A SUMATRAN RHINOCEROS CONSERVATION PLAN
FOR
THE ENDAU-ROMPIN NATIONAL PARK, MALAYSIA

Problem Report

Submitted to Division of Forestry

of

West Virginia University

in Partial Fulfillment of the Requirements

for the Degree of

Master of Science

in

Wildlife Management

by

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B.S., West Virginia University, 1983

Morgantown

West Virginia

1985

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ACKNOWLEDGEMENTS

Many individuals deserve thanks for their contributions to this research problem and to the program of graduate study at West Virginia University. Throughout I have been supported, guided, and aided by professors, professional natural resources managers, and many others. Their interest and willingness to help has been a constant source of encouragement. I am grateful to all those persons who have made it possible for this work to begin, flourish, and come to completion.

I am especially indebted to the Government of Malaysia for making my studies at West Virginia University possible. In particular I wish to acknowledge the expressions of generosity and confidence of the Public Service Department in granting me the wildlife scholarship and the Department of Wildlife and National Parks for supporting my academic endeavors by way of a 48-month study leave. Further, I wish to acknowledge the support of Zanariah Abdullah and Nordin Chik who kindly agreed to be my scholarship guarantors.

I am particularly indebted to the supportive members of my graduate committee who have guided and enabled development of my academic potential. Dr. David E. Samuel who, as my major professor, has carefully and thoughtfully monitored the development of this study and my graduate education. Professor Joseph M. Hutchison and Dr. Robert Leo Smith enriched my educational experience in arranging for the internships with the National Park Service at Cape Cod National Seashore and with the Smithsonian Institution,

National Zoological Park at the Wildlife Conservation and Research Center, Front Royal, Virginia, during the summer of 1984. Further, I am grateful to the Graduate Committee for their comments and editing of this plan.

I am indebted to those persons who have served as resources in the development of this plan. Khairiah Mohd Shariff and Shahir Othman have provided considerable information on rhinoceros conservation matters in Malaysia between 1982-85. Nordin Chik and Arshad furnished cost estimates on various buildings and structures for this plan. The Malaysian Meteorological Service was generous in giving their permission to use unpublished data gathered at Kluang and Mersing stations. Countless hours of discussions on wildlife conservation in Malaysia with Zaaba Zainal Abidin have been a source of idea. My colleague Rodney W Flynn, who introduced and improved rhinoceros research, has been the source of enthusiasm for me to work on the species.

Most of all, I am deeply indebted to my companion and wife, Laila Ibrahim, for her great tolerance, understanding, and encouragement. Without her counseling and unselfish cooperation this study could not have been completed. I am also indebted to my parents, Abdullah and Habsah, and the members of my family, especially Zanariah and Abdul Manaf, who have always encouraged my interests. Lastly, to my little friend and son, Hafez, who's overtures for attention and affection have been not always acknowledged during the preparation of this plan, I owe the promise of time

together as father and son.

From the time of enrollment in my first course in wildlife ecology, West Virginia University has exerted a profound, enriching, and permanent influence on me. My sincere thanks goes out to those many persons who have been a part of this influence.

MTA

April 1985

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INTRODUCTION

Purpose

The proposed Endau-Rompin National Park Management Plan (Flynn 1980) states that:

> "Much of Malaysia's native fauna has become greatly reduced in distribution and abundance because of the great loss of habitat. ..... The precarious status of these species warrants the implementation of special management programs within the park to provide improved habitat and protection."

Recommendations for the management of the Sumatran rhinoceros (Dicerorhinus sumatrensis) are as follow (Flynn 1980);

1. Prohibition of human activities in rhinoceros areas.
2. A patrol system to protect rhinoceros poaching.
3. Critical rhinoceros habitat, presently excluded from the parkland, to be added to strict natural area.
4. The feasibility of rhinoceros translocation program should be investigated.

This plan will expand the above management framework and provides guidelines primarily for the perpetual preservation of rhinoceros in the proposed park. It provides general guidelines for the Department of Wildlife and National Parks (DWNP), Federal and states governments,

governmental and private agencies, and concerned public to act effectively and productively to preserve the habitat and protect the population of the endangered species. The plan sets as a foundation for developing specific programs and activities for future management and research needs.

The ultimate aim of the 10-year conservation plan is for the recovery of the endangered Sumatran rhinoceros in the entire Endau-Rompin region. It is, therefore, developed within three major elements that will cover most aspects of rhinoceros management, namely, habitat, population, and people.

Nomenclature

The terms in this plan are defined as the following:

Bukit	hill .
DWNP	Department of Wildlife and National Parks, Peninsular Malaysia .
Endau-Rompin	the proposed Endau-Rompin National Park, an area of 870 sq km.
region	the entire area around Endau-Rompin.
Gunong (G)	mountain .
Kampung (K)	village.
Keruing	Dipterocarpus sp.
Meranti	Shorea sp.
M$	Malaysian ringgit currency, US$ 1 = M$ 2.60.
Ministry	Ministry of Science, Technology, and Environment. DWNP is under this ministry.
Orang Asli	Aboriginal people.
Pekan	town.
Sungai	river (R)
Ulu	area in the upper reaches of a river.
Kuala	mouth of a river or a tributary.

Endau-Rompin Environment

Physical features

The Endau-Rompin environment has been sufficiently described by Flynn (1978, 1980, 1983). The area extends from latitudes 2° 21'N to 2° 46'N and longitudes 103° 5'E to 103° 25'E. It covers an area of forest totalling 870 sq km. About 56% (490 sq km) of the total parkland is in the state of Johore and the remaining 44% (380 sq km) is in Pahang. The entire proposed park falls within Labis and Mersing Forest reserves in Johore and Lesong Forest Reserve in Pahang. It is located about 250 km southeast of the capital city Kuala Lumpur, 45 km east of Segamat town, and 8 km from a tiny Pekan Ayer Panas on its west border (Fig. 1). As a result of logging operations and human settlements, the area is accessible by dirt roads at Kampung Peta on the east, Kampung Selai on the south, and Kampung Kepoh, Juaseh, and Ulu Pukin on the west border (Fig. 2).

The topography of the park is marked by undulating hills. The elevations range from 40 m at the lowland to 1036 m at the summit of Gunong Besar. High points in the central part, Gunong Besar (1036 m), Gunong Beremban (839 m), and Bukit Peta (552 m), demarcate the Johore-Pahang boundary. Gunong Ulu Kemapan (854 m) and Gunong Bekok (953 m) are among the highest points in the north and

south respectively. The mountains have been associated with granitic rocks. Rhyolitic volcanic composition of Triassic and Permian age occur on the north-south treading mountain range (Gobbet and Hutchison 1973). Red and yellow latosols and podsolic soils derived from acidic igneous rocks cover most of the area (Flynn 1983). Soils derived from igneous rocks are average in fertility and if the forest is cleared and cultivated with crops, they tend to pack and form impermeable crust (Ooi 1959, Panton 1964). Most of the area in Endau-Rompin is not suitable for agriculture because of steep slopes and shallow soils (Smallwood 1966 as cited in Stevens 1968a). Most benches are dissected by drainageways on the east and west watershades. The Sungai Endau and Sungai Rompin drain the east and northeast areas into the South China Sea and the western parts are drained by Sungai Muar into the Straits of Malacca (Flynn 1978).

Climate

Although there are no meteorological stations in the Endau-Rompin region, the climate can be described based on data from stations surrounding the area.

The Malay Peninsula has an equatorial monsoon climate, where annual temperatures are constantly high and the northeast and southwest monsoons bring heavy rainfall (Nieuwolt 1977). The northeast and southwest monsoons prevail from December to March and June to September respectively.

The two monsoons bring warm and humid air masses which are related to the high sea surface temperature, above 25°C, in the region (Nieuwolt 1977). The air temperature is high throughout the year with mean annual temperature of 27°C (Dale 1963). The meteorological conditions from stations near Endau-Rompin (Malaysian Meteorological Service 1984) are in Appendices D and E.

The mean annual temperatures at Kluang and Mersing, between 1982 to 1983, is 27.1°C and 26.8°C respectively. The mean annual maximum and minimum air temperatures at Kluang are 31.5°C and 22.8°C. For Mersing, the mean annual maximum and minimum temperatures are 30.4°C and 23.2°C. Days are hot between March to June, with temperatures ranging from 30.7°C to 34.7°C at both stations. The mean maximum relative humidity ranges between 88.1 to 100%, and mean daily evaporation is between 2.1 to 5.0 mm. In the most parts of the country sunshine averages 8.5 hours per day, mostly in February and March (Dale 1964). Average annual rainfalls are 2220.3 mm at Kluang and 3005.2 mm at Mersing with highest amounts occuring in December and lowest between February to April.

Biotic environment

Endau-Rompin is in the Indo-Malayan rain forest region and the tropical rain forest occurs in the area (Whitmore

1975). The perpetual midsummer condition and high temperature results in uninterrupted and luxurious plant growth in the tropical forest (Smith 1980). Malay Peninsula has about 7,900 species and 1,500 genera of seed plants (Whitmore 1975). The great richness of the tropical vegetation is illustrated by an hectare plot that contains about 110 species many of which have 0.3 m in minimum girth (Wyatt-Smith 1966 as cited in Whitmore 1975).

From the top view, a tropical rain forest consists of varying patches of trees at different developmental stages. In undisturbed primary rain forest, numerous gaps caused by death of large trees which are created by windfalls, lightning strikes, landslides, and fungal attack (Whitmore 1975, Richards 1983). The impact of falling crown can create a 0.04 ha wide gap. The collapsed trees release the vital nutrients that are otherwise stored in them for many years. Consequently, the most important resources, space, nutrients, and sunlight, are made available for lower strata species to recolonize and pioneer plants to invade in competition with each other. Continuing growth of the saplings eventually bring good competitor species into mature stages.

The structural stratification of tropical rain forest is classified into 5 major catogeries (Whitmore 1975, Richards 1983). The discontinous upper stratum, emergent layer, is composed mainly of Dipterocarpaceae

(Dipterocarpus sp., Dryobalanops sp., and Shorea sp.) and Leguminoseae (Koompassia sp., Dialium sp., and Sindora sp.). These trees range from 40 to 60 m tall. The second layer is the main canopy which is fairly continous and dominated by dense stands of 20 to 30 m trees. Burseraceae and Sapotaceae are the major families. Numerous gaps are found in this layer created by collapsed trees in emergent and main layers. The lower boundary of main canopy is called the inversion surface which separates the crowns that are exposed to full sunlight and those that receive energy by reflection. The euphotic zone, above the inversion surface, provide the most food (leaves, flowers, and fruits) for herbivorus animals. The oligophotic zone is dominated by unproductive immatures. Major tree families in the lower story are up to 20-m high Euphorbiaceae, Rubiaceae, Annonaceae, Lauraceae, and Myristiceae. The last two categories are the woody treelets (1 to 2 m) or shrubs and herbs and seedlings.

Based on Whitmore (1975), there are 2 main types of forest formation that can be recognized in Endau-Rompin. First, the tropical lowland rain forest which is commonly found up to 750 m altitude. This is also considered the prime rhinoceros habitat in Endau-Rompin. Dipterocarpus sp., Shorea sp., and Dryobalanops sp. are commonly found with big woody climbers. Typically, the forest is dense, some trees are 45 m or higher, clear bole of 30 m and reach 4.5 m

girth. The major strata are the emergent, main, and lower story. The understory is mainly of sapling that provide rhinoceros browse species. The western portion of Endau-Rompin is dominated by mixed meranti-keruing forest (Gykis 1966 as cited in Stevens 1968a). Second, the tropical lower montane forest, up to 1,500 m altitude, is typified by; Shorea sp. and Dipterocarpus sp., canopy height of 15 to 35 m, emergent often absent or small (up to 35 m), most trees without butresses, big woody climbers absent, and many vascular epiphytes. Not so commonly found is the montane ericaceous forest, in the upper montane forest formation. It is characterized by flattish canopy, slender tree with gnarled limbs, and is found on mountain tops southeast of Gunong Besar (Heaslett 1970). Rhododendron sp., Dacrydium sp., Leptospermum sp., and Podocarpus sp. are abundant on the "Gunong Chabang Tiga" peaks (Heaslett 1970).

There is no complete record of fauna found in Endau-Rompin area. Besides the rare Sumatran rhinoceros, the habitat contains seladang (Bos gaurus), elephant (Elephas maximus), and tiger (Panthera tigris), all are threatened and endangered species (Flynn 1980). Other mammals occurring in the primary forest include tapir (Tapirus indicus), bearded pig (Sus barbatus), common pig (S. scrofa), mouse deer (Trangulus napu, T. javanicus), sambur deer (Cervus unicolor), and leapord (Panthera pardus)

(1968a) to exclude the denudated land in the proposed 780 sq km Sungai Endau Wildlife Reserve. An area of 260 sq km of the Lesong Forest Reserve in Pahang to be added to the north side of the Endau-Kluang Reserve.

In 1972, the Pahang Tenggara Regional Development Authority proposed that Endau-Rompin be set aside for nature preservation (Flynn 1980, Aiken et al 1982). At the same time, a joint Federal-State committee agreed to designate Endau-Rompin as national park. It was proposed that about 900 sq km be designated as strict nature reserve and surrounded by a forested buffer zone (Flynn 1980). The proposal was revised in 1977 by DWNP to include most of the Sumatran rhinoceros habitat. However, Pahang began a drastic move against conservation efforts by granting 12,141 ha logging concessions in the core of the proposed park (Aiken et al 1982). Protested by public and concerned groups, logging operation ceased in August 1978 after 6,000 ha was logged in upper Jemai and Kemapan (Flynn 1980, Aiken and Leigh 1984).

Outside the north side of the proposed park boundary, the area is under Lesong Tree Farm concession (Flynn 1981). About 500 sq km of the forest area contains rhinos; however, it will be logged in the next 30 years. On the northwest, in Pahang section, Federal Land Development Authority (FELDA) is converting forest into agricultural schemes. FELDA Selanchar schemes 7 and 8 are planned to

be added to the park. These are part of the Sumatran rhinoceros critical habitat.

