reported to occur here until the early 1980's (C. Phillipps, personal communication).

14. *Tangkulap Commercial Forest Reserve*, logged, and contiguous with Deramakot. Sabah Foundation staff found rhino footprints here in the early 1980's (P. S. Ajan, personal communication), but there have been no reports since then, despite the accessibility provided by ongoing logging operations.

15. *Bukit Tingkar section of Sungai Pinangah Commercial Forest Reserve*. Fresh rhino wallows were found here in the mid 1960's (W. Meijer, personal communication), but the area has been made accessible by logging during the 1970's and 80's. In the absence of any reports for more than two decades, it is very unlikely that any rhinos remain here.

16. Mainly *Sungai Pinangah Forest Reserve*, mostly undisturbed, with much very steep terrain, and access difficult. Geological survey teams which made two long traverses through the central parts of this area in 1989 found no signs of rhinos (C. Marsh, personal communication).

17. *Ulu Sungai Milian and part of Sungai Pinangah Forest Reserves*, mostly logged but with extensive areas still undisturbed. There have been several reports from logging workers of the presence of rhinos in this area during the 1980's, but none have been able to pinpoint exact locations. Although probably a few rhinos are present, it is unlikely that they constitute a viable breeding population.

18. *Maliau Basin Conservation Area* (39,000 ha), an area set aside (in Gunung Rara Commercial Forest Reserve) for conservation within the Sabah Foundation 100-year logging concession. Small numbers of rhinos occur within this remote area. Payne *et al* (1989) suggest that, although natural ecological factors may limit rhino abundance here, a history of occasional but intense hunting (evidence for which exists) may have nearly wiped out the population because the form of the Basin makes immigration of new animals an unlikely event.

19. *Sungai Imbak-Sinua area*, in Pinangah Commercial Forest Reserve, mostly undisturbed forest, to be opened up for logging during the 1990's. People living around the fringes of this area, who enter to collect rattan canes, report the occurrence of salt springs and of banteng, but not rhinoceros. There is now road access from the north into this area, but wildlife surveys have yet to be done.

20. *North-western part of Kuamut Commercial Forest Reserve.* Undisturbed forest on very broken, rugged terrain. One of the least-known areas in Sabah, despite its proximity to the Kinabatangan River and long history of both human settlement and logging to the north and east. If rhinos occur, the ruggedness of this area may have limited hunting.

21. *Ulu Kuamut section of Gunung Rara Commercial Forest Reserve.* Undisturbed forest, due for logging from 1991 onwards. Rhino footprints were reported found by a Sabah Foundation timber survey team in November 1989 and follow-up work suggests that several rhinos are present within an area of 50 sq km at least (Khamin Diun and Rashid Saburi, personal communications). In December 1989, a Sabah Foundation team met a group of nine hunters in the area, who claimed that they were hunting rhinos, but this report reached wildlife authorities only in late January 1990. There may have been a long history of considerable pressure from skilled rhino hunters in this area, which was formerly most accessible by boat up the Kuamut River from the Kinabatangan River, but was more exposed during the 1960's to 80's as the region to the south was opened up from Tawau.

22. *Malibo Basin and forest to the west and south-west, in Gunung Rara Commercial Forest Reserve.* Mostly undisturbed forest on very rugged terrain now being opened up for logging. Signs of rhino were reported as present in two separate sites by Sabah Foundation staff in 1988. Footprints were confirmed in the southern site, outside the Malibo catchment, by the November 1989 Wildlife Department/WWF Malaysia survey (Payne, 1990).

23. *Southern Sabah, Commercial Forest Reserves.* A logging road bisecting this region from west - east was completed in the mid 1980's. Rhinos occurred through much of this region in the early part of this century (for example, Weedon, 1906), but there have been only a few, mainly vague reports during the past decade, despite the better access provided by logging operations throughout the region.

The western end of the region (area 23a), incorporating much of Sapulut Forest Reserve, contains natural salt licks visited by elephants (Davies and Payne, 1982). There are reported to be at least two small mud volcanoes near the eastern side of Sapulut Forest Reserve, around 4° 34' N, 116° 51' E (SKT logging camp manager, personal communication), formerly (mid 1980's) used by wildlife, but now rarely because of hunting and logging disturbances. Independently, it is reported that a large male rhinoceros was seen by logging company surveyors in 1983 in the same general area, but that no rhinos have been reported locally by company workers since then (Syarikat Kretam logging camp manager, personal communication). The only recent, probably reliable report of rhino in this area is from hunters in March

1989, around 4° 40' N, 116° 50' E, to the south of the Maliau Basin (SKT logging camp manager, personal communication).

There are no definite reports of rhinos during the past decade from the middle part of the region (area 23b, incorporating parts of Gunung Rara and Kalabakan Forest Reserves), despite intensive logging activity in many parts. It was here, however, to the south-west of region 22 near the mouth of the Simbilan River, that in 1907, W H Beech and his companions saw "many" rhinos (three of which they shot) during a period of a few days (British North Borneo Herald, 1907, pp. 89-90). Beech noted that large mamals generally were especially abundant at this spot.

The eastern part of the region (area 23c, incorporating parts of Kalabakan and Gunung Rara Forest Reserves) was almost entirely logged during the 1960's to 80's, but no reports were received by wildlife authorities of rhinos in this area during that period. Surveys conducted by the Wildlife Department/WWF Malaysia in November 1989 failed to find any evidence of rhinos is this area, although other large terrestrial herbivores mammals, including elephants and banteng, were common (Payne, 1990). It has been rumoured for many years that semi-professional rhino hunters, mainly Ibans originating from Sarawak, have been active in south-eastern Sabah. There is also some evidence that a syndicate has been using Tawau as a centre through which rhino horn from south-eastern Sabah, as well as from Indonesia, is exported to Singapore and Hong Kong (Martin, 1989). Thus, it is possible that rhinos were formerly present but wiped out by skilled poachers unknown to wildlife authorities.

