

Distribution and Status of the Sumatran Rhinoceros in Peninsular Malaysia

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ABSTRACT

Distribution and status of the Sumatran rhinoceros Dicerorhinus sumatrensis in Peninsular Malaysia were studied from 1975 to 1981. We compiled information collected from field surveys, interviews with people living near rhino areas, and the literature. Most potential rhino areas were surveyed on the ground to confirm the presence of animals, estimate numbers, and evaluate the status of the habitat. We confirmed that rhinos presently occur in ten isolated areas scattered throughout the Malay Peninsula. The number of rhinos is estimated at 50 to 75 animals with the Endau-Rompin (20–25), Taman Negara (8–12), and Sungai Dusun (4–6) areas containing the largest contiguous populations. The Sumatran rhino appears threatened with immediate extinction in Peninsular Malaysia. Excessive killing of rhinos because of the high commercial value of their body parts has greatly reduced numbers. Habitat destruction from logging and forest clearance has separated and isolated already small populations. We recommend that conservation efforts for this species in Malaysia be concentrated in the Endau-Rompin region because this population has the best chances for survival.

INTRODUCTION

The Sumatran or two-horned Asiatic rhinoceros *Dicerorhinus sumatrensis* Fischer 1814, one of the world's rarest large mammals, is threatened

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with extinction throughout its range (Simon, 1969). Once found across southeast Asia, this rare, forest-dwelling rhino is now restricted to small isolated populations occurring in Burma, Thailand, the Malay Peninsula, Sumatra, and Borneo (Van Strien, 1974; McNeely & Laurie, 1977; Borner, 1979; Schenkel & Schenkel, 1979; Payne, 1980; Flynn, 1981). Excessive hunting has greatly depleted rhino numbers and reduced their distribution (Van Strien, 1974). The high value of their body parts, especially the horn, continues to encourage illegal killing (Martin, 1979). In addition, extensive habitat destruction from logging and forest clearance for agricultural development has isolated already small populations and reduced the amount of suitable habitat.

In Malaysia, little information has been available on the distribution and status of the Sumatran rhino, the literature consisting mostly of old accounts by hunters and game wardens (e.g. Hubback, 1939; Foenander, 1952; Hislop, 1965). Difficult field conditions and elusive animals have discouraged extensive field surveys. After reviewing the status of rare Asian wildlife, Talbot (1960) emphasized the lack of information on the Sumatran rhino in Malaysia. A brief field survey by Milton (1963) provided information on the occurrence of a small rhino population near the Bernam River in the state of Selangor. In 1965, the 40 km² Sungai Dusun Wildlife Reserve was established to protect these rhinos. Strickland's (1967) short study of this rhino population provided the first ecological information on the species. About the same time, Stevens (1968) surveyed other existing wildlife reserves in Malaysia and proposed the establishment of additional sanctuaries where he had found rhino sign.

In 1974, the Malaysian Department of Wildlife and National Parks (DWNP) initiated a long-term study on the distribution and status of the Sumatran rhinoceros in Peninsular Malaysia. This paper presents the results of that study along with a review of historical reports collected from the literature and DWNP files. From 1975 through 1981, we compiled all rhino reports collected from DWNP field staff and interviews with people working or living in rhino habitat. Potential rhino areas were surveyed on foot to confirm the presence of animals. Confirmation of rhino reports by field surveys was necessary because most people confuse rhino tracks with those of Malayan tapir *Tapirus indicus*. We found that many people believe tapirs are actually young rhinos; the base Malayan name (badak) is the same for both animals.

During the field surveys, we recorded all rhino sign, especially tracks

and wallows, encountered while hiking through suspected rhino areas. Usually we walked along stream bottoms or ridges, where sign was most likely to be found. Sometimes a local guide would show us specific places where tracks or wallows had been observed previously. Recent rhino tracks were followed until at least 10 rear footprints could be recorded. For each track, the maximum width between the lateral toes and the width of the middle toe was measured (Flynn, 1978). The minimum number of individual animals in an area was estimated based on differences in median track size and the distance between track locations (Flynn & Abdullah, 1983). Also, the relative frequency of rhino sign encountered during a field survey was used as a rough index of rhino density.

We attempted to survey all potential rhino areas, but time availability and travel restrictions prevented us from visiting some places and adequately covering others, especially in the northern states of Perak, Kedah, and Kelantan. These states contain large, remote forested lands, and much of the border region is closed to non-military personnel. Our research effort was concentrated in areas that showed the most promise for conservation of the species, especially the Endau-Rompin region in the southern portion of the Malay Peninsula.