The impact of Orang Asli

The Orang Asli (forest-dwelling aboriginal peoples) have existed, interacted, and adapted as an ecological component of the area long before civilized men knew all about Endau-Rompin. They may have descended from the Hoabinhian of the late Pleistocene and beginning Holocene period (Rambo 1979a). In some Hoabinhian settlements in Malay Peninsula, there were remains of wide varieties of animal species utilized by the primitive hunter-gatherer society. This includes the extinct Javan rhinoceros (Rhinoceros sondaicus) (Rambo 1979a). On the other hand, the abandoned swidden plots by recent Orang Asli provide browse from regenerated vegetation (Rambo 1979b). Therefore, the similarity and dissimilarity of the present day Orang Asli and their prehistoric ancestors have major influence on the forest resources in the tropical habitat. According to Rambo (1979a), they are responsible for direct selection, dispersal, habitat modification, and domestication of the natural genetic pool.

The Proto-Malay, a race of the Orang Asli, live on the fringe of Endau-Rompin border. Their main settlement areas are at Kampung Peta, Kampung Selai, Ulu Pukin, and

Kampung Juaseh. They are dependent on the forest resources at Endau-Rompin for fuelwood, fruits, medicinal plants, rattan (Calamus sp.), resin, wild animal, and fish. The Federal laws and State enactments allow them to enter forest and wildlife reserves for the purpose of collecting wild games and forest products for their own consumption. However, according to Rambo (1979b), wild resources are both for their own use and for trade for cash. Near Endau-Rompin Orang Asli supplement their proteins and carbohydrates requirement by farming food crops and fruit orchard keeping. Rubber is the main cash crop in some settlements. Some are employed as laborers by logging contractors . Every Proto-Malays community is headed by a batin (chief) who combines secular with ritual authority (Rambo 1982).

The hunting-gathering pressure on tropical rain forest is indicated by a study on a 10-household Temuan community in Selangor (Rambo 1979a). In a 10-day period, the Orang Asli hunted 4 wild pigs, a barking deer, 5 porcupines (Hystrix sp.), 15 primates, 15 amphibians, 6 reptiles, a flying fox (Pteropus sp.), 45 birds, and 191 fish species. It is not known how much of the hunting-gathering activities are going on in Endau-Rompin. Whether their continuing activities affect the Sumatran rhinoceros distribution or is part of the ecological process should be the subject of a long-term study.

Population, Habitat, and Feeding Characteristics

Former status

There is a lack of historical record of occurrence of Sumatran rhinoceros in Endau-Rompin region. As early as 1877, a specimen was captured for zoological garden in Europe from an unknown locality in Johore (Reynolds 1960). Foenander (1944) thought that the animal were found around Gunong Lesong of south-eastern Pahang and in the hill ranges along Pahang-Johore border. There was no known population estimation for the area during that time.

Present status

In 1966, the Sumatran rhinoceros was reported in the upper areas of Endau, Emas, and Semberong rivers (Hislop 1966, Stevens 1968a, 1968b). Extensive surveys between 1974 to 1984 have extended the known ranges into upper Endau, Selai, Kemidak, Juaseh, and Segamat watersheds in Johore and the upper Pukin, Jekatih, Sekin, and Kemapan basins in Pahang (Flynn 1978, 1983, Khairiah Mohd Shariff pers. comm.). Contrary to the reports by Foenander (1944) and Stevens (1968a), there was no indication of rhinoceros in the area between Endau and Semberong rivers which had been turned for agricultural development , the eastern portion of Gunong Lesong, and the Sungai Emas which had been logged

(Flynn 1983). It was concluded that rhinos were found throughout the 1,600 sq km primary forest of Endau-Rompin region (Fig. 3) (Flynn 1983). The high-density area was estimated to 10 rhinos, 1 animal per 40 sq km, and the low-density at 10 to 15, 1 animal per 80 to 120 sq km. Therefore, the total estimation for the entire region was 20 to 25 animals.

General characteristics

The Sumatran rhinoceros is the most primitive and smallest among the living species in Rhinocerotidae family (Groves 1967, Fisher et al 1969). Adults have head and body lengths of 233 to 249 cm, a tail of 50 to 56 cm, height of 129 to 137 cm at shoulder, and 216 to 243 cm in girth behind shoulder (Garrod 1873, Evans 1904, 1905, Hubback 1939). The weight estimates between 1,000 to 2,000 kg (Anderson 1872, Wray 1906 as cited in Van Strien 1974). An immature and sick female held at Malacca and Basel zoos weighed 598 kg and 386 kg respectively (Grizimek 1972, Anon 1984). The rhino horn is packed filamentous in structure and has evolutionary association to hairs (Ryder 1962). Both female and male have two black anterior and posterior horns. The length on outside curve of female anterior and posterior horns are 21 cm and 3.8 cm, while the male anteriors are 19 to 26 cm and posteriors ranging between 11 to 15 cm (Hubback 1939).

The average basal circumferences of anterior and posterior horns are 45 cm and 35 cm (Hubback 1939, Foenander 1944).

The ears are about 19 cm long, rounded and tubular at the base and the eyes are small (Evans 1905, Foenander 1944).

The width measurements of the hind track vary from 15 to 22 cm, fore foot between 18 to 24 cm, central nail of front foot from 6.8 to 88.8 cm (Hubback 1939, Strickland 1967, Flynn 1983).

The legs, ears, and tip of the tail are conspicously hairy, while the face and head are sparse with hairs (Foenander 1944). The skin is granular, dark to dirty grey and about 16 mm thick (Evans 1904, Hubback 1939, Metcalfe 1961). There are two conspicous skin folds, the first encircling the trunk behind the fore legs and the second over the sides and belly.

Hubback (1939) observed an acute sense of hearing and smelling but poor sight. The prehensile-shaped upper lip curls up when testing the wind for scent. When alarmed, the animal makes a peculiar noise by blowing its nostrils.

Sumatran rhinoceros is solitary in its social behavior. The only time two rhinoceroses come together is when they mate or during mother and calf association (Hubback 1939).

Wallowing in mud is essential for rhinoceros in the wild and captivity (Hubback 1939, Metcalfe 1961, Skafe 1961, Borner 1979, Khairiah Mohd Shariff per. comm.). Mud bathing might have a thermoregulatory function on its skin.

Borner (1979) observed that wallowing frequency increased during dry period.

Habitat characteristics and feeding behavior

Habitat requirements are associated with availability of food and nutrition, various types of cover, water, and special needs (Willis 1975, Teague and Decker 1979, Bailey 1984). These habitat elements might be reflective of the carrying capacity to support a wildlife species in a given area. Such characteristics can be ranked, from optimum condition to the least favorable, and can be used in habitat evaluation for a wildlife species (refer Appendix A).

The papers by Flynn (1976, 1977, 1978, 1979a, 1979b, 1981, 1983) on his work at Endau-Rompin study area and Hubback (1939) are the main sources of reference in this section.

Habitat preference, food selection, and feeding behavior are influenced by browse quality, food availability, habitat attributes, and feeding adaptation. In Malay Peninsula, the Sumatran rhinoceros live totally in the primary tropical rain forest. Although lowland habitats are used by rhinos in Endau-Rompin, the high-density area is in the hill forest, above 250 m in elevations. Preference for hill forest might be an adaptive strategy to maintain the conditions of the thick and sensitive skin. In the core rhino area, the mean daily air temperature is

3°C lower than at Segamat (28m a.s.l., 27°C). The ridges and numerous drainageways provide natural banks for wallowing sites. About 74% of the wallows in Selai, Endau-Rompin, occur along stream plain or edges of stream plain next to steep bank and 26% are found on ridgetop. Habitats that are drastically modified (logging) are usually avoided. Rhinos have never been found closer than 0.5 km to a disturbed area.

The Sumatran rhinoceros is a generalist herbivore, feeding on 49 plant families, 102 genera, and 181 species. This constitutes about 46% of the total plant families in Peninsular Malaysia. About 75% of the total forage are from 30 genera which can be regarded as principal food plants. Prunus sp. 15%, Ficus sp. 6.4%, Medusanthera sp. 3.8%, and Eugenia sp. 3.0% contributed the greatest amount to the diet.

In terms of canopy stratum, 75% of feeding occurs on plants representative of the understory, 18% are juveniles from mid-canopy, and 2.8% are saplings of emergent trees. From the available food plants, 10% are juveniles from timber species. Athough Dipterocarpaceae family dominates tropical rain forest, it is not the principal food for rhino. In regard to successional development, about 74% are commonly of closed canopy forest (mature and building stages), 14% are of secondary forest, and 11% are of forest gaps. About 78% of the food are commonly found in

lowland and hill forest.

Rhinoceros feeding methods are often destructive. Short plants are browsed from above without damaging the main stem. Large woody saplings are usually pushed and small saplings are broken or twisted sideways. Plants more than 3.5 cm dbh are occasionally selected for food. The rhinos browse the leaves and small stems after breaking or pushing the plant.

Physiography and canopy cover are major habitat attributes that determine sites selected for browsing. About 60% of the feeding sites are in stream bottom, 35% in lower slope, and 5% in upper slope. In selection for the canopy cover, rhinos show significant preference for the old gap (30%) forest succession. About 63% of the feeding is in closed canopy. New gap and riverine contribute 5% and 2% respectively.

Selection for physiography and canopy cover can be explained by the quality, availability, and distribution of plant species. There are 6,740 stems/ha of woody saplings (0.8 to 3.2 cm dbh) found in stream bottom, 5,000 stems/ha in lower slope, and 4,710 stems/ ha on the ridge. The amounts of available leaf biomass are 550 kg/ha in the stream bottom and 370 kg/ha in the lower slope. Prunus sp. 2.1% and Eugenia sp. 10% are important food plants found in stream bottoms. Plants on stream bottoms and lower slopes contain relatively higher mean concentrations of minerals,

suggesting a higher nutritional quality of forage. The alluvial soils brought by runoff and erosion into stream bottom areas may contain more nutrients for sapling growth. Although the ridges are selected against, they are used as travel corridors between drainage systems.

In the Selai study area, 83% of closed canopy and 15% of forest gaps are available. Therefore, utilization of forest gaps (35%) is significantly higher than their availability. In terms of browse, 98% of the available leaf biomass consist of mature leaves in the forest understory. In small gaps, shade tolerant seedlings and juveniles are typical of the adjacent forest understory. Since gaps are widely scattered and available in small proportion, feeding in them would require significant amount of search time and energy investment.

The Sumatran rhinoceros diet is composed of 95% woody saplings (shrub and juvenile trees with dbh between 0.4 to 6.0 cm), 3.5% of woody climbers, and occassionally fruits. Mature leaves accounted for about 90% and stem materials (less than 5 mm in diameter) contribute 8.6% in total diet. Chemically, rhinoceros diet is characterized by high in fibre, moderate minerals (K, CA, and ash), phenolic compounds, and crude protein (11.3%) but extremely low phosphorus (0.08%). Mature foliage of plants has low nutrients and is, therefore, poor in nutritive quality.

Fruits are high in mineral and energy contents and

can subsidize digestion of low nutrient leaves. Fleshy fruits such as Mangifera foetida (cultivated mango), and M. lagenifera (wild mango) are highly preferred. Other fruits found in rhino diets are Calophyllum macrocarpum , Parkia sp., Citrus sp. Payena costata (mengelut), Garcinia forbesii (mangosteen), Artocarpus rigidus (monkey jack), Mezzetia leptopoda (mempisang), and Pauteria mainguyi. Calophyllum sp. have evolved to have their fleshy fruit wall removed by animals before germination (Ng 1983). Fruits of Mangifera sp. are usually found sprouting in the dung piles.

During fruiting season, March to September, rhinoceros spend a considerable amount of time searching for fruits fallen on the ground. Rhinos frequently return to the same fruiting trees to feed.

Changes in abundance and phenology of food plants might influence rhinos to select a more diverse diet. Ng (1980, 1981, 1983) who studied phenology and germination of tropical forest plants, include 30 species in the rhino's diet. Seed germination period and length of dormancy have some implication on the availability of rhino food plants. The majority of rapid germinated species (within 12 weeks) belong to the Dipterocarpaceae family; however, they do not form an important food source. The period to germinate for rhino browse species range between 1 to 36 weeks. Species with rapid germination

constitute 86% of the food plants. However, Prunus sp., which accounted for 15% of the diet, germinated between 14 to 22 weeks. Long dormancy might be a strategy to germinate during the most favorable condition that will allow higher germination success. This, however, will effect the abundance and availability of principal foods throughout the habitat.

Threats to Rhinoceros Preservation

Loss of habitat

The first conflict between wildlife preservation and agricultural began in the 1920s when reserves were degazetted by State legislatures (Stevens 1968a, Aiken *et al* 1982). Soon after independence from the British adminstration, about 26% of the total 13.2 million ha of land area in Malay Peninsula was deforested (Wyatt-Smith 1958, Marshall 1973). Land under wildlife reserves and parks were reduced from 8,000 sq km in 1940s to 6,700 sq km in 1968 (Stevens 1968a, Marshall 1973). This represented a backward step in nature preservation and left about 5% of the land area in Peninsular Malaysia for conservation purposes.

In the early 1960s, the Federal launched a nation-wide rural development to improve its economic level and social prosperity (Ho 1965). The Federal Land Development Authority (FELDA) became the agency to implement the government's policy. Rubber (*Hevea brasiliensis*) and oil palm (*Elais guineensis*) were introduced as the main monocultural cash crop in FELDA plantation schemes. Concurrently, a Technical Sub-Committee for Land Capability Classification (LCC) of the National Development Committee was established (Stevens 1968a, Mohd Darus 1979, Aiken *et al* 1982). Efforts by all agencies were coordinated to map

productive lands. These areas were ranked by economic priorities, namely, mineral potential, soil suitable for agriculture, and productive forest.

Wildlife habitat was classified in Class V, defined as land possessing little or no mineral, agriculture, or productive forest potential. In other words, wildlife production was on steep, poor, and unproductive area. In contrast, wildlife in Malaysia is always associated with the rich lowland forests. The lowland rain forests support 78% of terrestrial mammals and 60% of bird species (Wells 1976, Stevens 1968a).