24. *Border region between southern Sabah and East Kalimantan*, incorporating parts of Sapulut and Kalabakan Commercial Forest Reserves, under forest cover, both logged and undisturbed. Old residents of the Sumatalun River, in the western part of this area, report that rhinos were present in Sabah-Kalimantan border area many decades ago, but that they are now extinct. There have been no reports from logging company staff. This area is contiguous with the vast forests of East Kalimantan, however, which are likely to contain rhinos in some regions.

25. *Malubuk area*, incorporating parts of Kuamut, Ulu Segama and Gunung Rara Commercial Forest Reserves, under logged and undisturbed forest. The northern part of this area has been accessible by logging road since the 1960's and it is unlikely that any rhinos remain there. Surveys conducted in the middle of the area in April 1986 (Anon., 1986) and November 1989 by Sabah Foundation staff in conjunction with Wildlife Department/WWF Malaysia found no footprints (Payne, 1990) but the latter survey located old, large wallows (in the locality shown on Map 2) which must have been made by rhinos (J. Gasis, personal communication). It is to be hoped that more rhinos are present in the unexplored, steep middle parts of this area, which forms a link between those rhinos to the west (in areas 18, 21, 22 and 23) and those to the

east (in areas 26 and 27).

26. *Malua Commercial Forest Reserve*, predominantly under logged forest, with logging operations expected to end in 1990. Rhinos were present in undisturbed forest in the middle part of this area in 1986, in one section surveyed at an estimated population density of one animal in 43 to 130 sq km (Anon, 1986). That section was logged during 1986 - 1989. Logging company surveyors, who had spent much time in the area during the logging period, had seen no signs of rhinos, nor were any found by the Wildlife Department/WWF Malaysia survey team in the southern part of the area in December 1989 (Payne, 1990). It is possible that the rhinos were hunted after the 1986 survey, but most likely some, at least, shifted northwards into forest which had been logged earlier (i.e. to the northern part of area 26).

27. *Danum Valley Conservation Area* (42,755 ha), an area set aside (in Ulu Segama Commercial Forest Reserve) for conservation within the Sabah Foundation 100-year logging concession. The presence of rhinos was suspected in 1976 (Kiew, 1976) and confirmed in the mid 1980's, when road access and a permanent Field Studies Centre were established on the eastern periphery of the Conservation Area. Subsequently, Ahmad Darus (1987) conducted an ecological study of the rhinos in the vicinity of the Centre and estimated that at least 5 and probably 8 rhinos used the study area of about 50 sq km, including two juvenile animals. During an east-west traverse through the Conservation Area in November 1989, rhino footprints were found only at one site in the middle of the Area (Payne, 1990). No signs of rhinos were found on Gunung Danum, a mountain of ultrabasic rock in the middle of the Area, during a scientific expedition conducted in mid 1989 (Shukor Md. Nor *et al*, in preparation). Resident staff and scientists have noted that rhinos seem to have almost disappeared from the vicinity of the Field Studies Centre (see section 4 for discussion), but fresh rhino footprints were found in December 1989, further to the south-west, just outside Ahmad Darus' study area (Elaine Gasis, personal communication).

28. *Ulu Segama Commercial Forest Reserve, southern section*, under logged forest. This area appears to have contained rhinos in the past (Burgess, 1961; Leong, 1974), but there have been neither wildlife surveys nor reports of rhinos in recent years. The area is of concern because it could represent an extension of the Danum Valley rhino population, yet it is relatively open to poachers from the privately-owned land and state land to the south.

29. *Ulu Segama Commercial Forest Reserve, northern section*, predominantly under logged forest with some undisturbed forest. The occurrence of individual rhinos in this area is reported occasionally, mostly by Forestry Department staff to Wildlife

staff in the regional Wildlife Department office at Lahad Datu. There appears to be no particular concentration of rhinos in any part of the area, and numbers are clearly both small and scattered.

30. *Tingkayu area*, under agricultural plantations and heavily logged forests. Rhinos were present in the past (Burgess, 1961; unpublished documents in Sabah Forestry Department files) but they are now probably extinct. It is possible that a very few remain in scattered forest remnants. The most recent report dates from 1986, when local residents stated that a rhino was present in forest near the coast, around the mouth of the Tingkayu River, (Arsid Amzah, personal communication), but presumably this was killed as nothing was subsequently heard.

31. *Ulu Kalumpang Commercial Forest Reserve and Tawau Hills Park*, logged and undisturbed forest. Rhino footprints were found in the north-west part of this area in 1980 by wildlife staff (Anthony Gorotud, personal communication). There have been no subsequent reports, but probably very people have entered from the north since logging ceased in the early 1980's, and a few isolated individuals may remain.

32. A rhino was shot here, near the *Tawau/Semporna/Lahad Datu road junction*, by a policeman in 1968. This well-documented case was brought to court, but a plea of self-defence was accepted. This area is almost entirely under agriculture now and no rhinos remain.

33. Rhino footprints were reported in the *Pock hills* here by a geological team in the early 1960's (Sabah Forestry Department file report), but the species no longer occurs in this part of Sabah.

34. *Ulu Lamag, Pin and Koyah area*, under a mixture of agricultural plantations and heavily logged forests. Much of the forest was burned during the 1983 drought. Various old reports show that rhinos were once common in this area. At least three reliable people have described encounters with rhinos to J. Payne: (a) a solitary adult, in the upper Latangon River in 1978, which was killed on a logging road by being run down with a Landrover, (b) three rhinos together near the Bilong River in about 1978 (Jali Udin, personal communication), and (c) a mother and calf in a pond near an abandoned logging camp, during the 1983 drought, in the upper Pin drainage (Tan S L, personal communication). Access has improved since 1983 through the development of new plantations and logging, yet there have been no subsequent reports of rhinos.

35. *Koyah-Tenegang area*, like area 34, now under plantations and heavily logged forest. Rhinos were formerly present but there are no recent reports.

36. *Tenegang-Sapsidom area*, mainly under heavily logged dipterocarp forest and freshwater swamp forest, with one oil palm plantation. A mature male rhino caught in this area is now in captivity at Sepilok Forest Reserve. Several more rhinos are believed to remain. Most of the land is either owned by the state or by private individuals. A wildlife sanctuary has been proposed, primarily for proboscis monkeys (Payne, 1989) but, even if established, such a sanctuary would probably be too small to support a viable breeding popualtion of rhinos. At present the rhinos here are relatively safe, being far from the areas frequented by semi-profesional hunters.