Peninsular Malaysia, located at the southern tip of the Asiatic continent (1° to 7° N latitude and 100° to 103° E longitude), contains $131,700 \text{ km}^2$ of land divided politically into 11 states. Sarawak and Sabah, the Malaysian states in northern Borneo, were not included in this study. The topography of the Malay Peninsula is characterized by a prominent north-south granitic mountain range with several lesser ranges and small valleys. Broad plains lie along the east and west coasts. Several major river systems dissect the country into large basins which form the basis for most political subdivisions. Malaysia's climate is tropical ever-wet with little seasonal variation because of close proximity to the equator and warm oceans (Whitmore, 1975). The days are hot and humid, with the mean temperature near 27°C in lowland areas and annual rainfall ranging from 2000 to 5000 mm (Dale, 1952). In the northern part of the peninsula, rainfall is more seasonal, influenced by the October-to-December monsoon season in the northeast, and the June-to-September monsoon in the northwest.

The natural vegetation of Peninsular Malaysia is tropical evergreen rain forest of the Indo-Malayan formation (Richards, 1952). These forests are exceedingly species-rich, containing about 4000 species of woody plants, primarily trees and climbers (Whitmore, 1975). Forest

structure is characterized by large (to 60 m) emergent trees, dominated by the family Dipterocarpaceae, which extend above a nearly closed main canopy at a height of 20 to 45 m. The dense understorey consists of numerous small trees, palms, climbers, and herbaceous plants. Many problems exist in the classification of these forests (Poore, 1963), but the primary forest can be grouped into 15 general forest types (Wyatt-Smith, 1964; Whitmore, 1975). In this study, the following general forest types were encountered: (1) lowland dipterocarp forest (below 300 m); (2) hill dipterocarp forest (300 to 800 m); (3) upper dipterocarp forest (800 to 1200 m); and (4) montane forest (above 1200 m).

Almost 99 % of Peninsular Malaysia was once covered with tropical rain forest (Lee, 1980). Recently, large tracts of forest have been cleared and planted to agricultural crops. Today, about 55 % of the total land area is covered with forest (Forest Department, 1977) and about 22 % of the land area is planted to agricultural crops, primarily rubber, oil palm, and rice. The balance of the land area is wasteland, swamp, or urban development. Of the present forested lands, about 30 % have been logged, including most of the lowland forest below 300 m. By 1990, most of the lowland areas will have been converted to agricultural crop lands, and most of the remaining commercial forest will have been logged (Lee, 1980).

DISTRIBUTION AND NUMBERS

Southern region

Endau-Rompin area

The literature contains many reports of Sumatran rhinos occurring along the border of the states of Johor and Pahang, within the upper watersheds of the Endau and Rompin rivers (Fig. 1). Foenander (1961) conducted several brief surveys in Pekan District of Pahang and mapped the distribution of rhinos based on interviews with villagers. Milton (1963) collected a few reports of rhinos occurring in the upper Endau River basin and also near Tanah Abang and the Tersap River along the lower Endau. During a survey of the Endau-Kluang Wildlife Reserve, Stevens (1968) found rhino sign between the Endau, Emas, and Semberong rivers, and he recommended that this area be protected as a wildlife sanctuary. In 1970, members of the Malayan Nature Society (Ellis, 1971) made several trips

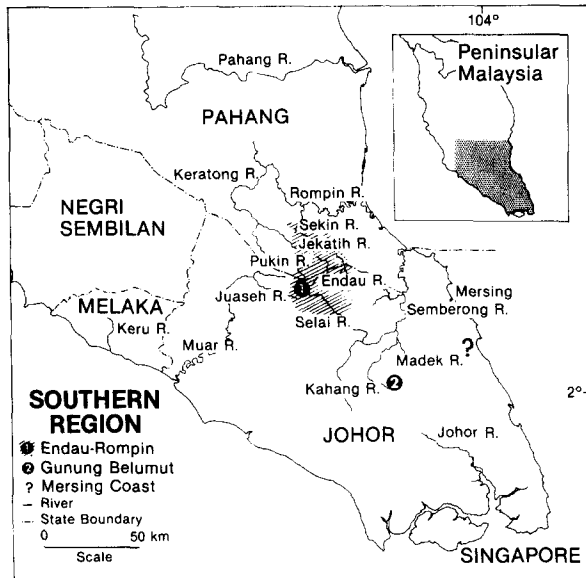


Fig. 1. Locations of Sumatran rhino track observations in the southern region of Peninsular Malaysia. Rhino distribution in the Endau-Rompin area is marked by cross-hatching. An unconfirmed report is indicated by a question mark.

into the upper Endau River area and reported evidence of rhinos in the upper Selai, Segamat, and Endau watersheds.