As LCC become widely accepted as the unofficial land use policy for planning, tremendous agricultural expansion, forest exploitation, mining, industry, and human population growth continued to consume lowlands that were otherwise best for wildlife preservation. It was very unfortunate situation that certain agencies had adopted LCC recklessly without any "common sense" and ecological considerations (Stevens 1968a, Lee 1981, Aiken et al 1982). Apparently, there was no control by the government to check land abuse by agencies.

By 1976, forested land was estimated close to 54% of the total land area (Arshad 1979). The Federal, under the Third 5-Year Malaysia Plan (1976-1980), proposed to add 8,989 sq km to a network of parks, nature monuments, sanctuaries, and wildlife reserves (Government of Malaysia

1976). The proposals and conservation efforts have failed miserably, including the proposed Endau-Rompin National Park, after the end of the 5-year period. Ironically, at that time, the government recognized the significance of preserving representative samples of Malaysian natural ecosystems as part of the national heritage (Government of Malaysia 1976). When the government implemented the Fourth Malaysia Plan (1981 - 1985), the previous nature conservation philosophy was entirely omitted.

It is estimated that 6.4 million ha (48% of land available) are suitable for agriculture and will be cleared for that purpose (Marshall 1973, Aiken and Moss 1975, Arshad 1979). Four million ha (30% of total area) are earmarked as logged-over and agro-conversion forests (Arshad 1979). Currently, agricultural development and forest exploitation are at the annual rate of 80,900 ha and 240,000 ha respectively (Marshall 1973, Arshad 1979, Aiken et al 1982, Grainger 1983, Ng 1983). At that rate of deforestation, it is speculated that nothing will be left on lands below 1,000 m in altitude by the turn of the century (Marshall 1973, Aiken and Moss 1975).

Protection of productive forests for wildlife is further complicated by the rights the states have on land resources. By establishing Endau-Rompin under the new 1980 National Park Act, Pahang and Johore will relinquish their rights to the Federal ministry. As

Hubback (1937) states, "Officials hate the idea of allowing a tract of country, that may contain minerals, timber, or something else that will produce money, being tied up for the propogation of wildlife." Thus, the unwillingness of the states to establish Endau-Rompin under a sound Federal law reflect their opposing attitude toward protection of primary forest for the preservation of Sumatran rhinoceros.

In 1977, a significant portion of the core Endau-Rompin area, at Jemai and Kemapan rivers in Pahang section, was denudated by destructive logging operations. Apart from that, FELDA planned to convert the area around Pukin River for agricultural plantations (FELDA Selanchar Scheme). The disturbances drove rhinoceros into the surrounding primary forest. Logging activities opened access to the region. This increased the vulnerability of Sumatran rhinoceros to poaching, disturbance, and habitat encroachment. Modification of the primary forest is causing a drastic effect on the regeneration of plant community, Due to loss of nutrient, soil compaction, erosion, and increased exposure, immature trees cannot retain the original height of the forest (Ng 1983). The horizontal and vertical compaction, due to logging, of the forest reduce the production of wood, leaves, flowers, and fruits, and the availability of living space for fauna and flora (Ng 1983).

The minimum area requirement needed to support a viable breeding population of Sumatran rhinoceros is still

an open-ended question. While creating a 870 sq km park can protect the area from future exploitation, it will not insure that the area could support the viable numbers for continuing preservation of the Sumatran rhinoceros. The area might be too small for long-term management of larger population size (refer Appendix B). It is necessary to have adequate biological information to determine the ecological boundary for preservation of Sumatran rhinoceros within the protected habitat.

The urgent concerns for future preservation effort is to withhold the pressure of economic and social progress that will convert prime rhinoceros habitat into other land use. Habitat degradation will continue to reduce the potential space to support a viable population. If land development exceeds its conservation, Endau-Rompin will become a small forest island where the chance of extinction is greater.

Population and vulnerability

The first legislation to protect rhinoceros population was introduced in Pahang in 1896 (Hubback 1939, Stevens 1968a). A game hunting license was required to kill a rhinoceros. However, illegal hunting was so prevalent that its population in Pahang was depleted in 1930s (Hubback 1939).

In Johore, legislation to protect wildlife was

enacted in 1912. But law enforcement came 11 years later, in 1923, when a new Enactment made provisions for the appointment of game wardens (Aiken et al 1982). Generally, the early laws were not properly instituted to deter local hunters to kill rhinoceros illegally.

When the 1972 Wildlife Protection Act was passed to give total protection on Sumatran rhinoceros, its population in Malaysia was extremely low in isolated habitats.

In a series of surveys between 1974 to 1981, the Sumatran rhinoceros population was estimated between 50 to 75 animals (Flynn 1983). The main population centered at Endau-Rompin (20 to 25), Taman Negara (8 to 12), and Sungai Dusun Wildlife Reserve (4 to 6). Small populations, between 1 to 5 rhinos, are found at Gunong Belumut, Mersing Coast, Ulu Lepar, Sungai Depak, Kuala Balah, Bukit Gebok, Krau Wildlife Reserve, Ulu Selama, Ulu Belum, and Kedah border (Fig. 4).

Since about 40% of the total Sumatran rhinoceros population occurs in Endau-Rompin region (1,600 sq km), it is worthwhile to concentrate all preservation efforts in this habitat. However, Endau-Rompin has unique problems itself. Rhinoceros reproduction in the area is very low. Flynn (1983) speculates that there might be nutritional deficiency in rhinoceros diet. Low phosphorous content in the browse might be the key factor that reduces rhinoceros fitness. The population is also unevenly distributed

throughout the region. The Selai, upper Endau, Juaseh, Kemidak, Tenang, and Segamat drainages are the high-density area that support 1 animal per 40 sq km. The rest of the habitat supports 1 rhinoceros per 80 to 120 sq km. Information on factors that are affecting rhinoceros population and habitat suitability are unknown.

The management concern is to maintain breeding nucleus and increase reproduction for the restoration of Sumatran rhinoceros in the entire Endau-Rompin region.

Other factors

For the purpose of this plan, people include concerned citizens, the general public, and salaried government employees who are involved in various ways in the preservation of the Sumatran rhinoceros in Malaysia.

Non-consumptive activities on rhinoceros, such as photography, nature study, etc are unpopular. But over many years rhinoceroses were hunted, harassed, and captured for local use and for zoological gardens in Europe (Reynold 1960, Van Strien 1974). The Orientals, especially the Chinese, believe that rhinoceros horn, body parts, and blood have powerful medicinal, aphrodisiac, and supernatural properties (Hubback 1939, Metcalfe 1961, Schaurte 1966, Martin 1979). The problem is sometime compounded by ignorance of the public and media (Appendices F and G) on existing law prohibiting possession of rhinoceros parts.

The neighboring local communities at Endau-Rompin are aware of the rhinos in the area. On many occassions the Orang Asli collected forest produce in Endau-Rompin. The existing laws allow them to enter and collect wild game and forest product in wildlife and forest reserves. There is potential risk that their game trapping method (using wire snare) might be dangerous to rhinoceros or they might be recruited by rhino poachers on the pretext to hunt wild game.

In the past, wildlife biologists at DWNP were self-trained by making trial and error in the field. Some were more absorbed in administrative jobs than field work. Consequently, management problems on endangered species remain unsolved by lack of knowledge. DWNP require professional biologists who can spend considerable amount of time in the field to collect reliable information. They should be able to originate management-oriented research, test hypothesis, and provide leadership in the Sumatran rhinoceros conservation programs.

Rhinoceros preservation is on a collision course with short-term economic interests. A concerted and deliberate effort by Federal and State governments, professional biologists, and people are necessary for the recovery of Sumatran rhinoceros in Endau-Rompin region.

PART II : CONSERVATION PLAN

Goal, Objective, and Rationale

Realizing that the Sumatran rhinoceros is rare, endangered, and threatened with extinction throughout its range in Peninsular Malaysia, the DWNP shall be the leader to preserve, protect, and enhance the species and its habitat for the ecological, esthetic, historical, educational, and scientific value for the nation and its people. It is the primary goal of this plan to provide protected habitat and improve population levels for the restoration of Sumatran rhinoceros in the Endau-Rompin region. The tentative goal is to have at least 50 rhinoceroses in the entire 1,600 sq km region. The objectives, tasks, and policies are developed to achieve the goals. The main objectives of this plan are;

1. Protect and manage rhinoceros in the Endau-Rompin region.
2. Increase the number of rhinos and acquire information on viable population levels conforming with the availability of suitable habitat.
3. Provide the opportunity for people to support rhinoceros preservation and promote non-consumptive use for education and scientific purposes.

The plan contains management and research recommendations

to be accomplished in a 10-year period. Within that span, the objectives, tasks, and policies should be reviewed periodically to meet the accepted goal of restoration. During the implementation, the plan should be flexible depending on the availability and adequate funding, professional biologists, and knowledge on management. The first half of the 10-year period shall be devoted on developing techniques, acquiring information, and monitoring habitat and population response to management prescriptions. Major revisions of the plan is expected when implementing the second half of the term.

At this time, the questions of what and how much habitat manipulation to improve quality and how many rhinos make a viable population are not known. With major deficienceis in management-orientated information, this plan cannot provide absolute solutions. Management prescriptions can be cautiously done on an experimental basis. Survey and inventory before and after treatments provide a great deal of information about population and habitat. Therefore, appropriate data gathering tasks are proposed to accumulate needed knowledge in habitat availability and suitability, ecology, population dynamics, behavior, and captive breeding techniques. Management recommendations are directed to increase the protection and quality of habitat, enhance population, and strengthened public awareness in rhinoceros preservation needs.

The prospects of total commitment for Sumatran rhinoceros preservation in Endau-Rompin is uncertain. After the park proposal was made 12 years ago, Johore and Pahang agreed (recently) in principle to establish Endau-Rompin as a protected area. It is not known under what legislation the states would agree to establish the park. Under the 1980 National Park Act, the states would have remote a chance to revoke the park status without written permission from the Federal Minister. However, the states could easily establish the Endau-Rompin park through state legislations if they had a total commitment (Aiken and Leigh 1984). If the recent announcement is a typical lip service to the Federal, then the states might be expecting major concessions to reduce the boundary and have better control on the future of the park. Any changes on the park area is an attempt to decimate the habitat and the Sumatran rhinoceros population. Therefore, this plan will be the working document on what ought to be done for continuing preservation of the rare species.

Management Recommendations

Protect and manage habitat

Habitat loss and degradation is the major factor which can cause extinction of Sumatran rhinoceros in the Endau-Rompin region. Protection of a large area is important to minimize extinction rates (Terborgh 1974, Diamond 1975, 1976). To meet the goal of 50 rhinos, an area of 1,600 sq km should be protected and managed. Rhinoceroses in protected habitat might be able to breed and the surplus will repopulate the surrounding suitable areas.

Permanancy of land tenure is the key for long-term rhinoceros preservation. At the same time, man's intervention and manipulation is necessary for the survival of the endangered species.

1. Prevent habitat loss. Endau-Rompin should be declared a national park under the provisions of the 1980 National Park Act. The legislation is considered reasonably sound because the states cannot revoke the park status without approval from the Federal Ministry.

If enacting the park under the new law fails, the Federal should intervene by acquiring the entire region. Under the Article 84 of the Malaysia Constitution, the Federal is authorized to acquire state lands in the national interest. A compensation should be paid to the states based on the current market value of the land or

on economic potentials. The high-density rhinoceros habitat, about 400 sq km, should be top priority, followed by low-density areas and that already disturbed.

2. Resolve conflicts in land use. This is the precautionary step to be taken to insure protection of prime rhinoceros areas, especially the high-density habitat, while the State and Federal settle on their political rhetoric to declare the park.

Johore, Pahang, FELDA, Forestry Department, Department of Aboriginal People, and Department of Land and Mine will evaluate the existing and proposed activities and modify to avoid negative effects on the Sumatran rhinoceros. Some of the proposed activities are classified informations which /could not be made accessible to the public. The agencies should declassify proposed land use for the benefit of this plan and rhinoceros preservation. DWNP shall coordinate and cooperate with all agencies in their evaluation process and make necessary adjustments to protect rhinoceros habitat from conflicting land use.

All negative and positive impacts should be identified for existing and proposed activities. The FELDA Selanchar 7 and 8 schemes. around Pukin River, the Orang Asli Reservation at Ulu Tenang, and the Lesong Tree Farm on the northern border of the park shall be evaluated of their impacts on the Sumatran rhinoceros preservation.

Should the impact statements show adverse effect

on the Sumatran rhinoceros, DWNP must make recommendations to the agencies of withdrawing the existing and proposed land use in the Endau-Rompin region.

3. Expand park boundary. Explore the opportunity to expand the northern park boundary, in the Pahang section of the Lesong Tree Farm, to include most of the present rhinoceros range. About 500 sq km of the area will be logged in the next 30 years.

Assessment of potential rhinoceros habitat outside the proposed park boundary will be done by implementing the interim habitat evaluation procedure for the species (Appendix A). HEP can also be used to mitigate detrimental impacts of land development on known Sumatran rhinoceros habitat. DWNP should utilize HEP as a quantitative basis to gain and protect rhinoceros range.

4. Protection mandate and patrol system. Under section 64 of the 1972 Wildlife Protection Act (Anon 1972), it is illegal to kill, shoot, or take a totally protected wildlife. The Sumatran rhinoceros is listed in Schedule One of the totally protected wild animals. The offense for taking the species is a maximum fine of M$3,000 or imprisonment up to 2 years or both.

Section 81 makes it illegal to enter a sanctuary without a permit. The offense for illegal entry is a fine to a maximum of M$1,000 or imprisonment to a term of 6 months or both.

Under Section 8 of the National Park Act (Anon 1980), the DWNP is authorized to carry out its provisions and have directive and supervision responsibility on the park. In Section 11(J), it provides the Minister the authority to make regulations pertaining to wildlife in the park.

Flynn (1980) has meticulously described the setting of guard posts and a patrol system which would be part of the resource protection program at Endau-Rompin. The main purpose of the patrol system is to regulate entry and restrain encroachment and poaching. Guard posts are located at key access positions on the east, south and west of the park parameter (Fig. 2). At this time,the park management plan cannot be implemented because of lack of fund and the area is not officially gazetted as national park (Shahir Othman pers. comm.).