37. *Kretam area and the lower Segama River*, under new agricultural plantations and heavily logged forest. Sightings by local residents in 1980 and the finding of footprints at that time by a faunal survey of Sabah team (Davies and Payne, 1982) indicated the presence of at least several rhinos in this area. Most of the forest still existing at that time has since been converted to plantations. There were no reports of rhinos here for several years but footprints of one individual were found in early 1989 near the Segama River, south of Kretam Forest Reserve and Kulamba Wildlife Reserve, area 38 (J. Payne, personal observation). Surveys in the same area in December 1989 by experienced wildlife staff failed to find any signs of this rhino (Ambu, 1989). It is likely, however, that a very small number of rhinos remain trapped in isolated forest patches in this area.

38. *Kulamba Wildlife Reserve* (20,682 ha), mainly freshwater swamp forest. Rhinos have been reported from the southern and western periphery of this Reserve in the early 1980's (Davies and Payne, 1982; WWF Malaysia, 1985) and there was a more recent occurrence to the south (area 37). The absence of any evidence of the species in the Reserve during a 1984 management survey (WWF Malaysia, 1985) and the fact that much of the area is liable to both seasonal flooding and drying out suggests that this Reserve may not be adequate to support a breeding population of rhincs. Most adjacent non-swampy land has been alienated for agriculture but the small Kretam Forest Reserve (near to the south-western corner of Kulamba), which contains five mud volcanoes, used as salt sources by large mammals, should be joined to Kulamba by incorporation of the intervening land (WWF Malaysia, 1988).

39. *Lower Segama - Lahad Datu area*, plantations, secondary forest and heavily logged forest. Despite the proximity of this area to the rhino-hunting peoples of the Segama River and to some of the longest-established agricultural plantations in Sabah, it has long been known that rhinos inhabit and breed in the area. It was in this area, in March 1987, that the first rhino was caught in Sabah under the captive-breeding project initiated by the Sabah Rhino and Wildlife Conservation Committee. (This mature male animal died in the trap, probably in part as a result of old bullet wounds). It was a surprise to many, however, when in April 1989, an immature female rhino wandered into a village only seven miles from Lahad Datu town and was caught with ease. Evidently there are other rhinos still in the area, under great risk from hunters. No signs of rhino were found, however, during a survey conducted in December 1989, in the area where the rhino had been trapped in 1987 and where other rhinos were believed to exist at that time.

40. *Tabin Wildlife Reserve* (120,521 ha), under logged and undisturbed forest. Most of Tabin W R was logged during the period mid 1960's to 1989, when the last logging licence expired. Tabin W R was established under the Forests (Amendment) Enactment, 1984, and by law management is the responsibility of the Sabah Forestry Department. Tabin W R is contiguous with seven Virgin Jungle Reserves (VJR's), and together they protect about 1,225 sq km of forest land. In addition to the VJR's, about 86 sq km of undisturbed forest has been retained as a "core area" in the centre of Tabin W R. There are at least seven salt licks in Tabin W R, of which three are mud volcanoes. Population densities of one rhino in 20 to 40 sq km have been estimated for the core area (Payne, 1986a: Shukor *et al*, 1989) and, although actual densities may be higher here, the average population density throughout the Reserve is believed to be much lower.

Although more rhino survey work has been conducted in Tabin W R than in any other area in Sabah (Davies and Payne, 1982; Payne, 1986a, 1986b; Shukor *et al*, 1989) it is still impossible to provide a reliable estimate of the present number or population structure of rhinos present. This is mainly because individual rhinos seem to have moved according to logging disturbances, and because natural rhino population density, even under conditions of no logging disturbance, appears to vary greatly thoughout the Reserve. Also, it is believed that illegal hunting of rhinos still occurs occasionally within and around the Reserve. About half of the periphery of the Reserve is contiguous with forest on state land and privately-owned land outside the boundary, some of which is probably used by rhinos.

41. *FELDA (Federal Land Development Authority) Sahabat Agricultural Settlement Scheme* (about 1,030 sq km) and other nearby agricultural areas. There were reports of the presence of rhinos in this area, then entirely under logged forest, to Forestry Department staff in the late 1970's and early 1980's. One rhino was killed near Tungku in 1983, and local residents reported that more were present in the eastern part of the area at that time (Sampoladon Pilik, personal communication; personal communications from local residents to J. Payne). Almost the entire forest in this area was cleared between 1982 and 1989, yet no recent reports of rhinos have been received. While the rhinos may have died from poaching or fire, it is possible that a very small number may have moved westwards into Tabin Wildlife Reserve.

## 4. FACTORS WHICH DETERMINE DISTRIBUTION, ABUNDANCE AND STRUCTURE OF RHINO POPULATIONS

Both the distribution and numbers of living Sumatran rhinos are now known to be greater than was thought two or three decades ago, in Sabah especially (compare, for example, Burgess, 1961 and section 3, above) and in South-east Asia generally (compare, for example, Skafte, 1964 and Wyatt-Smith and Wycherley, 1961, with Mohd. Khan, 1989). The reason is that there is now more information available, not that there are more rhinos (Andau, 1987).

Excessive hunting by people over very long periods has almost invariably and uncritically been blamed as the sole or main reason for the decline of the species in Borneo (for example, Medway, 1977; Andau and Payne, 1982), as elsewhere. More recently, however, it has become apparent that other factors may be implicated in the present distribution and abundance of rhinos in Sabah.

Firstly, there is some doubt as to the extent to which hunting can affect mammal populations under conditions of extensive tropical rainforests. For example, it has been supposed that human predation was responsible for extensive gaps in the distribution of orang-utans in Sumatra and Borneo (Rijksen, 1978), but a recent study in Sabah has demonstrated that there is no consistent relationship between the distribution of orang-utans and the past or present activities of human hunters (Payne, 1988). The banteng or tembadau (*Bos javanicus*) in Sabah has been subject to intense hunting pressure with both dogs and guns in recent decades, yet in no area where there is extensive forest has the species been completely wiped out by these pressures (J. Payne and L. Ambu, personal observations over ten years). In the case of sambar deer (*Cervus unicolor*) in Sabah, most hunters readily concur with the conventional wisdom that they are contributing to the demise of the species - yet, paradoxically, closer questioning suggests that the same hunters repeatedly return to the same areas where, they claim, deer are abundant, while never going to other areas where deer are said to be rare or absent (J. Payne and L. Ambu, personal observations).