We surveyed the entire Endau-Rompin region, with an emphasis on the remaining tract of contiguous unlogged forest (Flynn & Abdullah, 1983). Rhino sign was found throughout the region, especially within the contiguous primary forest, an area of about 1600 km². Rhino tracks were found consistently in the upper Endau, Selai, Kemidak, Juaseh, and Segamat watersheds in Johore; and the upper Pukin, Jekatih, Sekin, and Kemapan basins in Pahang (Fig. 1). We found no evidence of rhinos occurring in certain areas where they had been reported previously. Interviews with villagers living along the lower Endau River indicated that rhinos had not occurred in the Tanah Abang or Sungai Tersap areas for many years. Likewise, villagers living along the Semberong River stated that rhinos no longer occurred in that area, which had been proposed by Stevens (1968) as a rhino sanctuary. Much of the land between the Semberong and Endau rivers has been cleared for agriculture, and the Emas River area has been heavily logged. A survey along the eastern portion of the region near Gunung Lesong indicated that rhinos probably

no longer occur east of the mountains, as reported previously by Foenander (1961).

The number of rhinos occurring in the Endau-Rompin region was calculated by multiplying estimated rhino densities by the amount of occupied habitat. Based on the frequency that rhino sign was encountered during the survey, the habitat was divided into high and low density areas. The high-density area was censused four times between 1977 and 1980 to estimate the minimum number of animals (Flynn & Abdullah, 1983). The 1980 census estimated that 10 animals occurred in the 400 km² census study area, a density of 1 animal 40 km⁻². In the rest of the region, rhino density was much lower, probably less than half. Within the 1200 km² of low-density habitat, we estimated rhino density conservatively at 1 animal 80–120 km⁻². Thus, a total of 20 to 25 rhinos occur in the entire 1600 km² of remaining habitat (Table 1).

During the study period, the tracks of at least three young rhinos were recorded. In 1975–76, the tracks of a cow/calf pair were found often in the

TABLE 1
Number of Sumatran Rhinoceros in Peninsular Malaysia

<i>Region</i>	<i>Number</i>	<i>Forest type</i>
<i>Southern</i>		
Endau-Rompin	20–25	Lowland and hill
Gunong Belumut	2–3	Hill and montane
Mersing Coast	0–1	Lowland
<i>Northcentral</i>		
Taman Negara	8–12	Lowland and hill
Sungai Lepar	3–5	Lowland and hill
Sungai Depak	3–5	Hill
Kuala Balah	3–4	Lowland and hill
Bukit Gebok	1–2	Lowland and hill
Krau Reserve	0–1	Lowland and hill
<i>West Coastal</i>		
Sungai Dusun	4–6	Lowland
<i>Northwest</i>		
Ulu Selama	3–5	Lowland and hill
Ulu Belum	3–5	Lowland and hill
Kedah Border	0–1	Hill
Total	50–75	

upper Selai and Endau river areas. During the 1977 census survey, P. Conry (pers. comm.) recorded tracks of a cow/calf pair in the upper Juaseh-Kemidak area. Several reports of a cow/calf pair in the upper Kemidak basin were obtained in 1981. Beginning in February, villagers at Kampung Juaseh reported that they occasionally encountered tracks of a cow/calf pair in the upper basins of the Juaseh and Kemidak rivers. The presence of this pair was confirmed by track observations during March and June. All other track observations were of single animals, probably adults or independent sub-adults. This information indicates that the Endau-Rompin rhino population is still reproducing, but at an extremely low rate (0.5 young per year).

In 1933, 1014 km² of the upper Endau River area in Johore was established as the Endau-Kluang Wildlife Reserve by the state government. For many years, the remoteness of the region protected it from exploitation, but during the 1960s most of the land suitable for agriculture was excised, and several timber concessions were allotted, even within the wildlife reserve. In 1972, the federal government proposed that the Endau-Rompin area be established as a national park, with protection of the Sumatran rhino a major justification. This national park would contain the upper Endau River basin and adjacent lands, including portions of Johore and Pahang.

In conjunction with the rhino surveys, the Endau-Rompin area was evaluated as a national park, and a management plan was prepared (Flynn, 1980). Briefly, this plan recommends that 870 km² of this region be classified as a national park, with special attention given to the most important rhino areas. High-use rhino areas would be zoned to exclude unnecessary disturbance and patrolled extensively by park wardens to prevent poaching. According to this plan, the proposed park would preserve about 65% of the remaining rhino habitat in the region. The balance of the rhino habitat, which includes most of the high-value commercial timber, has already been committed to timber concessions. Most of the area to be logged will remain covered by forest and managed by the Department of Forestry (DF) for timber production. Presently, the Malaysian government is considering the proposed management plan.

Gunong Belumut

Stevens (1968) reported finding rhino tracks near Gunong Belumut in central Johore (Fig. 1). During 1977, a rhino was observed swimming across the Kahang River near the northwest slope of the mountain (DF

staff, pers. comm.). We made a brief visit to the Gunong Belumut area in 1978 and found tracks of at least one rhino in the upper Kahang River basin. Additional reports of rhinos occurring in the upper Kahang and Madek watersheds on the west and north slopes of Gunong Belumut were received in 1980 from villagers living along the lower Kahang River. Based on the limited information available, we estimate that two or three rhinos occur in the Belumut area.