The enforcement specialist, assistants, and special grade rangers will enforce the existing law and regulation. The enforcement specialist shall plan, direct, and coordinate a patrol system. An assistant and special grade ranger shall be stationed at each guard post. The facility for enforcement staffs are;

a. Kepoh Command Post. This is the headquarters of the patrol system. The post should have an office, garage, storage, and staff housings.

b. Guard Posts. Located at Ulu Pukin, Kampung Selai, and Kuala Jasin. The post building should have a minimum of 2 sleeping rooms, an office, toilet,

and garage. Two officers will be stationed at a time and will be rotated from one station to another.

Apart from doing their official work, law enforcement people are encouraged to get involved with Orang Asli and Malay community activities near the posts. They must strenghtened and improve relationships with community leaders, but not by using intimidation on them. By maintaining good relations, dissemination of information on rhinoceros preservation and DWNP regulations can be conveyed readily among villagers. Entry by Orang Asli into Endau-Rompin to collect food and forest produce can be easily regulated once they understand the conservation message. Trusted villagers can be recruited by DWNP as informants on poaching activities around the park. Informants can receive rewards and yet their identities can be protected under the Wildlife Act.

5. Habitat enhancement. In mature tropical forests, some plants cannot produce potential food resources because they are poor competitors or are suppressed beneath the main canopy. In other cases, changes in plant communities that effect wildlife result from removal of vegetation and establishing a succession different from the mature forest. The removal and alteration of vegetation affects rhinoceros through loss of potential browse species and canopy cover. Silvicultural treatments can modify the closed canopy by creating gaps for rhinoceros feeding site or enhance

disturbed habitat to produce food resources.

Since the Sumatran rhinoceros is sensitive to drastic physical changes and disturbance, habitat manipulation must, therefore, emphasize minimum perturbation and gradual changes while providing the quantity and quality of food. Release by thinning can open up forest canopy, creating conditions for optimum growth immediately around each selected tree (Proud and Hutchinson 1980). On the other hand, planting trees bearing fleshy fruits can encourage use of disturbed habitat and supplement rhinoceros diet with high nutrients and energy food resources.

The procedure for thinning is modified from Proud and Hutchinson (1980).

a. Make a complete inventory of the vegetation in Endau-Rompin. Identify and mark trees that produce fleshy fruits consumed by rhinos. The trees must have well-formed trunks and good crown, 10 cm dbh or more.

b. Poison-girdling all trees selected against which are overtop a selected fruit tree.

c. Poison-girdling trees which in future will compete with selected fruit trees.

d. The liberation of 23 trees (10 to 60 cm dbh) per ha requires poison-girdling of 69 trees and takes 3 man-day per ha.

e. The hazardous sodium arsenite commonly used by

Malaysian Forestry Department should be avoided. One of the 2, 4D and 2, 4, 5T group of hormones can be used instead. A 3% mixed solution in dieseline applied as bark spray is effective.

f. Trees will be ready to fall 2 to 4 years after poisoning. Falling trees in primary forest is part of the natural phenomenon and, therefore, will not disturb rhinos in the area. Collapsed trees will also create small forest gaps which are preferred rhino browsing sites.

g. This program should be on experimental area in the northern section of Zone 2, on the upper reaches of Kinchin River (Fig. 2). This is also a low-density rhinoceros area and thinning might increase utilization of the area by providing more browse.

In the disturbed forest, in Zone 3, production of fruits might induce rhinoceros to utilize its degraded habitat. The possibility of planting preferred browse, such as Prunus sp. , should be discussed with the Forestry Department. The department is currently doing research on plant phenology which include some of the important rhino browse species. Cooperative management and research will benefit both agencies and the rhinoceros in the long run.

The procedure for transplanting fruit trees in Zone 3 are as the following;

a. Mangifera sp. (wild mango) which can easily be found in Endau-Rompin will be used in this pilot project. Other species will be recommended later depending on their availability and consumption by rhinoceros.

b. Collect 5,000 fruits or sprouted seeds during fruiting season (March to September) and plant them in a nursery. The seedlings would be enough for transplanting an area of 250 ha. For the following year, the number of seedlings and area for planting should be increased.

c. A few week after complete germination, the seedlings should be transferred into potted polythene bags. Tentatively, allow the seedlings to grow 6 months or to the height of 1 m before transplanting. Select areas that are accessible by abandoned logging road for easy future maintenance when needed.

d. About 40 sq km of the area in Zone 3 that is disturbed will be transplanted. The estimated success rate of transplanting is 1 for every 10 trees planted (Dawkins 1959 as cited in Proud and Hutchinson 1980). If 20 trees to be planted per ha, then it would require 80,000 seedlings for rehabilitation on the disturbed habitat.

e. Since Mangifera sp. are large trees, they will take

more than 10 years to bear fruits. Monitoring the success of the transplanting will provide valuable information for management and costs for a larger scale transplanting program in the future.

Protect and manage population

Theoretically, in small population there is significant increase in genetic homozygozity as a result of inbreeding (Franklin 1980). Inbreeding depression can further lead to reduced fitness or low reproductive success. In populations in isolated habitat, this may result in lower genetic variation that would be detrimental to the population. This case in genetic variation can be prevented by occasional introduction of several rhinos from other populations.

There is an estimated 18 to 30 rhinoceros populations occuring in unprotected and isolated habitat throughout Malay Peninsula (Fig. 4). These populations are very small, ranging from 1 to 5 animals, and some without the prospects of survival due to future land development. This plan will take use those animals to increase the population at Endau-Rompin by translocation and captive breeding.

1. Capture and translocation. Trapping efforts by using corrals have not been successful (Flynn 1976, Sahir Othman pers. comm.). The general guidelines for this program are as follow;

Endau-Rompin. Site for release must be evaluated on its suitability and carrying capacity. HEP (refer Appendix A) is a way that can be used to get an index on the carrying capacity of an area. The technique should be revised and modified as new information is made available.

2. Captive breeding. A successful captive propagation program can enable the addition of a few individuals for release into the wild. Captive breeding of endangered wildlife could also fulfill 4 conservation functions (Conway 1980);

a. as a substitute for wildlife populations in basic research in population biology and sociobiology,
b. as a replacement for wild populations in development of care and management techniques,
c. as genetic reservoirs for infusions of new offsprings or new population, and
d. for species which have no opportunity to survive in natural habitat.

The critically low population at Endau-Rompin justify the need for captive propagation while serving the conservation functions. Some general guidelines on the site and facility of captive breeding are as following;

a. Establish a breeding nucleus of 7 pairs of rhinoceroses in a large enclosed habitat at

Sungai Jasin, in Zone 3 (Fig. 2). An area of 1,400 ha will be fenced and compartmentalized into 14 smaller portions for rotational use. This can result in better utilization of available browse with less danger of depleting food resources and cover. After about 6 months of use, the divisional fence will be opened. The animals should be allowed to move into new compartmets by their own instinct. The used area should be revegetated by transplanting browse species (seedlings and seeds). Supplemental feeding reinforced with mineral nutrients and vitamin in the form of concentrated food, commonly used in zoos, should be provided at artificial shelters.

b. Minimum fencing requirement follows recommendation for American bison (Bison bison) (National Buffalo Association 1985). It consist of 1.8 m, #9 gauge woven wire, supported by heavy duty posts spaced 5 m apart. Smaller pens and corrals within the compartment are important to restrain animals during examination, handling, and separating breeding pair. The pens should be made of planks or poles. Such fences obscure the view of activities outside the corral and reduce disturbances within. Planks make it easy for workers to climb when they seek escape from excited animals.

c. Barbed wire and concrete should not be used in the rhinoceros fence or artificial shelter. The barbs and concrete can cause injury to animals which could lead to infection.

d. The natural banks or steep slopes near the stream bottoms around Sungai Jasin tributaries should provide good wallowing sites. Piping free flowing water should be an alternative during dry season or if the compartment does not have a natural stream.

e. Although pairing up the animals violates the natural selection process by our selecting of particular phenotypes and mating, it would control inbreeding. Mating pairs should be exchanged to avoid sibling-sibling or parents-siblings mating. After successful breeding, mating pairs can be increased and the surplus be radio tagged and released without further delay.

f. Investigators should take the opportunity to study the behavior, physiology, nutrition, genetics, and calf development. Clinical techniques and artificial insemination methods should be developed.

<u>People management</u>

Changing the attitude, behavior, or lifestyle for

better perception on the need for the preservation of the Sumatran rhinoceros will be a great achievement in people management. Wildlife preservation goals will not be realized as long as major decisions on funding and legislation are determined by people who view conservation as antithesis to development. Therefore, it is the responsibility for wildlife biologists and conservators to educate the legislative bodies, planners, and public at large on the basic concept of biological conservation and species preservation. At the same time, rhinoceros biologists and conservators must maintain their technical and professional skills through academic endeavor and scientific assembly.

1. Develop conservation guidelines. Develop guidelines and manuals for conservation education of Sumatran rhinoceros for various target groups. Make exhibits, presentations, talks, slide shows, seminars, meetings, and conduct tours on the research and breeding facilities to maintain awareness on rhinoceros conservation.

The audience should include;

a. legislative body,
b. planners,
c. teachers and pupils,
d. concerned public and citizens,
e. government officials (Ministry, Treasury Department, Public Service Commission, and Public Service Department),

f. community leaders, and

g. television, radio, and news media.

Result of conservation education should be evaluated and from time to time monitor education needs.

2. Endangered Species Act and Policy. If the legislature and the public are receptive on the idea of conservation of wildlife, the next step is to provide better protection and management of endangered species.

a. Explore the possibility to introduce an Endangered Wildlife Act that will explicitly specify the needs, procedures, and financing for the recovery of the species in its natural habitat. Such legislation should follow the guidelines in the American Endangered Species Act of 1973 (Committee on Merchant Marine and Fisheries 1977).

b. Introduce a departmental policy on the conservation of endangered species. The proposed Sumatran rhinoceros conservation policy (Appendix C) could be implemented along with this plan.

3. Aids and donations. Explore the opportunity to solicit aids (financial or technical) and donations for research, management, and conservation education. Some of the bureaucratic red tape should be abolished to allow flexibility in control of funds donated to DWNP.

4. Personnel training. There should be a long-term commitment by DWNP and Public Service Department, as

sponsoring agencies, to train a team of specialists and professional biologists to implement the plan.

5. Coordination of research and management. DWNP shall coordinate all research and management efforts on the Sumatran rhinoceros by local and foreign institutions. At this time there are American and British groups interested in rhinoceros conservation in Malaysia. The Asian Rhinoceros Survival Service Commission of the IUCN should be able to provide additional funding to DWNP and interested groups in their conservation efforts.

Periodically, there should be scientific assembly on the state-of-the-art of the Sumatran rhinoceros research and management.

Facility and research development

Research facilities should be built to study the habitat, population, and captive propagation.

1. Habitat Research Center. The facility should be constructed outside the western boundary of the strict natural area at Kepoh. The center will consist of an office building with a lab, library, herbarium, conference room, garage, and workshop. A center director/leader will plan, direct, and provide professional supervision on all research and management. Several biologists, specialists, forester, and investigators will be assigned

with specific tasks to be accomplished during the implementation of this plan. Visiting scientists should be encouraged to fill positions or serve as counterparts to local biologists during the initial phase of the implementation. From time to time, scientists from other institutions shall be invited to participate in the research and management programs. The staffs and visiting scientists will be provided with adequate housing.

2. Captive Breeding Center. The facility should be constructed in the managed natural area at Jasin River. The center will consist of an office plus a laboratory, clinic, library, conference room, garage, and workshop. The center will also provide interpretive opportunities for a limited number of visitors interested in rhinoceros conservation. Housing for staff and visiting scientists will be provided.

An area about 1,400 ha will be fenced for a breeding nucleus of 7 pairs of rhinoceroses.

3. Research development. The glaring weaknesses at the DWNP are the lack of skilled research biologists and the underfunding of management and research-related programs. The Federal Government policy of rejecting technical and financial assistance from outside agencies is, in the long run, counterproductive for rhinoceros preservation. By accepting external technical and financial assistance, the Federal Government may reduce

its burden regarding funding, facilities, and scientific and managerial positions. At the same time, outside biologists could provide research expertise and new ideas for local scientists to emulate.

The DWNP should secure the service of competent biologists sponsored by the International Union for the Conservation of Nature/Asian Rhino Survival Service Commission. They could be used to alleviate a shortage of appropriately trained scientists and to enhance the professional development and competencies of local scientists.

The protection, enhancement, and management of the Sumatran rhinoceros will be based on factual field information obtained through professionally conducted research. A research development plan outlining the current state of knowledge is to be prepared. Formal research proposals should be submitted to Research Center Directors for approval. A proposal shall consist of a title, literature review, goal and objectives, methodology, statistical procedure, schedule of operation, and budget.

Design and initiate data gathering on the following subjects:

Habitat

a. Map and describe the plant communities within the park and other areas suitable for rhino.

b. Identify the attributes of rhino habitat.

c. Determine the availability and quality of suitable habitat.

d. Survey the general location and distribution of food resources and large mammals.

e. Evaluate the sites suitable for the translocation of rhinos.

f. Monitor the habitat loss or gain.

g. Study the phenology of browse species and canopy cover.

i. Monitor the regeneration, succession, and utilization of disturbed habitat.

Population

a. Home range and movement pattern.

b. Population dynamics (reproduction, survival, and growth rates).

c. Determine the minimum viable population and area requirement for recovery.

d. Inter/intra-specific competition.

e. Effects of land use activities around the park on rhino population and habitat quality.

f. Impact of Orang Asli activities.

g. Monitor captive bred rhinos released in Endau-Rompin.

h. Develop new techniques which are effective and efficient to survey population and habitat parameters in order

PART III : IMPLEMENTATION AND SCHEDULE

Priorities for Implementation

Priority 1 : Actions absolutely necessary to prevent extinction of the Sumatran rhinoceros.

Priority 2 : Actions necessary to maintain the current population status.

Priority 3 : Other actions necessary to provide full recovery/restoration of the species.

Task categories

H : Habitat objectives.

R : Rhinoceros population objectives.

P : People objectives.

M : Management task.

I : Information gathering and research task.

Summary of Conservation Objectives and Tasks

This section summerizes the proposed management and research recommendations. For implementation, the management and research tasks are prioritized and given the years of practice to accomplish the goal (Table 1).