Secondly, three ecologically similar species of the order Perissodactlya - Sumatran rhinoceros, Javan rhinoceros (*Rhinoceros sondaicus*) and Malayan tapir (*Tapirus indicus*) - were present in Borneo until a few thousands of years ago (Cranbrook, 1986), but now only the Sumatran rhinoceros survives on the island. Hunting cannot account for the extinction of the tapir, which has no valuable horn or other part sought for Chinese medicines. Cranbrook (1986) argues that these three perissodactyls are ecologically well-adapted to the conditions of open forests under a seasonal climate, drier and cooler than at

present, which are believed to have obtained during the Pleistocene ice ages; and that they are relatively poorly-adapted to extensive evergreen rainforests. He suggests that the extinctions of the tapir and Javan rhino in Borneo are entirely natural. Viewed in this way, it may be asked why it is that the Sumatran rhino has survived, and if this species is heading for extinction irrespective of human activities. Cranbrook (1986) suggests that the very low productivity of vegetation in the understorey of evergreen rainforests is the specfic reason why this habitat is poor for perissodactyls. If this is the case, then it might be expected that the Sumatran rhino survives in habitats where productivity of understorey leaves is greatest. Although strictly comparable data for different areas are not available, the indications are that there is no correlation between distribution of rhinos and the productivity of understorey plants.

Thirdly, the concentrations of at least two elements - sodium and phosphorus - in most South-east Asian rainforest leaves are inadequate for the requirements of mammals (van Strien, 1985; Ahmad Darus, 1987; Payne, 1988). It is possible that amounts of trace elements in leaves are also inadequate, but there are no relevant data available. It is very likely, however, that the limiting factors for rhinos in these forests are essential chemical elements, not food generally. Strict herbivores, like the Sumatran rhinoceros, must obtain extra sodium and phosphorus from sources other than leaves. Fallen fruits, which are taken by Sumatran rhinos in small quantities, probably contain more phosphorus than do leaves, but they are unlikely to contain significant amounts of sodium. In any case, being scarce and unpredictable spatially and temporally, fruits are unlikely to be a resource upon which strictly terrestrial rainforest mammals can rely if their survival or reproduction is at stake. Generally, soils in humid tropical conditions are deficient in both sodium and phosphorus (Robbins, 1983; Tisdale *et al*, 1985; Jordan, 1985) and so soil is unlikely to be a reliable source of these elements for mammals. Mud wallows, which Sumatran rhinos frequent probably for thermoregulation and to escape the bites of tabanid flies, have also been shown not to be a significant source of sodium or phosphorus for this species (Mokhtar *et al*, in press).

The use of natural concentrated salt sources - often known as "salt licks" - by large wild mammals in the tropics, including Sumatran rhinos in South-east Asia, has long been known to both scientists and hunters alike. Davies and Payne (1982) noted a general correlation between the distribution of rhinos and salt licks in Sabah: of 25 accurate and independent records of rhinos obtained throughout the state during 1980 - 81, the median straight-line distance of the rhino from the nearest known natural salt source was 5.5 km, with a range of 0 to 14 km. Natural salt licks in Sabah (many of which are rather localised geological features known as mud volcanoes) contain high concentrations of sodium, but concentrations of other elements

vary considerably (for example, Haile and Wong, 1965; Leong, 1974; Payne, 1986a). While many biologists have noted the importance of salt licks to large wild mammals, few have assumed them to be an essential or limiting resource. For example, van Strien (1985) argues convincingly that, in Sumatra, only lactating rhinos visit salt licks for minerals and that other rhinos visit them merely to maintain contact with conspecifics, but remains doubtful that saltlicks are essential for the existence of the species. And, as noted by Mokhtar *et al* (in press), salt licks have never been discovered in two of those areas which support relatively high population densities of rhinos: Danum Valley in Sabah and Endau-Rompin in Peninsular Malaysia.

The answer to the apparent contradiction between the paucity of sodium and phosphorus in the rhino diet and the occurrence of rhinos in the absence of salt licks may be quite simple. The abundance of these elements in the Malaysian rainforest ecosystems as a whole is very low, but there is a considerable range in concentrations between sites and materials. The ranging and feeding strategy of the rhinos may be geared towards seeking points where these elements are concentrated, whether those points be plants which concentrate them, fallen fruits, soil, springs or salt licks. Due to geological factors, there may also be fairly extensive areas where abundance of limiting elements is relatively high, and in such areas salt licks may be unnecessary for the survival of rhinos if adequate amounts can be obtained from less prominent sources. Furthermore, concentrated sources of sodium may not necessarily be visible to the human eye. For example, Mykura (1989) recorded differences of up to ten-fold in the concentration of sodium in stream water under similar conditions of flow at sites 10 km apart in the Maliau Basin, Sabah, an area inhabited by rhinos but with no known salt licks.

Ahmad Darus (1987) claims that *Mallotus wrayi* as well as unidentified species of *Zingiber*, *Diopsyros* and *Alphonsea* at Danum Valley are rich in sodium and may, therefore, provide rhinos with sufficient supplies of this element. Such a concentration of sodium by plants in the humid tropics appears not to have been reported previously. Accordingly, a sample of *Mallotus wrayi* leaves from many plants was collected in the same area at Danum Valley in December 1989. Analysis showed a concentration of 0.011% sodium on dry weight in this sample, average for leaves in Sabah forests (Payne, 1988) and well below the 0.35% required by another perissodactyl, the horse (Ahmad Darus, 1987). It seems likely, therefore, that the earlier samples were contaminated, possibly with sweat.

