To Kees,
With compliments.
Rod Flynn

613.

DISTRIBUTION, ECOLOGY & CONSERVATION

OF

THE SUMATRAN RHINOCEROS

IN

MALAYSIA

Prepared by

RODNEY W FLYNN

Progress Report
July 1981

C O N T E N T S

1. INTRODUCTION

This project was designed to provide information on the distribution and ecology of the endangered Sumatran rhinoceros (Dicerorhinus sumatrensis Fisher 1814) in Malaysia which would be useful in developing a conservation program. Before this project was initiated in 1974, little information was available on this elusive species and a conservation program had not been developed. Since then, considerable effort has gone into this study and much useful information has been collected. Hopefully, a successfull conservation program can be implemented before this unique animal slips away to extinction.

This report provides a brief summary of progress made on this project during the present field season (1 August 1980 to 1 July 1981). Previous field work on this study was completed during January 1975 to December 1977 and January 1979 to May 1979. Most of the information presented in this report was collected during this field season, but all available information was combined for some of the data summaries. Any conclusions stated in this paper are only preliminary in nature until further data analysis has been completed. A final report will be available in January 1982.

Most of the objectives of this study were met during this field season even though some problems were encountered. Weather conditions were poor during most of the period with heavy rainfall during all months except January and February. These heavy rains prevented the collection of good information during some of the surveys because much of the data collection is based on locating foot prints in the soil. Thus more time was spent on other aspects of the study particularly the food selection portion during

the wet months. A lack of suitable transport prevented the completion of some surveys and limited the total time in the field to 7 of the 10 months. Thus no new information was collected on one project objective - to assess the ecological impact of the 1977/78 logging in the Pahang part of Endau-Rompin - because this area can only be reached by motorcycle. I had waited to do this survey until motorcycles could be made available to the project. When this equipment was not provided, this survey was abandoned.

Most of the remaining potential rhino habitat in the Endau-Rompin region was surveyed for the presence of rhinos. This included a large section of forest in the Lesong Forest Reserve which lies to the northwest of the previously known rhino areas. Unfortunately, a large block of forest in the southeast section of Endau-Rompin (Jasin area) was not adequately surveyed. Nearly all of the primary rhino area was resurveyed during this field season.

A census survey of the primary rhino area was completed during September 1980 to determine the number of animals within this intensive study area. A second census was planned for early 1981, but poor weather conditions and unavailable field personnel prevented the completion of this survey. Additional abundance information was collected during the numerous individual surveys of the area.

The food and habitat selection portion of the study progressed very well. Rhino trails were followed on 18 differect occasions for a total distance of 30 km with 247 new feeding cases obtained. In addition, each feeding site was described to provide information on the kinds of habitats used for feeding. Data

on the availability of habitat parameters was collected from transects placed in the study area. Samples of plant material were collected from many of the food plants along with a number of plants not eaten by the rhinos to provide data on the chemical composition of foods selected by the animals. Much of this information is not available at this time.

Recent information of the status of the Endau-Rompin area has been collected and incorporated into a management plan for the proposed national park. A preliminary draft of this plan was published by the Department of Wildlife and National Parks (DWNP) in November 1980. This plan is presently being reviewed by the relevent Malaysian government authorities.

Many people and organizations have provided valuable assistance in this project. I would like to thank Mohd. Khan bin Momin Khan, Director-General, DWNP, for his support and sponsorship. In the field work, I was assisted by DWNP Deputy Research Officer Mohd. Tajuddin Abdullah and rangers from the Rhino Unit. Primary funding for this project was provided by World Wildlife Fund under Projects 1649 and 1972. Additional support has been obtained from the National Wildlife Federation through an Environmental Conservation Fellowship. The assistance of Dr. Bart W. O'gara and Ginger Schwartz, Montana Cooperative Wildlife Research Unit, University of Montana, USA, has been appreciated. The plant materials have been kindly identified at the Forest Research Institute, Department of Forestry, Kepong, by Mr. K. M. Kochummem and Dr. F. S. P. Ng. The mineral analysis of the plant samples was done at Highlands Research Unit, Kelang, with the help of Mr. Chan Khoon San. Drs. Rudolf and Lotte Schenkel were instrumental in obtaining funding and made many useful comments on the study plan.

A special thanks to my constant field companion, Kang Kong Mintol, for sharing his intimate knowledge of the forest with me. Much of the success of this period can be attributed to him and my other assistants from Kampung Juaseh, Johor.