Today only about 230 km² of steep land adjacent to Gunong Belumut remain under forest; the rest of the former 2300 km² Endau-Kota Tinggi Wildlife Reserve has been cleared for agricultural development. Stevens (1968) recommended that this area be protected as a wildlife reserve, but no action was ever taken on his proposal. Some of the steep land adjacent to Gunong Belumut will probably remain forested, but the long-term survival of rhinos is unlikely there.

Mersing coast

Stevens (1968) found tracks of one or two rhinos along the east coastal plain within the Tenggara Forest Reserve, located about 40 km south of the district town of Mersing (Fig. 1). Unfortunately, we were unable to visit this area and no recent information is available. The presence of rhinos there is doubtful because much of the forested land has been logged or cleared for agricultural development.

Northcentral region

Taman Negara

Rhinos have been reported consistently from northern Pahang, southern Kelantan, and western Trengganu (Fig. 2), especially within Taman Negara (National Park) (Foenander, 1952; Hislop, 1961; Khan, 1971). Rhinos were hunted extensively in northern Pahang by Hubback (1939), but he provided few details on the location of his hunting areas. After Taman Negara was established as a national park in 1937, DWNP staff began collecting information on rhino distribution in this remote area (Hislop, 1961; Khan, 1971).

Rhino sign has been reported most frequently from the Spia River basin in the eastern section of the Park. Hislop (1961) hiked across much of the Park while he was a game warden and recorded rhino sign only from the Spia River north into the states of Trengganu and Kelantan. In 1976, M. Khan (pers. comm.) visited the Spia River area and found fresh tracks of

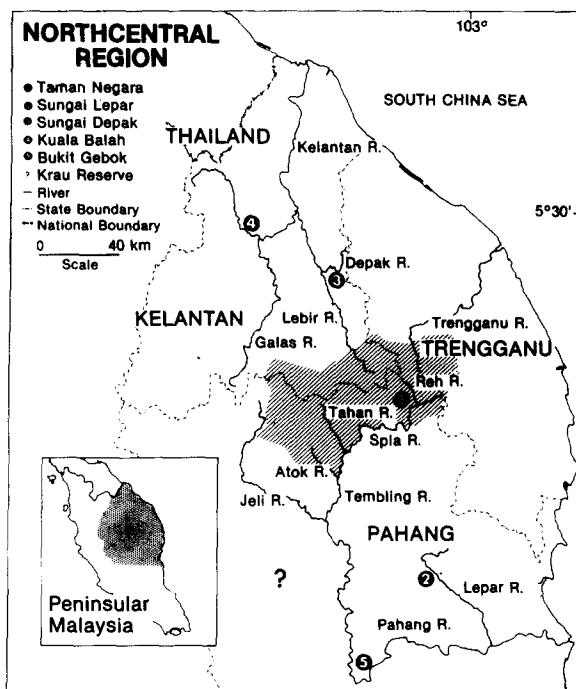


Fig. 2. Locations of Sumatran rhino track observations in the northcentral region of Peninsular Malaysia. An unconfirmed report is indicated by a question mark. The area occupied by Taman Negara (National Park) is shown by cross-hatching.

one or two rhinos near the mouth of the Reh River. Our survey of the Spia-Reh area in 1977 confirmed the presence of at least two animals in this region. Based on the locations of wallows, these animals appeared to range from the Spia River north to the Trengganu border. Information collected from our guide and other people living in the area indicated that these rhinos probably range farther north into southern Kelantan (Fig. 2). Recently, additional track observations have been recorded by DWNP staff in the Reh River area (Zaaba Abidin, pers. comm.). A brief survey of the upper Lebir River basin in the northeastern section of the Park during 1978 did not record any rhino sign.

In 1975, R. Olivier (pers. comm.) encountered tracks of an estimated three to five rhinos in the upper Atok River basin and adjacent areas in the southern portion of the park. Later in 1975, Musa Nordin (pers. comm.) recorded rhino sign at the same location. Our survey of the Atok River basin in mid-1976 confirmed the presence of at least one rhino, although

little evidence of use was found. Another survey in 1980 did not record any rhino tracks in the lower Atok area. This information indicates that rhino density in the lower Atok Valley is low, and areas located farther to the west are used more frequently.