If, as argued above, a major factor - possibly the major factor - limiting the natural distribution of the Sumatran rhino in Borneo is availability of sodium, then another possible reason for the decline of this and other perissodactyls becomes apparent. The change in climate in present-day Borneo, Sumatra and Peninsular Malaysia since the last ice age is believed to have been

characterised in part by an increase in rainfall (for example, Cranbrook, 1986), which leaches minerals from the soil, especially sodium, the most soluble of all cations (Robbins, 1983; Tisdale *et al*, 1985). If such an effect has occurred, then the distribution of rhinos in Borneo has declined since the Pleistocene period as a result of natural events. Human activities have contributed significantly to the decline, but not entirely caused it. Rhinos now may be able to survive only where they can obtain sufficient sodium, phosphorus and, possibly, trace elements. This is a major factor in itself that may have predisposed the rhino to its vulnerability to prolonged hunting pressure (other factors including: slow birth rate, vulnerability of rhinos when wallowing, and extraordinarily high prices for rhino horn). It is relevant to note here that communities of shifting cultivators in remote areas of Sabah used to boil water from salt licks to obtain their salt (personal communications from people in the Pensiangan and Ulu Kinabatangan areas, to J. Payne). It is possible that common use of salt licks by people and rhinos was a key factor in enabling the former to eliminate the latter. Even well away from human communities, semi-professional hunters in both Sumatra and Borneo sometimes make use of salt licks to locate concentrations of rhinos (van Strien, 1985; personal communications to J. Payne). If, as believed by van Strien (1985), salt licks are visited by Sumatran rhinos out of biological necessity only by lactating or pregnant females, then it becomes apparent that (a) these animals are the ones most at risk from hunters and (b) rhinos living far from salt licks may be non-breeding individuals. Female mature rhinos are also at greater risk than males from human hunters because females occupy smaller home ranges (van Strien, 1985) and hence attract the persistent hunter's attention from the greater localised intensity of their footprints and other signs. An indication of this tendency comes from the recent programmes to capture the Sumatran rhino. In Peninsular Malaysia, where persistent rhino hunters seem to be active in only a few localities and few have guns, the great majority of rhinos caught have been females and none have been mature males (PERHILITAN, personal communication). In Sabah, where rhino hunting has been intense wherever the species occurs and where many hunters have guns, three of the rhinos caught to date were fully mature males (two with old but serious gunshot wounds), one was almost certainly a mature male (it was seen in the trap, but quickly escaped) and one was an immature female, from its behaviour in entering a village near to a main road presumably in the process of leaving its mother. The grave implication is that a high proportion of remaining rhinos in Sabah are old males, with females and young having been decimated by hunters.

It remains a matter for speculation as to why the Sumatran rhino survived in Borneo but the Javan rhino and Malayan tapir became extinct. The Javan rhino appears to be adapted, like its larger Indian relative (*Rhinoceros uncicornis*), to conditions of "a mosaic of glades interspersed with patches of forest" (Ammann,

1985). It is perhaps not surprising, then, that this species became extinct as forest cover increased to cover the whole island of Borneo during the early Holocene, perhaps hastened by hunting. The species occurred in Sumatra and Peninsular Malaysia until this century. There are indications that the distribution of the Javan rhino in these areas was limited to areas of fertile lowland with relatively low rainfall (Whitten *et al*, 1984; Medway, 1978), conditions which have been eliminated by the spread of agriculture in Sumatra and Peninsular Malaysia, and which are naturally very limited in Borneo. The present distribution of the tapir defies all simple hypotheses.

In addition to long-term natural changes in the environment and to hunting, the forest habitat of rhinos in Sabah has been greatly affected during the past three decades by two main forms of disturbance: selective logging for timber and forest clearance for the development of agricultural and monoculture tree plantations. A third activity, shifting cultivation (or swidden agriculture), does not now affect rhinos, which have long since disappeared from areas where this is practised.

The first main form of recent forest disturbance, selective logging, involves the felling and removal of most trees with the trunk greater than six feet in circumference. This activity results in a highly disturbed forest, with perhaps less than half the original vegetation remaining intact. However, the forest regenerates and rhinos feed on the leaves and twigs of regrowth saplings and woody climbing plants (observations by Wildlife Department staff and J. Payne in Sabah). It has been observed in Sabah that rhinos vary in their immediate response to selective logging operations. In some cases, the presence of rhinos has been recorded before logging starts, yet the animals appear to have moved from the area well before tractors move in to make the first road. Elsewhere, rhinos remain in the forest until tree felling starts. The reasons for this variation in response remain unknown, but it is likely that several factors are involved, including the age, sex and experience of the rhinos, and proximity to salt licks. Further observations suggest that all rhinos move out of logging areas at some stage, always within a few weeks of the first tree felling at latest, and that they usually do not return until several years later, by which time there is a substantial regrowth of small trees. While rhinos in Sabah clearly do tolerate selective logging, for two reasons this activity definitely has adverse effects on the species. One is that breeding activity is certainly disrupted, a major factor where numbers - especially of females - are already seriously depleted. Another reason is that logging roads provide easy access for hunters. And in logging areas, not only semi-professional rhino-hunters are active, but also casual hunters who use vehicles and take pot-shots at anything which may venture to the roadside.

The second form of recent and extensive habitat disturbance, clearance of forest for conversion to monoculture plantations, has so far in all cases led to complete elimination of rhinos, either by hunting, loss of food, isolation of rhinos into non-breeding groupings, or a combination of such factors. Loss of forest to plantations has occurred most extensively and most rapidly during the past decade in the region between Sandakan and Lahad Datu, and to the east of Tabin Wildlife Reserve. Both regions contained substantial rhino populations in the past. Although some of the most extensive tree plantations for wood in South-east Asia have been developed in Sabah during the past fifteen years, none so far have involved the known recent distribution of rhinos. It is likely that the extent of such tree plantations will increase greatly in the future. In two regions, at least, tree plantations have been proposed in permanent Forest Reserves (Segaliud-Lokan and Bonggaya) in which rhinos occur; other Reserves may come under threat later. It will become important to investigate the response of rhinos to tree plantations developed for production of wood. Within a few years after planting, there is a thick growth of woody saplings of many species, presumably introduced through bird droppings, under the main monoculture tree crop (personal observations, J. Payne). Although rhinos would undoubtedly stay away (if they are not killed) during the first years of a plantation's existence, it is conceivable that some, or their offspring, could move back and find substantial amounts of food. In Kelantan, tapirs feed in *Acacia mangium* plantations (personal observation, J. Payne), but individuals may not be able to live entirely within a plantation.