**The following Malay words are used in the text:*

bukit	*- hill*	*Kuala*	*- river mouth*
gunung	*- mountain*	*sungai*	*- river*
kampung	*- village*	*ulu*	*- headwaters*

2. STUDY AREA

The Endau-Rompin study area is located in the southern section of Peninsular Malaysia about 225 km south of the capital city of Kuala Lumpur at 2° 30' north latitude and 103° 20' east longitude (Fig 1). The climate is ever-wet tropical with a mean daily temperature of 27°C. The annual rainfall is about 2550 mm and distributed throughout the year. The region's topography is primarily hilly with elevations ranging from 200 to 1000 m. The habitat is evergreen forest of the tropical lowland rain forest formation. These forests are exceedingly species rich with an estimated 3000 species of trees occuring in Malaysia. Most of the study area has been proposed to become a national park (Endau Rompin National Park) and contains no roads or development except for along the forest fringe.

Within the Endau-Rompin region, a 400 km^2 area containing the upper Juaseh, Kemidak, Tenang, Selai, Segamat, Endau and Jemai watersheds has been selected for the intensive census area. For the food and habitat selection portion of the study, a smaller 35 km^2 study area containing only the upper section of the Selai watershed was chosen. These areas will be referred to as Endau-Rompin, census, and Selai study areas respectively.

Figure 1. The general location of Endau-Rompin National Park within Peninsular Malaysia.

3. RHINO DISTRIBUTION

3.1 Methods

Potential rhino areas were surveyed on foot by field teams. During these surveys, all rhino sign (including tracks, wallows, and feeding evidence) was recorded on a standard form. The observation of such sign confirmed the presence of rhinos in the area and provided a rough indication of population density. A field team usually consisted of myself as leader; Tajuddin Abdullah, DWNP deputy research officer as co-leader; Kang Kong as chief guide; other local guides or porters; and DWNP rangers. Each field survey usually lasted for 10 days and 80 to 100 km were travelled by foot. The most efficient method of surveying an unknown tract of forest was to follow along the banks of small streams penetrating the area. Rhino tracks appear most readily along such streams and the animals appear to use streambottom habitat more frequently. A forest path had to be cut to facilitate travel in most areas resulting in the surveys being very time consuming. People living or working near potential rhino areas were interviewed to gather information on rhino sightings. These reports were evaluated for reliability and many of them were checked out in the field, but a lack of time prevented me from confirming all reports.

3.2 Results

The additional surveys conducted during this field season confirmed that rhinos still occur in most of the contiguous primary forest land remaining in the Endau-Rompin region (Fig. 2). This includes an area of about 1700 km^2. Evidence of rhinos was found throughout the Lesong Forest Reserve, especially in the Sekin and Jekatih watersheds with additional