Professionals are then assigned specific tasks to be accomplished within the 10-year term (Tables 2 - 5). Some of the tasks overlapped to meet the goal and objectives.

1. Habitat objectives

Tasks

1.1 Identify essential rhinoceros habitat.

1.11 Assess the attributes of suitable habitat used by rhinos.

1.12 Assess unoccuppied habitat which appears suitable.

1.13 Develop habitat evaluation procedure.

1.2 Protect and manage habitat.

1.21 Prevent habitat loss and resolve conflict.

1.22 Enforce existing law and regulation.

1.23 Device a patrol system.

1.24 Silvicultural treatment.

1.25 Restoration of disturbed habitat.

1.26 Inventory.

2. Population objectives

Tasks

2.1 Determine current number, distribution, and population dynamics.

2.11 Annual survey

2.12 Radio tag rhinos.

2.13 Develop indirect methods to identify individuals.

2.14 Determine home ranges.

2.15 Determine effects of human disturbances on rhino population.

2.2 Protect and manage population.

2.21 Enforce existing law and regulation.

2.22 Translocate rhinos in unprotected areas into Endau-Rompin.

2.3 Acquire necessary information for captive breeding.

2.31 Establish breeding population in captivity.

2.32 Develop handling, care, and clinical techniques on rhinos in captivity.

2.33 Study the behavior, physiology, nutrition, and genetics of captive rhinos.

2.34 Develop artificial insemination, storage, and handling methods of rhino germ plasm (sperm and ova).

2.35 Explore the possibility of artificial fertilization and use of surrogate cow.

2.4 Determine the population and habitat for recovery.

2.41 Determine what constitute a viable population.

2.42 Determine population structure and dynamics.

2.43 Determine the number, distribution pattern, and home range of breeding and nonbreeding rhinos.

2.44 Determine carrying capacity and effective population.

2.45 Determine the availability and quality of suitable habitat.

2.46 Determine the amount, distribution, and quality of suitable habitat of breeding and nonbreeding population.

3. People objective

Tasks

3.1 Establish and implement coordinating system and effective communication.

3.2 Develop and conduct education programs designed to enhance understanding, protection, and conservation of rhinos.

3.3 Conduct seminar and technical workshop.

3.4 In-service training for rhino team.

3.5 Establish funds for research, management, and conservation education.

Table 1. Conservation plan implementation schedule

Table 2. Staff summary of Habitat Research Center, Kepoh.

HABITAT RESEARCH CENTER, KEPOH

STAFF SUMMARY

Position Title	No. of	Job description	Qualifcn.	Salary scheme	Approx. annual salary + allowance
Center Leader	1	1. Implement habitat objectives. 2. Responsible for day-to-day administration, finance, and personnel. 3. Involve in planning for research and management. 4. Review, approve, or reject site-specific plan/ proposal. 5. Coordinate research and management effort. 6. Provide professional and technical supervision. 7. Prepare annual report and fiscal year budget	PhD	A12	$30,000
Habitat biologist	1	1. Task under sections 1.1, 2.42 2. Experiment on habitat improvement techniques. 3. Monitor habitat use and quality.	M.S.	A19	$24,000
Research biologist	1	1. Task under section 2.1 2. Improve survey and estimation methods 3. Determine limiting factors for population growth. 4. Faunal inventory.	M.S.	A19	$24,000
Management specialist	1	1. Task under section 2.22 2. Monitor translocated rhinos. 3. Implement habitat improvement techniques.	M.S.	A19	$24,000
Forester	1	1. Task under sections 1.24, 1.25 2. Experiment on silvicultural methods to improve habitat quality. 3. Study the phenology of Endau-Rompin forest. 4. Forest inventory.	M.F.	A19	$24,000
Research assistant	2	1. Assist investigators.	Diploma	B09	$18,000

HABITAT RESEARCH CENTER, KEPOH

STAFF SUMMARY

Position Title	No. of	Job description	Qualifcn.	Salary scheme	Approx. annual salary + allowance
Secretary	1	1. Filing, typing, and personnel records. 2. Purchase order, invoice, and maintain books	Diploma	B09	$12,000
Handyman	1	1. Basic maintenance of physical facility and vehicle.	Vocational certificate	D35	$ 7,200

Table 3. Staff summary of Captive Breeding Center, Sungai Jasin.

CAPTIVE BREEDING CENTER, JASIN

STAFF SUMMARY

Position Title	No of	Job description	Qualifcn.	Salary scheme	Approx. annual salary + allowance
Center Leader	1	1. Implement population objectives. 2. Responsible for day-to-day administration, finance, personnel. 3. Involve in planning for research and management 4. Review, approve, or reject site-specific plan/ proposal. 5. Coordinate research and management effort. 6. Provide professional and technical supervision. 7. Prepare annual and fiscal year budget.	PhD	A12	$30,000
Research veterinarian	1	1. Task 2.3 2. Keep clinical records. 3. Develop urinary oestrogen analysis to detect pregnancy in rhinoceros.	D.V.M.	A19	$24,000
Animal nutritionist	1	1. Task 2.33 2. Devise rhinoceros menu. 3. Keep nutrition records. 4. Study on nutrition and calf development.	M.S.	A19	$24,000
Research biologist	1	1. Task 2.33 2. Monitor behavior of captive bred rhinos released in Endau-Rompin.	M.S.	A19	$24,000
Quantitative ecology specialist	1	1. Task 2.41 2. Maintain and update data base (computer) for both centers. 3. Analysis of complex ecological/biological data. 4. Collaborate with investigators on design of experiment and statistical analysis. 5. Prepare statistics for annual report.	M.S.	A19	$24,000

CAPTIVE BREEDING CENTER, JASIN

STAFF SUMMARY

Position Title	No. of	Job description	Qualifcn.	Salary scheme	Approx annual salary + allowance
Research assistant	2	1. Assist investigators.	Diploma	B09	$18,000
Secretary	1	1. Filing, typing, and personnel records 2. Purchase order, invoice, and maintain books.	Diploma	B09	$12,000
Handyman	1	1. Basic maintenance of physical facility and vehicle.	Vocational certificate	D35	$ 7,200

Table 4. Staff summary of law enforcement and patrol system

LAW ENFORCEMENT AND PATROL SYSTEM

STAFF SUMMARY

Position Title	No. of	Job description	Qualifcn.	Salary scheme	Approx. annual salary + allowance
Enforcement specialist	1	1. Tasks 1.22, 1.23, 2.21 2. Plan and coordinate patrol and enforcement. 3. Investigate on poaching and encroachment. 4. Prosecuting in court. 5. Involve in community activities. 6. Prepare annual report and fiscal year budget.	B.S./M.S.	A19	$24,000
Enforcement assistant	4	1. Tasks 1.22 and 2.21 2. Keep record of entry by Orang Asli and permittee.	Diploma	B09	$18,000
Special Grade Ranger	4	1. Assist in enforcement.	Lower cert. of educn.	D46	$ 9,600

Table 5. Staff summary of conservation education and communication.

CONSERVATION EDUCATION AND COMMUNICATION

STAFF SUMMARY

Position Title	No. of	Job description	Qualifcn.	Salary scheme	Approx. annual salary + allowance
Special project coordinator	1	1. Implement people objectives. 2. Bring together all agencies and public for meeting, seminar, and workshop. 3. Coordinate research and furd with agencies and universities. 4. Liaison between agencies and public. 5. Academic advisory for in-service trainee and student.	M.S.	A19	$24,000
Conservation education specialist	1	1. Task 3.2 2. Use information, publication, and audio-visual to educate legislative body, planner, teacher and pupil, government official, community leader, and news media.	B.S./M.S.	A19	$24,000

A 10-year Budget Estimation

Note : 1. All estimations are in Malaysian ringgit (US$ 1 = M$ 2.60).

2. Housing classification and costs are based on estimation by Malaysian Public Work Department.

Habitat Research Center, Kepoh

1. Salary and fee

Leader, biologists, and support staffs	1,812,000
Consultation fee	10,000

2. Office and housing

Office with lab, herbarium, library, conference room, garage, and workshop 90 x 40 ft	380,000
10% site preparation	38,000
15% access road	57,000
20% fixture and equipment	76,000
1 Class C house; 2,640 sq ft	90,000
4 Class D house; 1,946 sq ft each	240,000
3 Class E houses; 1,634 sq ft each ...	150,000
2 Class H houses; 2 rooms each	50,000

3. Vehicle

Pick-up truck @ $25,000 x 4	100,000
Fuel and maintenance Yr 1-Yr 5 x 2	24,000

4. Research materials

Field equipment, lab material, and publication	200,000
Subtotal	3,227,000

Captive Research Center, Jasin

1. Salary and fee

Leader, biologists, and support staffs	1,812,000
Consultation fee	10,000

2. Office and housing

Office with lab, clinic, library, conference room, garage, workshop, captive breeding facility, and interpretive center	500,000
10% site preparation	50,000
15% access road	75,000
20% fixture and equipment	100,000
1 Class C house; 2,640 sq ft	90,000
4 Class D houses; 1,946 sq ft each...	240,000
3 Class E houses; 1,634 sq ft each ..	150,000
2 Class H houses; 2 rooms each	50,000

3. Vehicle	
Pick-up truck @ $25,000 x 4	100,000
Fuel and maintenance Yr 1-Yr 5 x 2 ...	24,000
4. Research material	
Field equipment, lab and clinic material, and publication	200,000
Subtotal	3,401,000
Law enforcement, communication, and conservation education	
1. Salary and allowance	1,124,000
2. Post and housing	
4 Guard Posts; 2 rooms each	100,000
1 Command Post	30,000
3 Class D houses; 1,946 sq ft each ..	180,000
4 Class E houses; 1,634 sq ft each ..	200,000
4 Class H houses; 2 rooms each	100,000
3. Vehicle	
Pick-up truck @ $25,000 x 4	100,000
Fuel and maintenance	40,000
4. Materials	
Equipment and publication	50,000
Subtotal	1,924,000
Running subtotal	8,552,000
+ 5% contingency	427,600
Grand total	8,979,600

3. Work Progress. Center Directors should prepare an annual report to be submitted to the DWNP Headquarters. The report should consist of summary of projects under the director's supervision.

4. Interim Status Report. A detailed project appraisal from both centers should be submitted to DWNP during the month of June of the 2nd, 5th, and 8th year during the 10-year period. Research and management results should be outlined by biologists involved in the projects.

5. Publication. Center Directors should encourage biologists to publish their findings in the journals having world-wide distribution, such as the Malayan Nature Journal, Ecology, Journal of Wildlife Management, Journal of Mammalogy, Biological Conservation etc.

6. Project Report. After the end of the 10-year period, Center Directors should prepare a final report on the findings and accomplishments of the Sumatran rhinoceros conservation program at Endau-Rompin. Recommendations should be made to facilitate the Second 10-Year Plan with nationwide Sumatran rhinoceros rehabilitation objective.

Major Agencies Involved

DWNP	sponsor and implementing the plan.
Ministry	co-sponsor of the plan.
Treasury Department ..	approval of the fiscal year budget for the plan.
Public Service Commission	recruitment of biologists and staffs.
Public Service Department	oversee Federal employee's service and benefit.
Public Work Department	examine bidding in a project tender, approve a contractor, and supervise construction of physical facility.

Sequence of Implementation

1. Adoption of the conservation plan by DWNP.
2. Design the facilities and detailed project costs submitted to Ministry for a joint fiscal year budget meeting with the Treasury Department.
3. Budget approval.
4. Recruitment of biologists and staffs and construction of facilities.
5. Implementation of management and research recommendations.

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Figure 1. The geography of Endau-Rompin region.

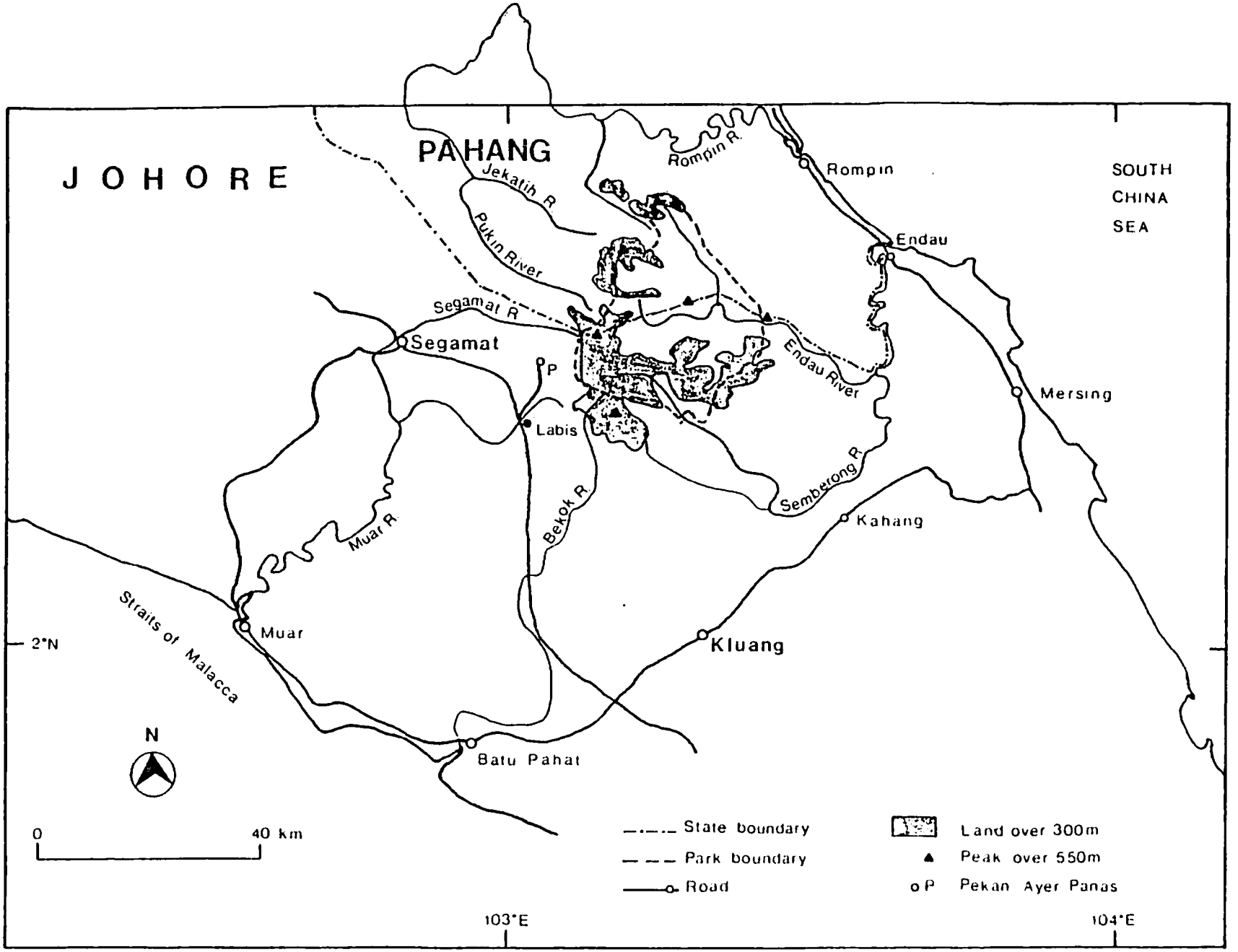

JOHORE
PAHANG
Jekatih R.
Pukin River
Segamat R.
Segamat
P
Labis
Muar R.
Bekok R.
Rompin R.
Rompin
Endau
Endau River
Sembrong R.
Mersing
Kahang
Kluang
Muar
Straits of Malacca
Batu Pahat
SOUTH CHINA SEA
2°N
N
0
40 km
State boundary
Park boundary
Road
Land over 300m
Peak over 550m
P Pekan Ayer Panas
103°E
104°E