The existence of the Danum Valley Field Studies Centre (see section 3, area 27) has provided an unexpected insight into the response of Sabah rhinos to human activities. During the first few years of the Centre's existence and use for forest research projects, rhinos and their signs were seen frequently by researchers, workers and even casual tourists in the area. So intense was rhino activity (relative to other areas) that Ahmad Darus was able to conduct an important ecological study of the species during only 28 days of field work in 1986-87, and to conclude that probably 8 rhinos were using a study area of 50 sq km, including three mothers with offspring and two mature males (Ahmad Darus, 1987). Although objective records have not been kept, it is clear that the amount of rhino activity declined drastically and fairly rapidly during 1987-88 wherever there has been repeated human activity at Danum Valley (Waidi Sinun and others, personal communications). In December 1989, a rhino survey team covered that part of Ahmad's study area which is not normally entered by people (the upper Palum Tambun River) and there, too, found no evidence of any recent rhino activity. Several rhino wallows were still prominent, but used only by pigs. Although people do not enter this area now, the noise of vehicles entering the Centre can be heard from the hill tops

above the Palum Tambun valley. Probably the generator used at the Centre can be heard from some parts of the forest. It is very unlikely that rhino hunters have been in the area around the Centre, which is probably the safest in Sabah for rhinos. It can only be concluded that generalised and harmless disturbance in the form of human voices, footprints, odours and noisy machines have been sufficient to scare rhinos away. This conclusion will come as no surprise to many people in Sabah, especially workers in logging camps, and including some rhino-hunters, who believe that rhinos and wildlife generally have been scared by human activities throughout Sabah and react by "running away" to Kalimantan and Sarawak. It is surprising, however, to most biologists, who believe that wild mammal populations respond to hunting and habitat modification, but not to insignificant use of natural habitat by harmless people. If the rhinos near Danum Valley Field Studies Centre have moved away as a consequence of such use of the area, there are at least three possible reasons why they have responded differently from mammals generally. None of the three are mutually exclusive and it is likely that all have operated at Danum Valley. The first is that hunting pressure has been so intense, for so long, that the normal behavioural response of all rhinos in Sabah might be to move away from any sign of repeated human activity unless salt licks keep them in that area. The second possibility is that rhino populations in Sabah have been so decimated by hunting that, provided adequate minerals are available in some form, choice of home range by mature females is to a large extent arbitary (male home ranges probably develop to maximise reproductive access to females). Thus, even minor but repeated disturbance by people may induce females to shift to habitat free of rhinos and lacking any human disturbance. Offspring and males would follow. Thirdly, females with offspring may be especially sensitive to any cues which indicate possible danger and seek to avoid them. Again, males would follow. Whichever factors are relevant at Danum Valley, the observed behaviour of the rhinos is relevant to rhino surveys and management (see section 5.8).

# 5. CONCLUSIONS AND RECOMMENDATIONS ON THE CONSERVATION AND MANAGEMENT OF THE SUMATRAN RHINO IN SABAH

## 5.1 GENERAL DISTRIBUTION AND ABUNDANCE OF RHINOS IN SABAH

The natural distribution of the Sumatran rhino in Sabah, and probably elsewhere, appears to be limited primarily by the distribution of concentrated natural mineral sources. These sources are often manifested as "salt licks", but in some areas high mineral concentrations may occur unseen in certain areas of soil, water or vegetation. Sodium is probably the main limiting element, also phosphorus, and possibly trace elements.

The distribution and abundance of the Sumatran rhino in Sabah, and Borneo generally, may have declined since Pleistocene times in response to natural causes, including the spread of tropical rainforest with its low productivity of food plants accessible to rhinos, and leaching of sodium and other essential minerals from the environment by constant heavy rainfall.

In addition to "natural causes", prolonged hunting pressure has greatly influenced the natural distribution pattern and abundance of rhinos (see section 5.2).

There are no rhinos in Sabah's Parks or Sanctuaries, the two kinds of protected area managed by Park and Wildlife authorities. All potentially viable rhino populations in Sabah are in Forest Reserves (which, by law, includes Wildlife Reserves), managed by the Forestry Department.

## 5.2 THE EFFECTS OF HUNTING

The impact of hunting on rhinos has been especially severe as a result of the rhinos' dependence on salt licks and other concentrated mineral sources. This dependence has allowed hunters to effectively concentrate their activities where rhino activity is greatest. Furthermore, hunters selectively (but unintentionally) take pregnant and lactating females, which appear to depend most on salt licks. In past times, too, communities away from the coast relied on natural salt licks for their own salt supplies, frequently bringing hunting people into contact with a species which is otherwise elusive.

The age-sex balance of the remaining, highly depleted and scattered rhino population in Sabah is probably unnatural, with old males predominant and mature females and immature animals scarce.

*If manpower is available for direct protection of wild rhinos, this should be concentrated specifically on stopping hunting in areas containing salt licks and other concentrated mineral sources in Tabin Wildlife Reserve and in the Ulu Segama - Kuamut regions (see section 5.3).*

Hunting remains the key threat to the survival of the species in Sabah, despite being illegal and with heavy penalties for offenders. Very high prices of rhino horns and lack of opportunities for other lucrative sources of income in rural areas provide the incentive. In addition, it is rarely possible to detect rhino hunting in the extensive forest areas which the animals inhabit, and almost impossible to prove that a particular person killed a rhino. For skilled hunters, therefore, the potential benefits far outweigh the risks involved in rhino hunting.