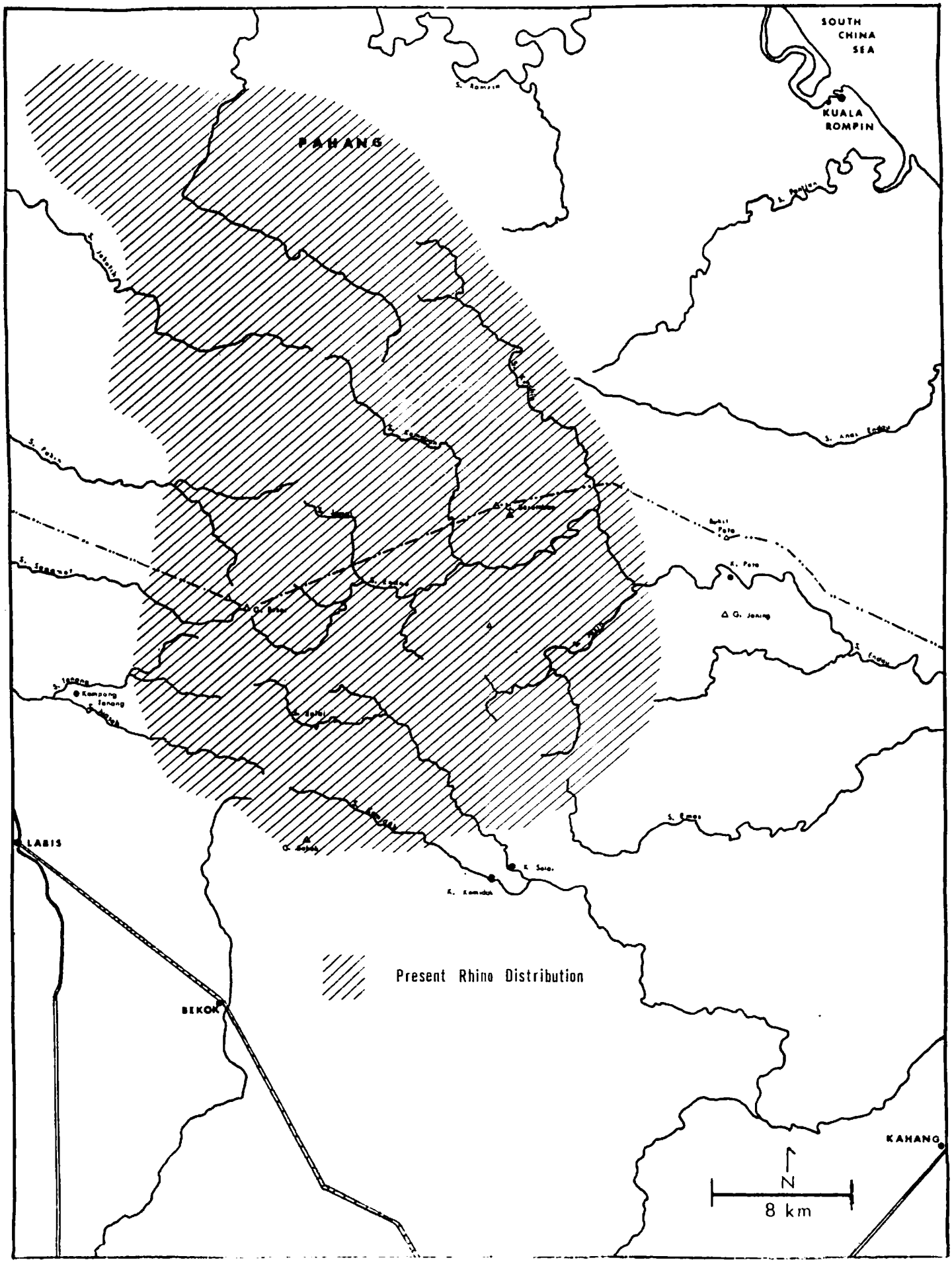

Figure 2. The present distribution of Sumatran rhinoceros in the Endau-Rompin region of Peninsular Malaysia.

reports coming from the Seplap and Pos Rivers. The discovery of rhinos in these areas was of special interest because it expanded the known rhino distribution about 13 km to the north and over an additional 500 km^2. The density of animals in this area appears to be quite low though with many of the sightings from hilly areas. The Lesong Tree Farm timber concession contains most of this area and logging is presently occuring near their base camp on the Sekin River. This logging activity may already have separated some of these animals into isolated patches of primary forest.

The north and eastern sections of Endau-Rompin were surveyed during January and February 1981. No recent rhino sign was found in these areas, but old sign was observed in the upper Kinchin watershed. Reports of rhino sign near Gunung Lesong were investigated and people in nearby logging camps were interviewed, but the presence of rhinos here was not confirmed. This information suggests that the rhinos occasionally use the Kinchin watershed but they seldom travel farther east of the hilly areas. Most of the lowland forest to the east of the proposed park boundary has already been logged up to the base of the Endau hills.

The upper Jasin area in the southeastern section of Endau-Rompin was not adequently surveyed. The status and number of rhinos in this area remains uncertain at this time. A field survey into this area was attempted in early March, but heavy rains prevented the collection of any useful data. A previous survey in 1976 indicated that rhinos occurred along the Jasin-Emas ridge. This observation has been supported by reports by people living at the nearby village of Kampung Selai. Until additional survey work can be completed, I have assumed that rhinos occur in the Jasin but at low density.

The census study area was surveyed regularly throughout this study. No changes in rhino distribution within this key rhino area were noted during the year. Rhino sign was found throughout the upper Juaseh, Kemidak, Tenang, Selai, Segamat, and Endau watersheds.

Rhino reports outside of the Endau-Rompin area were also received but these sightings were not confirmed. Of special interest were numerous reports from the Gunung Belumut area, especially in the upper Kahang and Madek watersheds. This isolated patch of forest lies about 30 km east of the district town of Kluang and 60 km southeast of Endau-Rompin. Additional field work will be needed to confirm the number and status of these animals. People living along the lower Endau River near Bukit Tanah Abang were interviewed after a report was received, but no positive information was received. Apparently, rhinos were common in this area about 10 to 20 years ago.