Figure 2. The proposed Endau-Rompin National Park management zones and guard posts.
(Source : Flynn 1980)

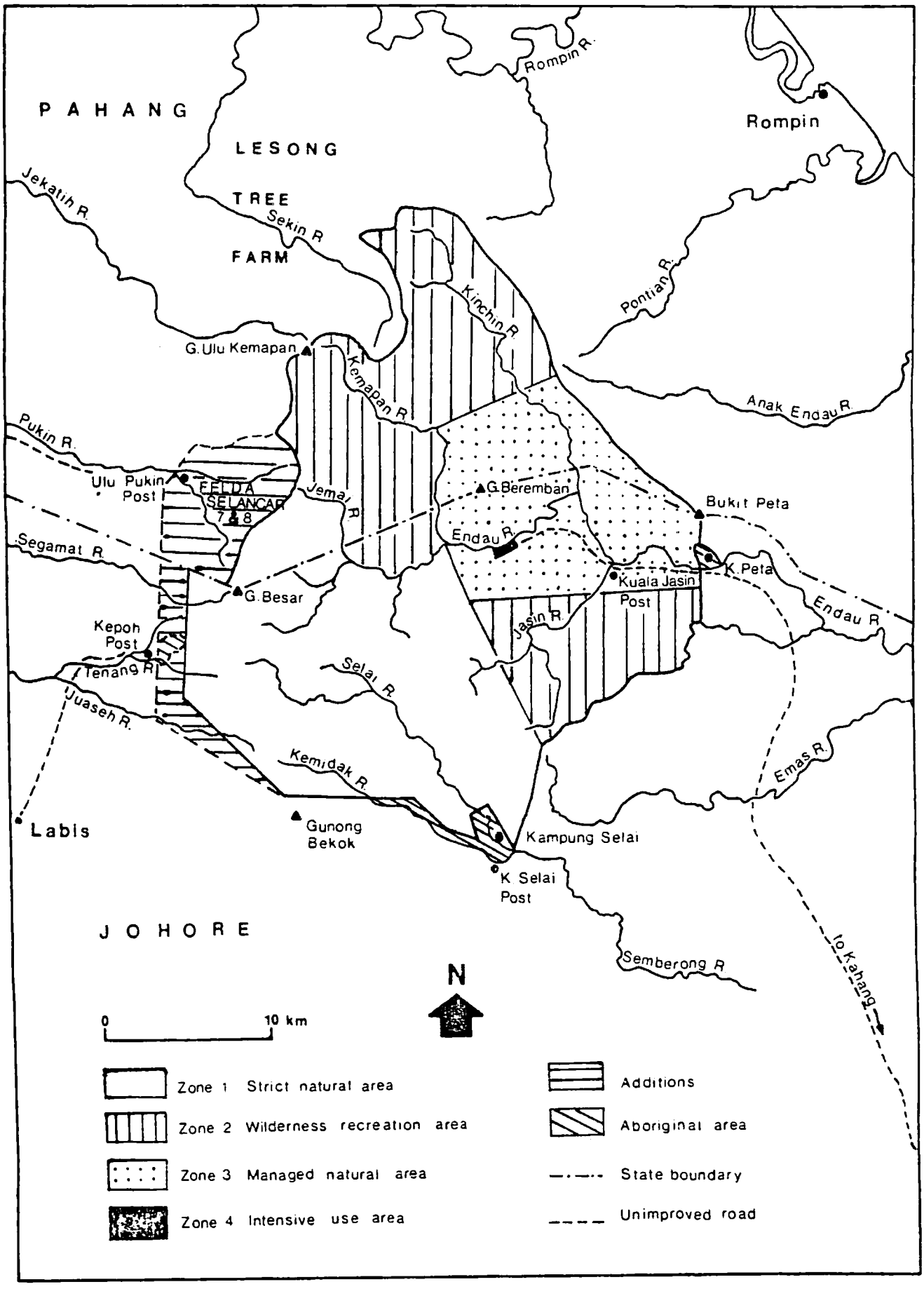

PAHANG
LESONG
TREE
FARM
Rompin R.
Rompin
Jekatih R.
Sekin R.
Kinchin R.
Pontian R.
G. Ulu Kemapan
Kemapan R.
Anak Endau R.
Pukin R.
Ulu Pukin Post
FELDA SELANCAR 7 & 8
Jemal R.
G. Beremban
Bukit Peta
Endau R.
Segamat R.
K. Peta
Kuala Jasin Post
G. Besar
Jasin R.
Endau R.
Kepoh Post
Tenang R.
Selai R.
Juaseh R.
Kemidak R.
Emas R.
Labis
Gunong Bekok
Kampung Selai
K Selai Post
JOHORE
Semberong R.
To Kahang
N
0
10 km
Zone 1 Strict natural area
Zone 2 Wilderness recreation area
Zone 3 Managed natural area
Zone 4 Intensive use area
Additions
Aboriginal area
State boundary
Unimproved road

Figure 3. Distribution of Sumatran rhinoceros in Endau-Rompin region

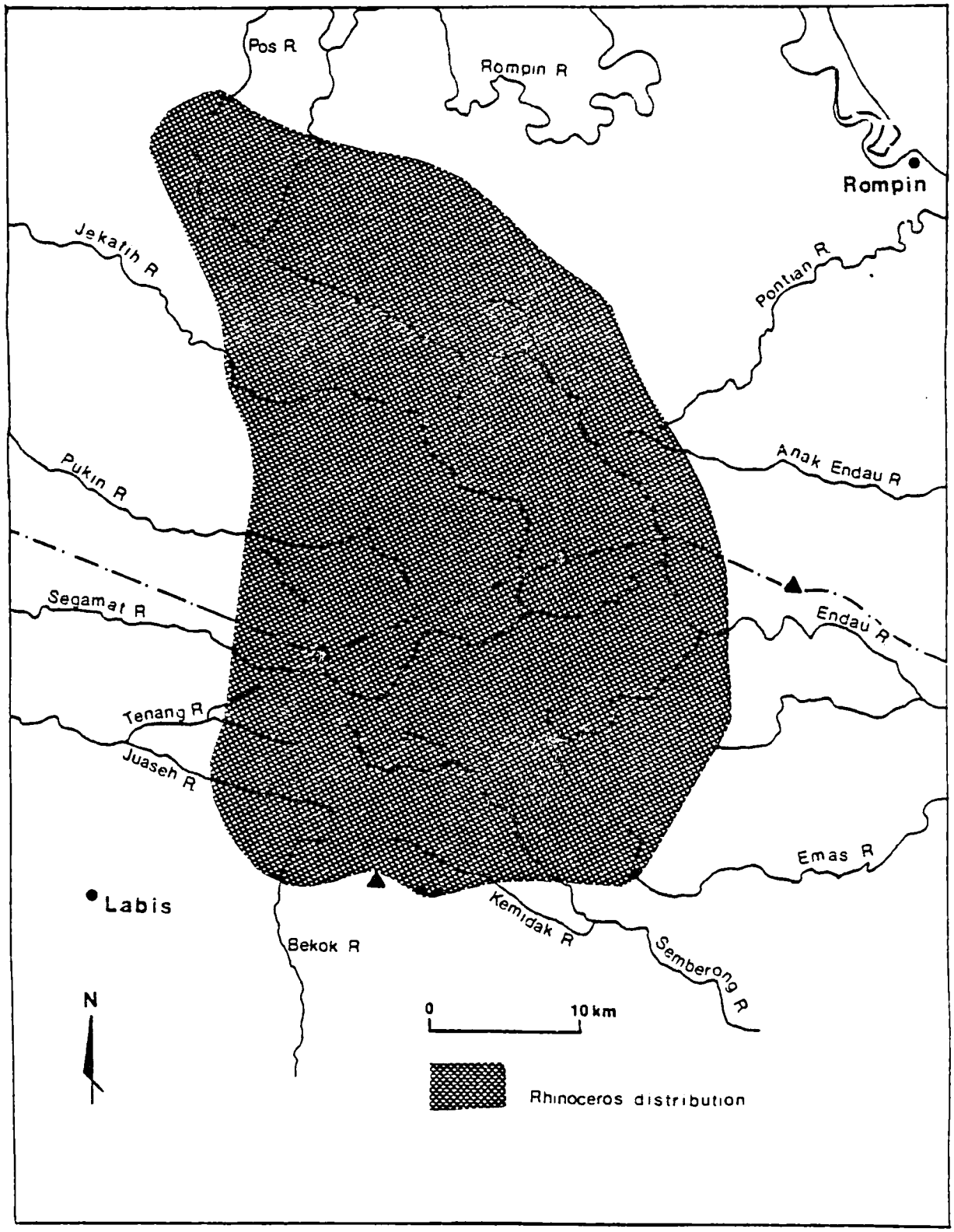
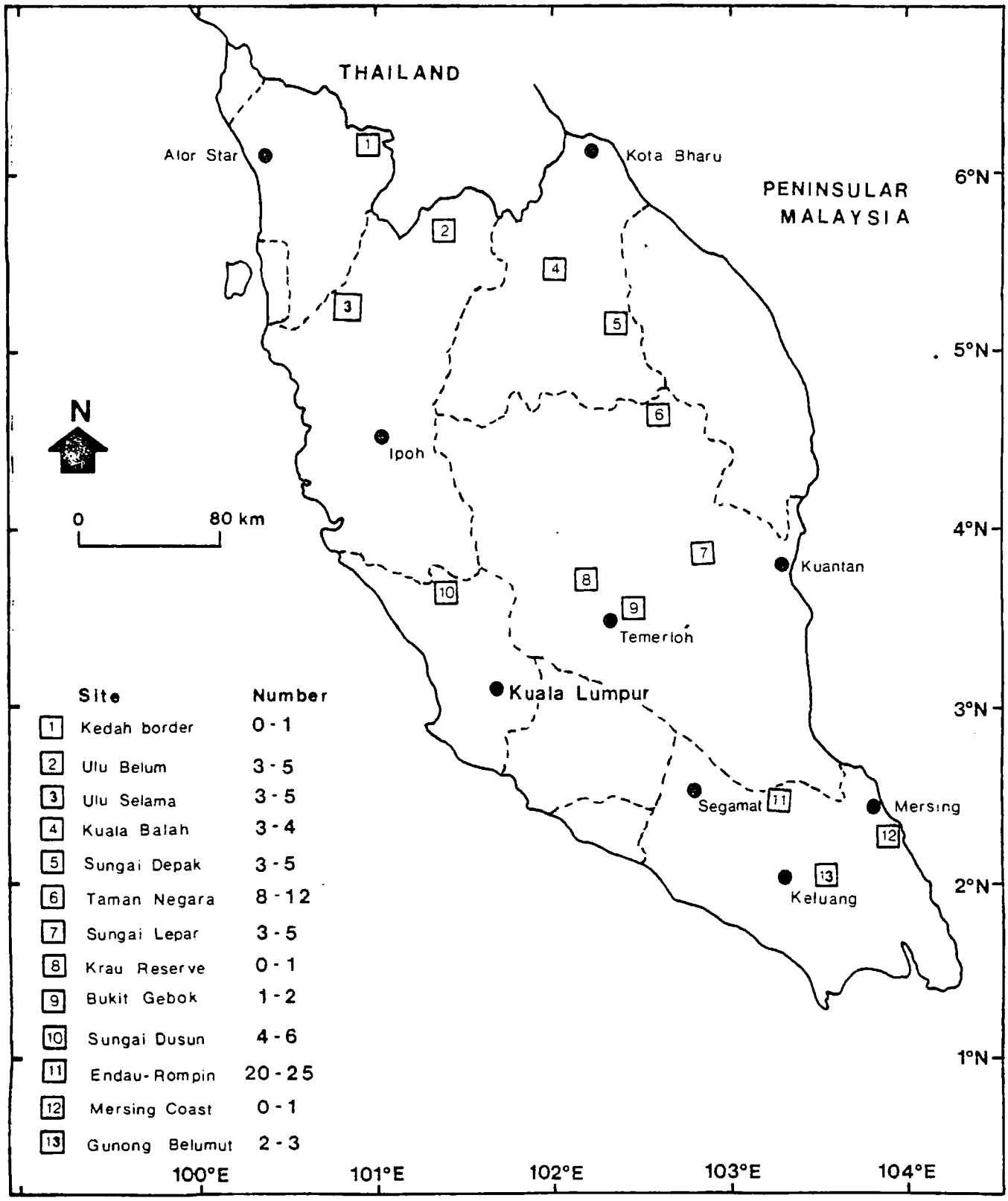

Pos R
Rompin R
Rompin
Jekatih R
Pontian R
Pukin R
Anak Endau R
Segamat R
Endau R
Tenang R
Juaseh R
Emas R
Labis
Bekok R
Kemidak R
Semberong R
N
0
10 km
Rhinoceros distribution

Figure 4. Distribution of the Sumatran rhinoceros throughout Peninsular Malaysia.