*Legislation relating to rhinos could be made more effective by providing for the heaviest penalties to be against anyone found in possession of any rhino part or product, and not specifically against hunters.*

## 5.3 AREAS WITH PROBABLY VIABLE RHINO POPULATIONS

Only in two regions of Sabah which are reserved by law as permanent forest estate (PFE) is it likely that wild breeding populations of rhinos stand a good chance of survival in the long term: (a) Tabin Wildlife Reserve (40 on Map 2) and (b) parts of the Ulu Segama, Malua, Kuamut, Gunung Rara, Sapulut and possibly Kalabakan and Sungai Pinangah Forest Reserves in south-eastern and southern Sabah (parts of 18, 21, 22, 23, 25, 26, 27 and 29, at least, on Map 2). For convenience, these are named respectively the Tabin population and the Ulu Segama - Kuamut population.

*As a general rule, activities related to the conservation of wild rhinos in Sabah are best directed at the Tabin and Ulu Segama - Kuamut populations, rather than "diluting" effort to cover all areas.*

### 5.3.1 TABIN WILDLIFE RESERVE

A best guess at present is that Tabin W R contains only between 15 and 20 rhinos, with well under half mature females. Illegal hunting probably still occurs occasionally. If this is the case, the Tabin population is highly endangered. It is the evident suitability of the habitat for rhinos which makes Tabin W R important for the species, and worthy of very high priority for the Wildlife Department.

### 5.3.2 ULU SEGAMA - KUAMUT AREA

The extent of the Ulu Segama - Kuamut rhinoceros population is impossible to estimate at the present time because it is scattered and incompletely known. Probably up to 4,000 sq km of forest is still used by rhinos to some extent, and a larger area may support rhinos in the future if hunting can be controlled. It is possible, however, that this population may not be contiguous. Although female rhinos are believed to have been depleted more than males (see section 4), males are equally precious in this population because it is they which are likely to move long distances in search of reproductive opportunities.

## 5.4 AREAS WITH POSSIBLY-VIABLE RHINO POPULATIONS

### 5.4.1 SEGALIUD-LOKAN/DERAMAKOT-TANGKULAP FOREST RESERVES

Three contiguous Forest Reserves - Segaliud-Lokan, Deramakot and Tangkulap (regions 12, 13 and 14 on Map 2) - are believed to still contain a small number of rhinos. Points which give rise to some optimism that a viable population may build up if hunting can be stopped are: (a) logging is due to cease in all three Reserves within the coming year or so, (b) the physiography and geology of the area is similar to other areas in Sabah where rhinos used to be naturally abundant, (c) it is possible that additional rhino genes can enter the area through infrequent crossings from the south over the Kinabatangan River from Malua and Kuamut Forest Reserve. Unfortunately, Segaliud-Lokan Forest Reserve - which represents nearly a half of rhino habitat in this area - has been chosen for conversion to exotic tree plantations.

> *The programme for conversion of Segaliud-Lokan Forest Reserve to tree plantation should ascertained and monitored, with a view to seeking means of maximising prospects for the rhinos' survival.*

### 5.4.2 MURUK MIAU

The presence of rhinos in this area (1b on Map 2) has not been confirmed, and even if the species is present within Sabah, numbers and distribution must be very limited. The potential importance of this area is that it is contiguous with the proposed Kayan-Mentarang Nature Reserve in northern East Kalimantan, at 21,000 sq km one of the largest conservation areas in Asia.

> *A specific aspect of survey work in the proposed Kayan-Mentarang Nature Reserve, and in adjacent areas in Sabah, should be to seek evidence of the presence of rhinos.*

## 5.5 RESERVES WITH PROBABLY NON-VIABLE RHINO POPULATIONS

The following Forest Reserves are believed to still contain small numbers of rhinos (the numbers refer to regions on Map 2): Sugut (3), Bonggaya (4), Ulu Tungud (5), Trus Madi (6), Sungai Pinangah and/or Ulu Milian (17), Ulu Kalumpang (31), and Kulamba Wildlife Reserve (38). It is very likely that in all these cases, the Reserve and/or rhino numbers are too small to be viable in the long term.

*The status of rhinos in these areas may be monitored by obtaining information from people working in and near these Reserve. Ground surveys are of relatively low priority.*

## 5.6 FORESTS AND RHINOS OUTSIDE THE PERMANENT FOREST ESTATE, AND THE CAPTIVE BREEDING PROGRAMME

Conversion of natural forests to other forms of land-use during the past decade or so has been a significant factor leading to the decline and local extinction of rhinos in the region between Sandakan and Lahad Datu, and also the area to the east of Tabin Wildlife Reserve. In these regions, forest has been converted to plantations, mainly of oil palm and cocoa, which cannot support rhinos. Much degraded forest remains in the former region, but in patches too small to support viable breeding populations.

Small numbers of "doomed" rhinos do still exist in isolated forest areas outside the PFE on land owned by the state and by private individuals and groups. The programme to capture doomed rhinos is still very important, primarily to guard against the possibility that all wild populations may become extinct in the future.

*For the time being, any rhinos caught should be retained in captivity for breeding.*

Pending more survey work in Tabin and elsewhere, however, it is possible that, in the future, female rhinos caught outside the PFE may have to be translocated into the Tabin or Ulu Segama - Kuamut populations in order to rectify the skewed sex ratio thought to occur in these populations.

## 5.7 THREATS OTHER THAN HUNTING TO RHINOS IN THE PERMANENT FOREST ESTATE

Tree plantations for wood are likely to be a major form of land-use in Sabah in the future. None of these tree plantations developed so far have affected rhino populations, but there are indications that future plantations are likely to be extended by

conversion of natural forest, containing rhinos, in the PFE.

*The effects on rare wildlife of conversion of logged natural forest to forest plantations, already proposed for the Segaliud-Lokan and Bonggaya Forest Reserves, should be investigated generally, but with particular attention paid to rhinos.*

The Bonggaya area cannot support a significant rhino population and so any study made would be for research purposes alone. However, any areas proposed for tree plantation which might form part of an extensive forest region with a viable rhino population should be viewed with concern. Segaliud-Lokan is one such area, and parts of the Ulu Segama Forest Reserve may come under threat in the future.