Only a few other reports of rhinos occurring within Taman Negara exist. In 1964, an adult rhino was observed near park headquarters at Kuala Tahan (DWNP ranger, pers. comm.). The tracks of this animal were followed along the Tahan River to a point near the Kelantan border (Khan, 1971). In 1977, another adult rhino was observed swimming across the Tembling River near Kuala Tahan. These animals may have come from the upper Tekai River area south of the Park, where Foenander (1952) suggested that rhinos occur. Our surveys of the upper Tahan River in 1977 and 1981 did not locate any rhino sign, even at a previously used salt lick (Jenut Segantang). Rhino tracks were reported at Jenut Segantang in 1981 by a park ranger (Zaaba Abidin, pers. comm.). R. Olivier (pers. comm.) surveyed much of the Pahang portion of the Park for elephants during 1973 to 1975, but he found rhino sign only in the Atok area. Interviews with Orang Asli (aboriginals) who live and travel extensively within the Park indicated that rhino sign was rarely encountered. Other rhino reports have been collected from the western portion of the Park in the upper Tanum River watershed, but these reports were not confirmed.

We estimate that 8 to 12 rhinos presently occur in the Taman Negara region, with the upper Atok and Spia river areas being used most frequently. This estimate includes animals that range extensively into areas adjacent to the Park in the states of Pahang, Trengganu, and Kelantan. Additional survey work is needed to provide better documentation of the distribution and number of rhinos in Taman Negara. However, our information indicates that rhino density in this region is quite low. Also, tracks of young rhinos have never been recorded, indicating that recruitment is extremely low. Perhaps present population density is below a minimum needed for successful reproduction.

Sungai Depak

Hislop (1965) suggested that rhinos ranged from Taman Negara into southern Kelantan (Fig. 2). In 1976, M. Khan (pers. comm.) found tracks of two rhinos along the Depak River in the upper Lebir River basin. Later in 1976, we confirmed the presence of at least two animals at the same location. At that time, a new logging road had been constructed along the

Depak River. Rhino sign was found only near the end of this road where logging had not yet started. During 1977–1979, much of the Depak area was logged. No positive rhino reports have been received since the logging began. In 1979, M. Griffin (pers. comm.) found no rhino sign while conducting a forest inventory of the upper Lebir River area. Based on available information, we estimate that three to five rhinos may occur in the upper Lebir River area. Animals found previously near the Depak River may have moved farther eastward or southward into more mountainous terrain, or they may have been eliminated during the logging operation by illegal hunting. During the next few years, most of the forested lands in southern Kelantan will be logged and the survival of rhinos outside Taman Negara is unlikely.

Kuala Balah

In 1976, we visited an area near Kuala Balah in the Pergau River basin, Kelantan (Fig. 2). Villagers in the area showed us recent tracks of one or two animals and a frequently used wallow located near the edge of the primary forest. In 1977, a rhino was killed by poachers in the same area, about 50 km to the northeast. This animal's horn had been cut off with a chain saw. No other information is available on this rhino population. Based on track observations and reports from villagers living in the area, we estimate that three to four animals may occur in this section of central Kelantan. The chances of these animals surviving are low because most of the forest will be logged or cleared for agricultural development during the next few years.

Sungai Lepar

Foenander (1952) suggested that rhinos occurred in the upper Jengka Valley and the northwest portion of the Kuantan District of Pahang. In 1976, we investigated a report of rhinos occurring in the Lepar River Valley, located about 80 km west of the town of Kuantan (Fig. 2). A villager showed us a place on the east side of the Lepar River where he had observed a rhino during the previous week. We followed fresh rhino tracks from the point of his observation into nearby secondary forest. Suddenly, we encountered a large adult rhino running from a well-used wallow. The next day, older rhino sign was found 9 km upstream from the wallow near the primary forest fringe. From 1976–78, P. Conry (pers. comm.) surveyed most of the lowland area within the Lepar Valley while studying the Malayan gaur *Bos gaurus*. Occasionally, he encountered the tracks and wallows of at least two animals along the primary forest

fringe west of the Lepar River. The only other rhino report from Kuantan District was received in 1979 from the geologist at the Sungai Lembing mine. J. Singh (pers. comm.), reported that a rhino was observed while a work crew was surveying the mountainous area directly north of the mine.

We estimate that three to five rhinos occur within this section of the Kuantan District. These animals may range northward from the Lepar River to Taman Negara. Unfortunately, a thorough search of the hilly lands to the west and east of the Lepar Valley was not possible. Presently, this mountainous area is contiguous with a large forested region to the north. Large-scale agricultural development is planned for the upper Lepar River basin and the adjacent Tekam Valley, which will isolate the Lepar rhinos from those in the Taman Negara region. The long-term survival of the Lepar rhinos is uncertain because of the large amount of agricultural and forestry development in the region.

Bukit Gebok

In 1980, rhino sign was reported from the Bukit Gebok area (Fig. 2). A survey of this small isolated patch of forest confirmed the presence of at least one animal. We suspect that this isolated, solitary animal will not survive long because this patch of habitat is small and the threat of poaching is high.

Krau Wildlife Reserve

Hislop (1965) reported that rhinos occurred within the 500 km² Krau Wildlife Reserve in 1941, primarily on the western slopes of Gunong Benom (Fig. 2). Milton (1963) recorded the last confirmed rhino sign in this reserve. We were unable to survey the Krau Reserve because access was strictly controlled by the police. Information collected from villagers living near the Reserve indicated that rhinos probably no longer occur within the Krau.