THAILAND
Alor Star
Kota Bharu
PENINSULAR
MALAYSIA
6°N
5°N
4°N
3°N
2°N
1°N
N
0
80 km
Ipoh
Kuantan
Temerloh
Kuala Lumpur
Segamat
Mersing
Keluang
100°E
101°E
102°E
103°E
104°E
Site
Number
1 Kedah border 0 - 1
2 Ulu Belum 3 - 5
3 Ulu Selama 3 - 5
4 Kuala Balah 3 - 4
5 Sungai Depak 3 - 5
6 Taman Negara 8 - 12
7 Sungai Lepar 3 - 5
8 Krau Reserve 0 - 1
9 Bukit Gebok 1 - 2
10 Sungai Dusun 4 - 6
11 Endau-Rompin 20 - 25
12 Mersing Coast 0 - 1
13 Gunong Belumut 2 - 3

II. Preferred food diversity		II._____
A. 40 or more families	8-10	
B. 20-39 families	4-7	
C. 10-19 families	1-3	
III. Browse availability		III._____
A. 80-100% mature leaves	8-10	
B. 40-79% mature leaves	4-7	
C. 10-39% mature leaves	1-3	
IV. Vegetation cover (shrub and sapling, 0.4-6.0 cm dbh)		IV._____
A. 80-100%	8-10	
B. 40-79%	4-7	
C. 10-39%	1-3	
V. Small forest gaps (0.1 ha)		V._____
A. many (15 or more)	5	
B. some (7-14)	3-4	
C. few (1-6)	1-2	
VI. Physiography types		VI._____
A. Stream bottom	5	
B. Lower slope	3-4	
C. Ridge/upper slope	1-2	
VII. Diversity of fleshy fruit species		VII._____
A. many (8 or more)	5	
B. some (4-7)	3-4	
C. few (1-3)	1-2	

(1) Total scores I-IV .....(1)_____

(2) Number of CHARACTERISTICS used in (1) .....(2)_____

(3) (1) ÷ (2) .....(3)_____

(4) Total scores V-VII .....(4)_____

(5) Number of CHARACTERISTICS used in (4) .....(5)_____

(6) (4) ÷ (5) .....(6)_____

(7) (3) + (6) .....(7)_____

(8) (7) x 2 ÷ 3 .....(8)_____

Habitat unit value

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APPENDIX B : Minimum Viable Population and Area requirement

Protection is sometimes termed as passive management technique that allow wildlife to take care by itself (Ferrar 1983). Protection measures instituted on the Sumatran rhinoceros population at the Sungai Dusun Wildlife Reserve has proven uneffective to increase the numbers of the species since 1964. Some kinds of manipulation to increase reproduction or its numbers are necessary in a small population. Captive breeding and translocation program can save endangered species from the brim of extinction (Conway 1980). However, having a few more captive bred individuals and release them into the wild could not guarentee that the species could escape extinction. Rhinoceros biologists must find solutions and define minimum viable population and area requirement for continuing preservation of the species.

In small island habitat where migration is restricted, extinction rate is higher (Diamond 1975). Inbreeding will usually occur which will increase genetic homozygozity and favors recessive genes (Franklin 1980). The long-term effect of such inbreeding depression will result in lower genetic diversity. However, introduction of wild species into an inbred population can help to reduce the level of inbreeding (Franklin 1980).

Soule (1980) proposed that for short-term management is to have 50 or more breeding adults, which correspond to 1% of the maximum allowable rate of inbreeding. Tentatively, Franklin (1980) proposed that in long-term management, a minimum size of 500 individuals are necessary to maintain genetic variability over many generations in future. For population in captivity, 50 to 100 adults could maintain the genetic variability over 100 generations (Conway 1980).

The present population, 20 to 25 rhinos, at Endau-Rompin is far below the levels recommended to maintain genetic variability in short- and long-terms. Even if all the isolated populations, estimated between 18 to 30 rhinos, are translocated into Endau-Rompin, there will be genetic loss in the long-term. A combination of translocation and captive breeding might be able to alleviate some of the problems at Endau-Rompin. Mean while, monitoring of the wild and captive rhinoceroses is important to define a viable population.

For the purpose of this plan, it is necessary to explain the rationale to manage about 50 individuals and the needs to increase the ecological boundary of the protected habitat at Endau-Rompin. The crude density of Sumatran rhinoceros at Endau-Rompin region is 1 animal per 40 sq km

(Flynn 1983). Let assume that there is little overlap in the ranging behavior within the homogenous habitat. Therefore, by crude estimation, to manage about 400 to 500 rhinos would require an area of more than 16,000 sq km. Thus Endau-Rompin is about 10 times smaller for long-term management. By the same criteria, the 1,600 sq km of the known suitable habitat in the region might be able to support between 40 to 50 rhinos in a short-term. However, a significant increase of the population within the proposed 870 sq km park, and assuming development has claimed the surrounding suitable habitat, may result in habitat deterioration, stress, and population crash. Eventually, the endangered Sumatran rhinoceros might be extinct within the refuge that we establish to protect them.

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APPENDIX C : Interim Sumatran Rhinoceros Conservation Policy

A conservation plan must work along the lines of sound goals, objectives, and policies. A Sumatran rhinoceros conservation policy will be the guiding principles designed to determine decisions and actions or help to find solutions on related problems for the benefit of the preservation of the species. A policy usually provides direction and guidance while functioning as a basis for relationships with other governmental agencies, wildlife enthusiasts, and private organizations (Crowe 1984).

The ideas and concepts of this policy are adopted and modified from the progressive American Game Policy (Leopold 1930), American Wildlife Policy (Allen 1977), Land and Water Conservation Fund Act (CMMF 1977), Endangered Species Act of 1973 (CMMF 1977), National Enviromental Policy Act of 1969 (CMMF 1977), Stevens (1968), Flynn (1980), Cano (1975), and Anon (1978).

Declaration of policy

1. The proposed Endau-Rompin National Park provides the unique habitat for the endangered Sumatran rhinoceros. The parkland is the largest ecosystem in the southern region of Peninsular Malaysia, and it is of major value for protection, conservation, and management of the species for ecological, historical, educational, esthetic, interpretive, and scientific value for the nation and its people.

2. All governmental agencies, public, scientists, naturalists, and protectionists share the responsibility and must be in productive relationship with one another to preserve the Sumatran rhinoceros in its natural habitat in accordance with this policy, the 1972 Wildlife Protection Act, National Park Act of 1980, or any other regulations.

3. Insure that all development in, near, or adjacent to the park and the animal's critical habitat do not jeopardize the continuing survival of the species, and neither any forms of habitat modification that produce significant adverse effect on the rhinos.

4. Train a team of local leaders, biologists, specialists, investigators, and administrators to carry out essential tasks, and create competative jobs and salaries for the ablest men.

5. Recognize that research is an integral part in the conservation and management of Sumatran rhinoceros.

6. Create a stable and dependable source of fund for research, management, habitat acquisition, conservation education, and administration.

7. Recognize that public relations and conservation education have direct influence on behavior, attitude, perception, and belief of the people.

8. Recognize that regional cooperative program as a way to enhance our knowledge, research, and management of Sumatran rhinoceros in the wild and captivity.

9. There is an urgent need for corrective legislation to resolve regulatory, management, and administrative problems of endangered species.

Sumatran rhinoceros policy implementation and program

1. Mandate and protection. The proposed Endau-Rompin National Park shall be declared and gazetted under the provisions of the 1980 National Park Act (Anon 1980). To emphasize the significance of the rare species in the area, it can be named as the Endau-Rompin National Rhinoceros Park.

The park management plan (Flynn 1980) shall be the main guiding document for resource development. The Sumatran rhinoceros conservation plan shall be the document for the preservation of the endangered species.

The land which is designated as the strict natural area (Zone 1) shall never be revoked, alienated, mined, logged, or used in any manner which can be detrimental for the perpetual survival of the Sumatran rhinoceros. Only scientific study and restrictive management that promote the production of quality habitat and increase the number of rhinos are allowed in the strict natural area.

All other known suitable habitats in Endau-Rompin region shall be added to the parkland. Whenever there is a significant change in ranging behavior or marked expansion of its ecological range of Sumatran rhinoceros into adjacent

area, the habitat shall be acquired and protected.

2. Coordination and relationship. Although the existing Federal laws give absolute law enforcement and regulatory authority to DWNP, little can be achieved for preservation without the cooperation and coordination among all agencies and public. They should do in all their powers, including financial and technical measures, to protect, create, or maintain the habitat which the rhinos could perpetually exist.

A Rhinoceros Conservation Council (RCC) shall be formed to bring all parties into productive relationship and to achieve uniformity in all matters involving habitat protection and acquisition. RCC should realize that species preservation shall take precedence over political clout and short-term economy gain. RCC shall find ways to reduce red tape controls by Federal and State governments in order to facilitate implementation of the conservation plan and policy. A representative from states of Johore and Pahang, Economic Planning Unit of the Prime Minister's Department, Ministry of Science, Technology, and Environment, DWNP, Department of Forestry, Department of Aboriginal People, Department of Land and Mine, and 4 eminent citizens or concerned public shall sit in RCC. They should review all existing and proposed land use in Endau-Rompin region so as to avoid adverse effects on the Sumatran rhinoceros. For any of the proposed projects, DWNP shall provide competent biologists to serve on the planning boards of the agencies along

with their engineers, economists, and lawyers. The biologists shall make impact statement which will be submitted to the Federal and State governments, RCC, and the planning boards. The report shall outline the proposed action, adverse effects if the proposal were to be implemented, and alternatives to the proposed action. After a period of review by all agencies and public, RCC shall make a final recommendation to the State and Federal on whether the project is in harmony with rhinoceros conservation objectives.

3. Staff training and education. Staff training is important to compensate for gaps or lack of knowledge on wildlife ecology and management or specialized subjects in the conventional curriculum of local universities. Sometimes new technology and scientific findins can render a wildlifer's training obselete within several years. There should be long-term commitment by DWNP to education for the workplace and to prevent major illiteracy on principles of wildlife ecology and management.

This program will provide trained leaders and professionals in rhinoceros research, management, and administration. The long-term aim is to train professionals at advanced (master's and PhD's degrees) and specialist levels. Technical training is provided for lower level personnels. Research and management personnels with basic (B.S. degree) backgrounds in wildlife biology, zoology, veterinary, and forestry shall be offered advanced studies and granted

A22 at DWNP, with basic minimum of M$880 and maximum of M$2,140 per month, while at the Forestry Department it is in A19, M$1,060 to maximum M$2,340 per month.

For the rhino team to be professionalized, they should be offered with attractive salary scale to compete with other agencies. The salary scheme for biologists with advanced or specialist training may be in A19, with variations in basic minimum depending on their qualifications, work productivity, and experience. Seniors positions are recommended in the levels A12 ($2,095 - 2,495), A11 ($2,095 - 2,595), and A10 ($2,650 - 2,770). At these levels, the biologists must have demonstrated and contributed significant knowledge in research and management of Sumatran rhinoceros. This salary system will be rewarding for skilled, motivated, and innovative biologists. Perhaps, it might be the competitive edge to lure good biologists with research background for rhino preservation works.

5. Research and management. There are major deficiencies in the knowledge on Sumatran rhinoceros, especially in ecology, population dynamics, and behavior. Knowledge is essential to further improve this plan. Such knowledge could allow choice between alternatives, establish realistic constraints, allow plan to be practical, and speed development of effective research methods (Schemnitz 1980).

For a comprehensive program to manage and restore rhinoceros population and habitat would require an inter-

disciplinary approach in solving conservation problems. Concerted efforts from wildlife biologists, ecologists, veterinarian, foresters, and specialists are required to find these solutions. The studies will be conducted to achieve management goals and objectives. Intensive studies can be done in 2 ways;

a. Basic study - identify and investigate problems in conservation and management.

b. Applied study - determination of specific problems to provide needed knowledge and develop analytical approaches in management.

There will be 2 main research opportunities available at Endau-Rompin;

a. Field research - find basic information, requirement for food, cover, and response to management practices.
   - long-term studies; monitoring the population and habitat.

b. Laboratory and captive research - find basic information on social and reproductive behavior, physiology, and nutrition.
   - develop techniques for care, artificial insermination, germplasm handling and storage, and population genetics.

Attempts to breed Sumatran rhinoceros in captivity must be done *in situ*. This is to avoid unnecessary risk of transporting and exporting the endangered rhinoceros away form its natural environment. Foreign institutions and expertise should realize the objective of Sumatran rhinoceros preservation in its habitat and should collaborate with DWNP to achieve the goal.

Artificial insermination and breeding techniques should only be the last resort if natural mating in captivity has failed. It should be undertaken only after intensive studies.

Research development - The protection, enhancement, and management of Sumatran rhinoceros population and habitat shall be based on field information obtained through professionally conducted research. A research development plan shall outline the current state of knowledge, what has been accomplished, and what has to be done to improve knowledge in management. A formal research proposal shall be submitted to the Research Center Directors for aproval. The proposal shall have a title, literature review, objective, methods, statistical procedures, and schedule of operation.

6. Funding. Inherent underfunding of research programs and over-regulation of Federal money are the major setback to work on endangered species. Research is a dynamic process that requires investment of money, time, and labor. Such investment should be flexible in response to changing policy and management needs. On the other hand, research proposals

usually get major cut from the Treasury Department, and the slow governmental process had always hindered research and discourage biologists who need adequate field materials and facilities.

The funding mechanism for Sumatran rhinoceros conservation should be dependable,stable, and flexible to meet research and management needs. The fund shall be set up by RCC. The money shall be used as supplements for urgent research, management, habitat acquisition, and conservation education. A M$10-million Sumatran rhinoceros Trust Fund can be set up and the money to be raised by;

a. accept gifts and donations,

b. adopt income tax chechoff.

c. transfer the admission and special recreation fees at Endau-Rompin into the Trust Fund.

d. matching requirements ;

   i. for every M$1 raised by RCC, the Federal will donate an equivalent amount.

   ii. payments of all programs under this fund will cover 50% of the total cost, the remaining share will be borne by the Federal or State government.