*Maintenance of the Ulu Segama Forest Reserve under natural forest is of great significance in maintaining the extensive but scattered rhino population of south-eastern Sabah, which is centered around Danum Valley.*

Sabah's PFE (which includes Forest Reserves on dry land, Mangrove Forest Reserves, and Parks under forest cover) currently occupies about 47% of the state's land area. A further 5% of Sabah has already been allocated for tree plantations (most of that land is under natural forests, with some degraded scrub and grassland). It is estimated that a maximum of 30% of the state's land area is suitable for permanent agriculture. In practice, much less than 30% is suitable because of various economic factors. Thus, there is a balance of at least 82% of Sabah which is neither suitable for agriculture nor in the PFE. Allowing that no more than 5% will be occupied by housing, roads, industry and other forms of land-use, at least 13% of Sabah which is neither PFE nor allocated for tree plantation should now be available either for retention under forest or for reafforestation.

*There is scope to increase significantly the extent of Sabah's PFE, and this could benefit rhino conservation if (a) existing Forest Reserves are retained under natural forest and (b) extensions to the PFE can be made to incorporate forest areas in eastern Sabah where rhinos still occur.*

Extensive burning of logged dipterocarp forests, resulting from rare periods of low rainfall coupled with the vast amounts of inflammable dry wood left in logged forests, and human carelessness, poses a major threat to Borneo forests generally in the future (Mackie, 1984; Beaman *et al*, 1985). Many wild species will suffer in any future forest fires, including rhinos. There is nothing specific that can be done to help rhinos in this eventuality, but the importance of both maintaining undisturbed forest which is less susceptible to fire (notably, Danum Valley Conservation Area and the Tabin core area) and of developing a captive breeding population is reiterated.

## 5.8 RESPONSE OF RHINOS TO HUMAN DISTURBANCES OTHER THAN HUNTING

Observations at Danum Valley have indicated that, in some areas at least, rhinos will move away from repeated human presence, even if that disturbance is harmless and seemingly trivial.

*Any programme devised to monitor wild rhino populations must allow for the animals' possible response to repeated human presence in an area. Repeat surveys should not be done too frequently, and it will be better to cover a given area by using different routes on different occasions.*

*If a facility is developed so that visitors can view wildlife at salt licks (for example, the mud volcanoes in Tabin Wildlife Reserve), it must be realised that this may have adverse effects on rhinos. If they grow to avoid the salt lick, not only will visitors be disappointed, but the rhinos' health and breeding success are likely to suffer.*

## APPENDIX: AN OUTLINE PLAN FOR FUTURE SURVEYS AND MONITORING OF SUMATRAN RHINOS IN SABAH

As a result of the work done during November 1989 to January 1990 to provide information for this report, it has become apparent that conducting ground surveys in the forest without the prior benefit of reports of rhino presence (from timber camp workers, Sabah Foundation field staff, rural hunters etc) is expensive, time-consuming and rarely worth attempting. It is much more productive to seek reports from people who have worked in the regions to be investigated, and base ground work on those reports. To the knowledge of this author, there has been no case in Sabah of reports of rhinos coming from people such as those mentioned above which turn out to be unfounded. Recent reports are, of course, most useful. However, even very old ones may be useful and worth following up, because rhino activity is concentrated near to salt licks over periods longer than the lifespan of one human being. Sabah Foundation is already assisting the Wildlife Department by forwarding information on sightings of rhino signs from its field staff.

The best way to tackle future survey and monitoring work on rhinos in Sabah is for one officer of the Wildlife Department to be responsible for accumulating and integrating all incoming information, and for coordinating all surveys efforts. It is neither useful nor possible to attempt to estimate the total number of rhinos in Sabah, even though this is what most enquirers to the Wildlife Department and WWF Malaysia wish to know. Instead, there are a number of specific aspects of the present rhino situation which require investigation in order to maximise prospects for the species' survival. The aspects which at the present time seem most important are outlined below.

Verbal surveys (below) are defined as any work aimed at obtaining information on rhinos from other people (including Wildlife staff who may have received second-hand information but not recorded it). Ground surveys are defined as surveys in the forest, to seek direct evidence of the presence of rhinos, by Wildlife Department staff. The numbered regions refer to those marked on Map 2.

The surveys suggested below are in *approximate* order of present decreasing priority, and priorities may change with time:

1. To obtain more information on rhinos in the Kuamut River region, the least known important rhino area in Sabah, and if possible to assess levels of hunting, *verbal surveys on the lower Kuamut River and at Tangkong and other settlements along the upper Kinabatangan River, to the north of areas 19, 20 and 25; plus ground surveys in area 21.*

2. To ascertain the extent of, and risks to, the Ulu Segama - Kuamut rhino population at its south-eastern (and most accessible) periphery, *a verbal survey in the area to the south of area 28, followed by ground surveys and protective actions in that area if appropriate.*

3. To obtain information on the possible numbers of breeding females in Tabin Wildlife Reserve, *major survey effort over a period of several weeks at and near all salt licks in the Reserve.* A similar survey could be attempted for the Ulu Segama - Kuamut population, but this would be logistically much more difficult.

4. To monitor distribution and relative abundance of the rhino population, *annual surveys in Tabin Wildlife Reserve.* As many personnel as possible should cover the area during a period of less than one month. It is not necessary to cover the same routes every year.

5. *Verbal survey throughout regions 23 and 24.* This should be repeated annually, and extended northwards into other regions as they are opened up for logging.

6. To provide more information on the extent of the Ulu Segama - Kuamut population, *ground surveys between and to the immediate south of the Maliau Basin (region 18) and Malibo Basin (area 22).*

7. To locate possible "doomed" rhinos for the captive breeding population *Verbal surveys in any of areas 8, 9, 10, 11, 34, 35, 36, 37 and 39.*

8. *Ground surveys in the area around Danum Valley Field Studies Centre* to locate rhinos formerly living near the Centre.

9. To provide more information on the extent of the Ulu Segama - Kuamut population *ground surveys in the central and southern parts of area 25.*

10. To ascertain if rhinos remain in the Sabah - Kalimantan border region *verbal and ground surveys in the Muruk Miau area (area 1b).*

11. *Verbal surveys in and around any of areas 3, 4, 5, 6, 12, 13, 14, 15, 17, 31 and 38. Ground surveys based on results from these verbal surveys.*

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