West coastal region

Sungai Dusun Wildlife Reserve

The Sumatran rhino occurred sympatricly with the Javan rhino *Rhinoceros sondaicus* along the west coastal plain (Fig. 3), especially in the states of Selangor and Perak (Foenander, 1952; Groves, 1967). The last known Javan rhino in Malaysia was shot in 1932 (Medway, 1969), and this species is now thought to be extinct in Malaysia. Because of the

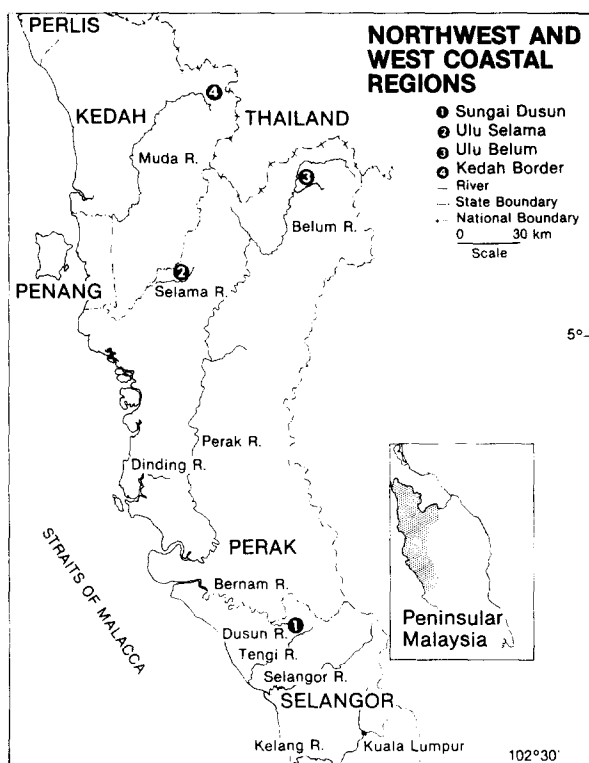


Fig. 3. Locations of Sumatran rhino track observations in the west coastal and northwest regions of Peninsular Malaysia.

overlap in their historic distribution, species identification has been uncertain in this area (Strickland, 1967).

Wray (1906) reported that rhinos were formerly plentiful in the Dindings District of Perak. Sumatran rhinos in the Bernam Valley west of the railway line were first reported in 1949 by Hislop (1965). In 1957 and 1960, a solitary Sumatran rhino was observed in Lima Belas Estate, Perak, 15 km north of the Bernam River. Milton's (1963) two-month survey recorded tracks of two to three rhinos in an area south of the Bernam River located between the Dusun and Tengi rivers. In 1965, the Selangor state government established the 40 km² Sungai Dusun Wildlife Reserve to protect this small rhino population. Strickland (1967) conducted a one-year study on the movements and ecology of these rhinos and concluded that at least three animals used the Reserve.

primarily the more hilly lands in the eastern section. Since 1970, DWNP rangers have been stationed at a guard post built near the Dusun River within the Reserve to protect these rhinos.

Several visits were made to Sungai Dusun to collect rhino reports recorded by DWNP rangers, and to survey areas located to the north and east of the guard post. Frequently, the rangers observed rhinos at the guard post or their sign in the nearby forest. During 1976, solitary rhinos were observed at the guard post six times, and a cow/calf pair was observed once. During 1979–1981, rhinos were observed at the guard post five times and tracks were frequently encountered at a well-used wallow 2 km east of the guard post. Apparently, the rhinos came to the guard post to feed on ashes from campfires. In 1979, C. Marsh (pers. comm.) encountered a rhino 1.5 km north of the Reserve and found tracks to the west of the guard post. During two of our five visits, we found fresh tracks within 3 km of the guard post.

Based on an evaluation of the above observations, we estimate that four to six rhinos use areas within or adjacent to the Sungai Dusun Wildlife Reserve. Apparently, these rhinos use areas to the north and west more frequently than the habitat within the Reserve. This Reserve is too small to contain the complete home range of such a far-ranging species. Milton (1963) and Strickland (1967) were both naïve to state that a 40 km² reserve would adequately contain the complete ranges of three animals. Unfortunately, rhino use of lands outside the Reserve, especially along the Bernam River, has not been adequately evaluated. The DWNP and the Selangor state government have proposed that 100 km² of adjacent land be added to this Reserve. The continued survival of this small rhino population will depend on expanding the size of this Reserve and protecting the animals within and outside the Reserve from poaching.