Under all circumstances, there must be major revisions of the Federal laws and State regulations before the Trust Fund can materialize.

6. Cooperative agreement. DWNP should enter into cooperative agreement with local universities, research institutions,

Sabah, Indonesia, and Thailand in research and management development. Where funding and trained professionals are available, local universities should be given the lead to develop techniques, carry out long-term research, and concurrently, train part-time and full-time master's and PhD's candidates in the rhino team.

Exchange of rhinoceros biologists between countries could help to expand scientific and technical information and develop new idea. Periodically, seminar and workshop could be useful to evaluate the present knowledge and identify what needs to be done to improve.

At local level, DWNP should allow or invite the Meteorological Department, Forestry Department, and other educational institutions to establish research stations to monitor the climate and the ecosystem of the tropical rain forest. The data should be made available to any interested agencies.

7. Public education. The long-term aim is to cultivate conservation leaders among the Malaysian society. This will involve regional and local conservation education programs to eradicate the unfounded believe and use of rhino products and enhance the understanding of basic concepts in biological conservation. Exhibitions, slide shows, talk shows, seminars, and meetings can help to increase understanding on rhinoceros preservation. The audience in this program shall include legislative body, private citizen and concerned

public, planners, teacher and pupil, government official, community leaders, and news media. It is hope that the next generation will change their attitude and belief and have better perception on the needs for preservation.

8. Corrective legislation. The 1972 Protection of Wildlife Act does not make provisions on how to manage endangered species and its critical habitat.

An Endangered Species Act shall be introduced that will make provisions for the needs of recovery plan, management procedure, habitat acquisition, and other means to rehabilitate the animal in its natural environment. The penalty for illegal activities shall be raised at least 10-fold.

At the international level, the Federal government shall legally rectify the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

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APPENDIX D : Records of Meteorological Data

Station : Kluang, 68 m a.s.l. lat. 2° 01'N long. 103° 19'E

Rainfall amount (mm)	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
	1982	59.8	57.2	304.6	352.5	214.7	132.4	195.0	246.8	86.1	102.0	304.9	745.5	2401.5
	1983	92.2	62.4	111.6	92.4	178.4	116.4	215.2	193.1	237.7	288.3	168.6	439.6	2204.9
Temperature (°C)														
24 hour mean	1982	25.0	26.3	26.2	25.8	26.5	26.5	26.0	25.5	26.0	25.6	25.5	25.3	25.9
	1983	25.7	27.1	27.9	27.9	26.7	26.6	25.9	26.0	25.3	25.9	25.6	24.2	26.2
Mean maximum	1982	29.3	32.4	32.4	32.2	32.2	31.6	31.1	31.2	31.6	31.7	31.9	29.4	31.4
	1983	30.0	33.1	34.7	34.3	32.6	31.8	30.8	31.5	31.2	31.5	30.7	27.9	31.7
Mean minimum	1982	21.1	22.7	22.7	22.6	23.1	23.4	22.2	22.3	22.5	22.3	22.5	22.7	22.6
	1983	23.0	23.1	23.5	24.0	23.3	23.2	22.8	23.0	22.4	22.7	22.7	22.3	23.0
Relative humidity (%)														
24 hour mean	1982	82.0	80.7	84.5	88.6	87.5	86.4	86.3	98.3	86.5	88.1	90.2	89.8	86.6
	1983	87.0	80.3	78.8	82.4	89.1	89.7	90.0	89.7	90.7	89.0	89.5	92.6	87.4
Mean maximum	1982	94.5	97.1	98.3	99.5	99.4	98.8	98.9	99.1	99.4	99.7	99.8	99.2	98.6
	1983	97.9	96.7	97.0	98.2	99.8	99.9	99.8	100.0	100.0	99.8	99.9	99.5	99.0
Mean minimum	1982	63.3	54.9	57.8	61.6	62.8	63.4	63.7	64.1	61.5	62.4	63.0	72.1	62.5
	1983	68.2	55.2	49.9	55.7	63.6	66.7	67.2	64.8	64.8	64.1	66.6	76.8	63.6
Evaporation (mm)														
Mean daily	1982	3.7	4.4	3.3	3.0	3.1	3.1	3.3	3.0	3.2	3.2	3.5	2.8	3.3
	1983	3.1	4.5	4.9	3.9	3.2	2.9	3.0	2.9	2.9	3.2	3.1	2.1	3.3

APPENDIX E : Records of Meteorological Data

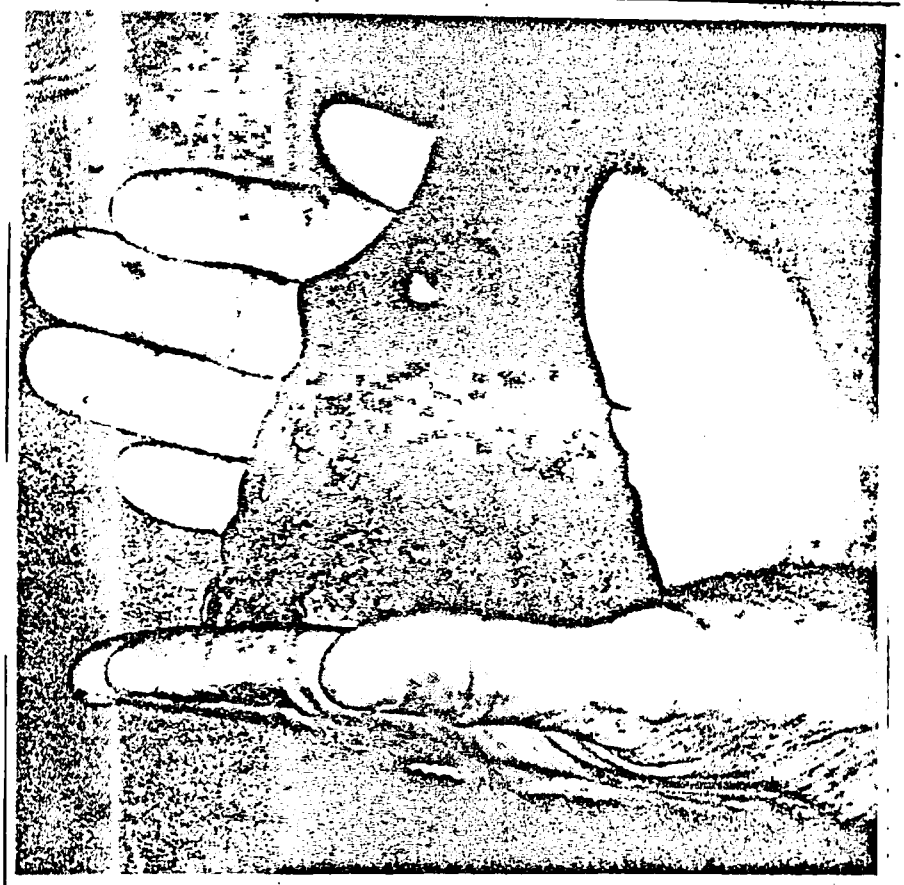
Station : Mersing 44 m a.s.l. lat. 2° 27'N long. 103° 50'E

Rainfall amount (mm)	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
	1982	249.2	2.4	99.8	71.6	153.5	271.0	183.7	292.9	73.9	237.6	87.8	1557.1	3280.5
	1983	154.2	62.4	2.2	13.0	103.0	211.1	122.6	112.4	171.0	145.9	550.2	1082.5	2730.5
Temperature (°C)														
24 hour mean	1982	25.5	26.5	26.4	26.1	26.1	26.1	25.5	25.2	25.8	25.5	26.1	25.6	25.9
	1983	26.2	26.9	27.6	28.1	27.4	26.9	30.5	30.3	30.7	30.9	30.7	28.3	26.5
Mean maximum	1982	27.8	29.3	30.7	31.1	31.4	31.1	30.5	30.3	30.7	30.9	30.7	29.3	30.2
	1983	28.6	30.1	31.8	32.8	32.4	32.1	30.9	31.3	30.9	31.4	29.7	27.0	30.7
Mean minimum	1982	24.1	24.2	23.4	22.9	23.1	23.3	22.4	22.4	22.5	22.4	22.9	23.5	23.1
	1983	23.9	23.7	23.7	24.0	23.8	23.4	23.1	23.2	22.6	22.8	22.9	23.1	23.3
Relative humidity (%)														
24 hour mean	1982	78.8	79.8	82.5	86.4	87.1	87.3	85.6	87.3	86.1	86.1	85.4	86.8	84.9
	1983	82.6	80.1	79.9	82.7	86.4	88.0	89.5	87.8	89.4	88.8	89.0	90.4	86.2
Mean maximum	1982	88.1	89.9	95.4	98.0	98.1	97.7	97.1	97.7	97.7	98.1	97.6	96.8	96.0
	1983	94.7	93.7	94.5	97.6	98.5	99.0	99.1	98.7	99.4	99.2	99.1	97.2	97.5
Mean minimum	1982	69.0	68.1	65.5	67.3	66.6	65.6	64.5	68.2	66.2	65.1	67.8	75.1	67.4
	1983	72.3	66.7	63.5	64.6	66.8	65.9	70.0	66.6	68.3	66.1	70.9	80.5	68.5
Evaporation (mm)														
Mean daily	1982	4.5	5.0	4.1	3.3	3.3	3.7	3.7	3.6	3.5	3.6	3.3	2.8	3.7
	1983	3.3	4.8	5.0	4.6	4.4	3.5	3.3	3.7	3.3	3.6	3.2	2.6	3.8

APPENDIX F : "Sumbu badak ini bernilai lebih $50,000"
(This rhino horn worth more than $50,000)

Source : Utusan Malaysia. April 28, 1981.
(a leading Malay language newspaper in Malaysia).

28/-/81 ● ● ● KDN 0003/81 35 SEN Selesa



Sumbu badak ini bernilai lebih $50,000

KATA orang: "Sudah dapat gading bertuah, tanduk tidak berguna lagi". Tetapi bagi suri-rumah Siti Rahmah binti Mohd. Salleh, 50 tahun, sumbu badak yang dimilikinya (gambar) juga boleh membawa tuah padanya kerana dipercayai bernilai lebih $50,000 sekiranya dijual.

Menurut Puan Siti Rahmah, sumbu 'bertuah' itu dihadiahkan oleh ibunya, Tengku Sharifah Aishah sejak zaman Jepun lagi yang hanya disimpannya hingga sekarang kerana tidak tahu apakah kegunaannya yang ada pada sumbu badak.

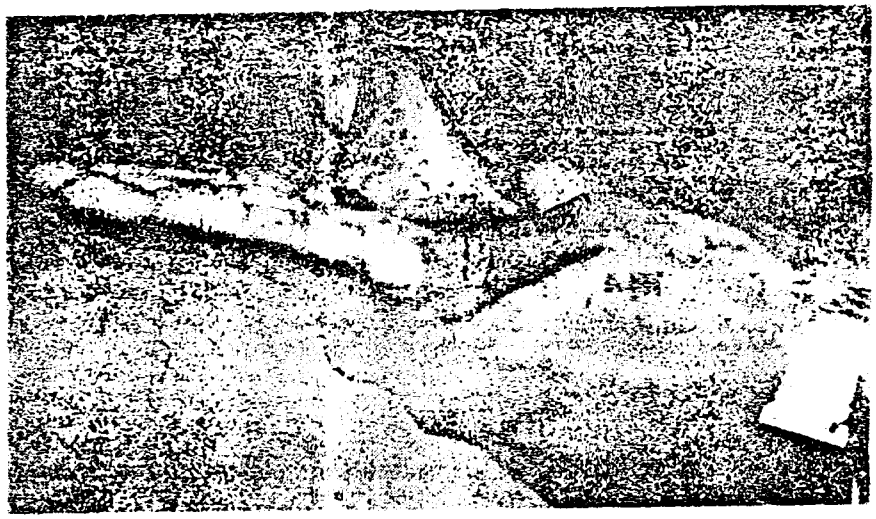
Puan Siti Rahmah hanya mengetahui betapa tingginya nilai sumbu badak itu bila terbaca sebuah rencana beberapa bulan lalu yang mengatakan sumbu badak bernilai sekurang-kurangnya $50,000.

Katanya, dari rencana yang dibacanya itu, barulah dia mengetahui sumbu badak digunakan sebagai ramuan ubat, sementara orang Melayu pula menggunakannya untuk ubat mata atau bengkak-bengkak.

SITI RAHMAH

Bagi orang Arab pula sumbu badak digunakan untuk hiasan hulu pedang.

Menurut Puan Siti Rahmah, dia sanggup menjual sumbu "bertuah" itu sekiranya mendapat tawaran yang baik.



Sumbu badak boleh mengubat penyakit

TIDAK ramai orang yang mengetahui khasiat sumbu badak. Untuk mendapatkan sumbu badak bukan mudah, lebih-lebih lagi di ketika ini kerana bilangannya di Malaysia sekarang berkurangan.

Banyak penyakit yang boleh disembuhkan dengan menggunakan sumbu badak. Ini disahkan sendiri oleh doktor.

Encik Hijazi Che Ros memang agak bertuah kerana menerima hadiah sumbu badak dari ayahnya.

Ayahnya menyimpan sumbu badak itu sejak sebelum Peperangan Dunia Kedua lagi.

Satu perkara yang agak menarik tentang sumbu badak kepunyaan Encik Hijazi ialah ukurannya. Walaupun ia telah digunakan hampir limapuluh tahun, namun ukurannya tidak banyak berubah dari yang asal.

Encik Hijazi, bertugas di TUDM Bukit Jugra, Banting, Selangor, pernah menerima tawaran untuk membeli sumbu badaknya.

Tetapi, dia menolak kerana amat sayangkannya. Dia menganggap sumbu badak itu pemberian pusaka yang berharga.

VITA

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Habsah binti Sulaiman

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Pekan, Pahang, Malaysia 1969

S.M.R.J.K (Ing), Jalan Bahagia
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April 30, 1985
Date of approval

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Chairman and advisor