Northwest region

Ulu Selama

Hislop (1965) stated that the largest number of rhinos in Malaysia occurred in the mountainous terrain within the Bintang Hijau Forest Reserve near the Selama River (Fig. 3). Milton (1963) visited the upper Selama River area and his party observed an adult rhino near a well-known salt lick (Jenut Sri Rimau). Strickland (1967) conducted a brief survey of the Selama basin and found tracks of at least three adult rhinos near the salt licks. During 1967, Stevens (1968) briefly visited the Selama

area and recommended that a 220 km² wildlife reserve be established in the Selama basin to protect this rhino population.

We were unable to survey the Selama area because access to the forest was restricted by the police. The only recent information about rhinos in this area was collected by B. Thong (pers. comm.). In 1977, he visited the salt licks and found fresh tracks of at least two rhinos. The present status of these animals is uncertain because this area receives no special protection. Based on previous track observations, we estimate that three to five rhinos occur in this region.

Ulu Belum

Hislop (1965) suggested that rhinos occurred in the upper Perak River watershed near the Thai border. Stevens (1968) recommended the establishment of a 2000 km² national park in this remote, mountainous region to protect the valuable wildlife resource. We were unable to survey the Belum River area because the border region has been the home of terrorists and bandits for many years. B. Thong (pers. comm.) briefly surveyed the lower section of the Belum River in 1972 and found tracks of at least two rhinos. Thong's observations are the only confirmed rhino reports from the area. Based on the above information, we estimate that three to five rhinos may occur in the Ulu Belum area.

Thai-Kedah border

Hislop (1965) reported finding rhino tracks in the mountainous land along the Thailand-Kedah border in 1941 (Fig. 3). This area was not surveyed because of police restrictions. Information collected by McNeely & Laurie (1977) on the Thai side of the border indicated that rhinos were no longer found there. A more thorough survey of the entire Thailand-Malaysia border region is needed to obtain adequate information on rhino occurrence there.

STATUS AND CONSERVATION

Today, the Sumatran rhinoceros appears threatened with immediate extinction in Peninsular Malaysia. Excessive hunting during the past few centuries has reduced this once widespread species to a few small scattered populations occurring in remote areas of the country. In addition, large-scale habitat destruction by logging and forest clearance

for agricultural development has further isolated the already small populations and has reduced the amount of suitable habitat. The exploitation of the forests has also brought the surviving rhinos into much closer contact with people, greatly increasing their susceptibility to poaching.

During the colonial period, Sumatran and Javan rhinos were given inconsistent protection in the Malay peninsula; their legal status varied among the states. With the approval of the Wild Animal and Bird Protection Ordinance in 1955, the DWNP was centralized and both rhino species were classified as totally protected. The Wildlife Act of 1972 provided for better organization of the DWNP and stronger penalties for the killing or possession of totally protected species (maximum fine US\$1200 and/or 2 years in jail). Since 1975, the DWNP has greatly increased the number of staff and the amount of funds available for conservation and law enforcement programmes. With the proper deployment and coordination of funds and personnel, rhino poaching can be minimized.

The high price of rhino body products continues to provide a strong incentive for poaching. Martin (1979) found the average retail price of Asian rhino horn in four Asian countries to range from US\$3000 to 11,000 per kg. The number of rhinos killed by poachers in Peninsular Malaysia is not known, but at least two animals have died since 1975. Even though the trading of Sumatran and Javan rhino body parts is prohibited under present law, African and Indian rhino products can be legally sold and are found in most Chinese medicine shops. At least eight brands of a fever tonic made from rhino horn (known as *ayer badak* or rhino water) can be purchased in most retail stores for under US\$0.50. The amount of rhino horn consumed or traded in Malaysia is not known. Recently, Malaysia signed an international treaty controlling the trade in endangered species (Convention on the International Trade in Endangered Species of Wild Fauna and Flora). This treaty prohibits all trade in rhino body parts because the status of all species is precarious throughout the world. Hopefully, a programme stopping the trade of all rhino products will soon be implemented in Malaysia.

Prospects for the long-term survival of the Sumatran rhino in Malaysia are poor. The loss of adult animals to poaching and the almost complete lack of reproductive success are the immediate problems. Evidence of young animals is seldom reported or encountered in the field. The only known recruitment of young rhinos has occurred in the Endau-Rompin and Sungai Dusun areas. Without any new births, a population is

essentially dead and able to persist only because individuals of the species are long-lived. Sumatran rhinos have been kept in captivity for over 32 years (Van Strien, 1974). Little information is available on the reproductive biology of this rhino species, but all evidence suggests that their reproductive potential is quite low. Borner (1979) estimated reproductive parameters based on data from similar rhino species. He conjectured that under good environmental conditions female Sumatran rhinos become sexually mature at 3.5 to 6 years of age, then produce a calf only once in about three years. Several other factors probably contribute to the low reproductive rate observed in this species. Adults are solitary, far-ranging, and occur at low densities (Van Strien, 1974; Borner, 1979). No evidence of a breeding season has ever been observed. Thus, the frequency of contact among sexually receptive animals would be low under optimal conditions and decrease rapidly with reduced population size. In areas with extremely low numbers, both reproductively active male and female individuals may not even be present in the population, or the density of individuals may be too low for successful mating.

The fragmentation of the rhino population into isolated habitat islands by logging and forest clearance has made the species more susceptible to extinction. The impact of demographic, environmental, and genetic stochastic factors increases in importance as population size decreases (Shaffer, 1981). An effective population size of at least 50 individuals has been proposed as the minimum necessary for maintaining short-term fitness in most species (Soulé, 1980). In the long-term, genetic variability will be maintained only if population sizes are of an order of magnitude higher (Franklin, 1980). All rhino populations in Peninsular Malaysia are below the suggested minimum viable population size. Thus, only the largest rhino populations (Endau-Rompin, Taman Negara, and Sungai Dusun) have much chance for long-term survival and smaller groups have little chance for even short-term persistence.

A conservation programme for this species needs to be developed which includes both short-term and long-term strategies. In the short-term, all animals must be protected from poaching and their habitat protected. All rhino areas should be regularly patrolled from guard posts located at main access points. The penalties for poaching and the trading in rhino body parts should be increased to facilitate the protection programme. Recent studies have shown that this rhino species avoids areas where their primary forest habitat has been modified by logging (Flynn, 1978). Thus, large tracts of preferred habitat need to be protected by establishing

national parks or wildlife sanctuaries. Priority for habitat acquisition should be given to areas that contain the largest rhino populations. The exploitation of other rhino areas that cannot be acquired should be delayed until a system of reserves has been established. Additional surveys of all rhino areas are needed to document distribution and numbers further. Known rhino groups should be carefully monitored to determine population trends, especially recruitment rates. Research into the habitat and food requirements of these animals should be continued until their ecology and habitat relationships are better understood. Experiments designed to increase food availability (Flynn, 1980) should be expanded and evaluated.

In order to prevent the extinction of this species in Malaysia, we suggest a long-term conservation strategy that would attempt to maintain viable rhino populations in a system of separated reserves. This programme would require the translocation of animals from areas with extremely low numbers or insecure habitat to sanctuaries which contain viable breeding populations, suitable habitat, and good law enforcement systems. The threats of habitat destruction, parasites, disease, and natural catastrophes would be reduced by maintaining several isolated populations. An occasional movement of animals among the reserves would permit genetic mixing to minimize the negative impact of inbreeding depression and other genetic factors (Franklin, 1980). However, capture and handling procedures would need to be developed before such a programme could be implemented.

In Peninsular Malaysia, three areas exist that may be suitable for maintaining viable Sumatran rhino populations. The Endau-Rompin region appears to be the best place and conservation efforts should be concentrated there. This area contains the largest (20–25) and most dense (1 animal 40 km^{-2}) rhino population in the country (Flynn & Abdullah, 1983). Although some evidence of reproduction has been observed, the low recruitment rate indicates that this population may be near a minimum number required for reproduction to occur. A portion of the suitable rhino habitat in the Endau-Rompin region may be protected as a national park (Flynn, 1980). This national park would contain about 870 km^2 and be surrounded by an additional 400 km^2 of forested lands managed for timber production. If approved as proposed, this national park will contain about 65% of the presently occupied rhino area, including most of the more heavily used habitats. Presently, DWNP rangers patrol portions of the rhino area, but this effort needs to be

greatly increased. Guard posts should be built at the main access points to facilitate the protection programme by discouraging human entry (Flynn, 1980).

Taman Negara is the next best area to maintain a rhino population in Peninsular Malaysia. This remote area contains the second largest number of rhinos in Malaysia (8–12), and the habitat within the park is reasonably secure because of legal protection as a national park. After Malaysia's agricultural lands have been cleared and the commercial forests logged, Taman Negara will be the largest tract (2683 km²) of primary forest remaining in the country. Presently, the density of rhinos there is extremely low; these animals may be too scattered to reproduce successfully. The Taman Negara area should be extensively surveyed to provide better documentation of rhino distribution, numbers, and recruitment rates.

The Sungai Dusun area is the only other place in Peninsular Malaysia that has much potential for maintaining a viable population of Sumatran rhinos. A small number of rhinos have persisted there for many years, and evidence of young animals has been observed occasionally. The present reserve may be too small for the maintenance of a viable rhino population. Lands on the north and west side of the reserve should be added to create a more suitable sanctuary. The DWNP ranger patrol system needs to be strengthened and expanded to include areas used by the rhinos that are adjacent to the present reserve.

Other areas within Malaysia have little potential for maintaining viable populations of Sumatran rhinos. Still, all known rhino areas should be regularly patrolled to prevent poaching and determine numbers. A programme should be developed to capture rhinos threatened by immediate habitat destruction or poaching for release in one of the more secure areas.

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