4. RHINO ABUNDANCE

4.1 Methods

Censusing a ground dwelling mammal in the tropical rain forest is a difficult task. The dense vegetation, rough topography, heavy rainfall, and secretive animals prevent the use of standard methods. Only indirect evidence can be used as the basis of a census method, because the rhinos can not be observed or captured. In this study, the size and locations of tracks form the basis of the census method. Individual animals can be separated based on differences in track size, the distance between track locations of similar size, and recognizable adult female/young pairs.

This census method uses survey teams which walk simultaneously across the study area along 5 permanent routes over a period of 4 to 5 days. Information is recorded on all rhino tracks encountered during the survey. The track locations are plotted on topographical maps and recorded as grid coordinates on a data form. Each set of rhino tracks is followed until at least 10 clear foot prints of the animal walking slowly in firm soil on relatively flat terrain can be measured. The outside width between the lateral toes of the rear foot of each track is measured to the nearest milimeter with a steel tape and calipers. The maximum width of the middle toe is also recorded in order to differentiate between rhino and tapir (Tapirus indicus) tracks. Only tracks of the animals rear feet are measured because the rear foot is often placed on top of the print of the front foot. If only tracks in soft mud or steep terrain can be found, these tracks are recorded with a note on soil condition. Track age is estimated based on the condition of the tracks and frequency of rainfall. In addition, the date, elevation, habitat type, and other pertinent information are recorded on the data form for each track observation.

A survey team usually consists of 1 DWNP officer as leader and 3 rangers. The team leader records all information on the forms and keeps a field journal which contains additional observations including a description of the team's progress. At the completion of the survey, each team leader gives the completed data forms, field journal, and a verbal report to the project leader who evaluates the data.

After a census survey has been completed, the information from each team is evaluated for accuracy and reliability. Any questionable or incomplete data are

eliminated from further analysis. For each series of track measurements, the range and median are calculated. The median track measurement appears to be the best measure of central tendency of a track series because the frequency distribution of a track series does not follow a normal distribution. Next an approximately 95% confidence interval for the median of a population is constructed for each track series. The 95% confidence intervals of the median for all tracks series are compared and oneswhich do not overlap are considered to represent unique individual rhinos. Rhino tracks of about the same size and age, but separated by more than 8 km in distance are also considered different individuals. The assumption being that the animals usually do not travel more than 8 km in straight line distance during a day period, especially over a mountain ridge into another watershed. Other information such as whether the animal had spent a large amount of the time in a particular area is considered in the evaluation of the distance between tracks. of the same size. The final criterion in separating individual rhinos is recognizable cow/calf pairs. Previous work has indicated that a young rhino travels with its mother until the calf's median track size reaches about 17.0 cm. Thus, if a track series with a median measurement of less than 17.0 cm is paired with a track of size greather than 19.0 cm., a cow/calf pair is recognized.

The number of young rhinos in the population can be calculated using the same track size criterion. All animals with a median track width of less than 17.0 cm can be considered to be depedent young, probably less than 2½ years old. All other animals are assumed to be either sub-adulats or adults. Sufficient information does not exist to further separate animals into age and size based on foot growth rates.

The previously described census method yields a minimum count of the number of rhinos occupying the

census study area during a given period. The detection of all rhinos within the study area by walking the 5 census routes is unlikely. If all rhinos within 2 km of the census routes are detected, then the routes can be considered as belt transects 4 km wide. Thus, the routes would provide for adequate sampling of about 75% of the census area. Because of this factor, an estimate of total number of rhino can be obtained by increasing the minimum count by 25%.

4.2 Census Routes

The census method uses survey teams which walk along 5 census routes crossing the 400 km^2 study area. These routes are shown in Figure 3. Ideally, the routes should be about 4 km apart and roughly parallel allowing for a systematic search of the sample area. In addition, the routes must:

1) follow along areas where rhino tracks can be readily observed,
2) provide adequate coverage of the sample area given a limited number of qualified personnel,
3) be able to be completed in a short period of time (4 to 6 days), and
4) locatable at a future time so that the exact same route can be repeated.

Considering the above factors, the census routes selected for this study were established along small streams which flow roughly parallel east to west across the study area. Previous work has found that rhino tracks can be most often found along these small streams because the animals use streambottom habitat frequently and their tracks are more noticeable in the soft soil. Often these streams provide the only available path for foot travel through the forest and they can be found at a later date.

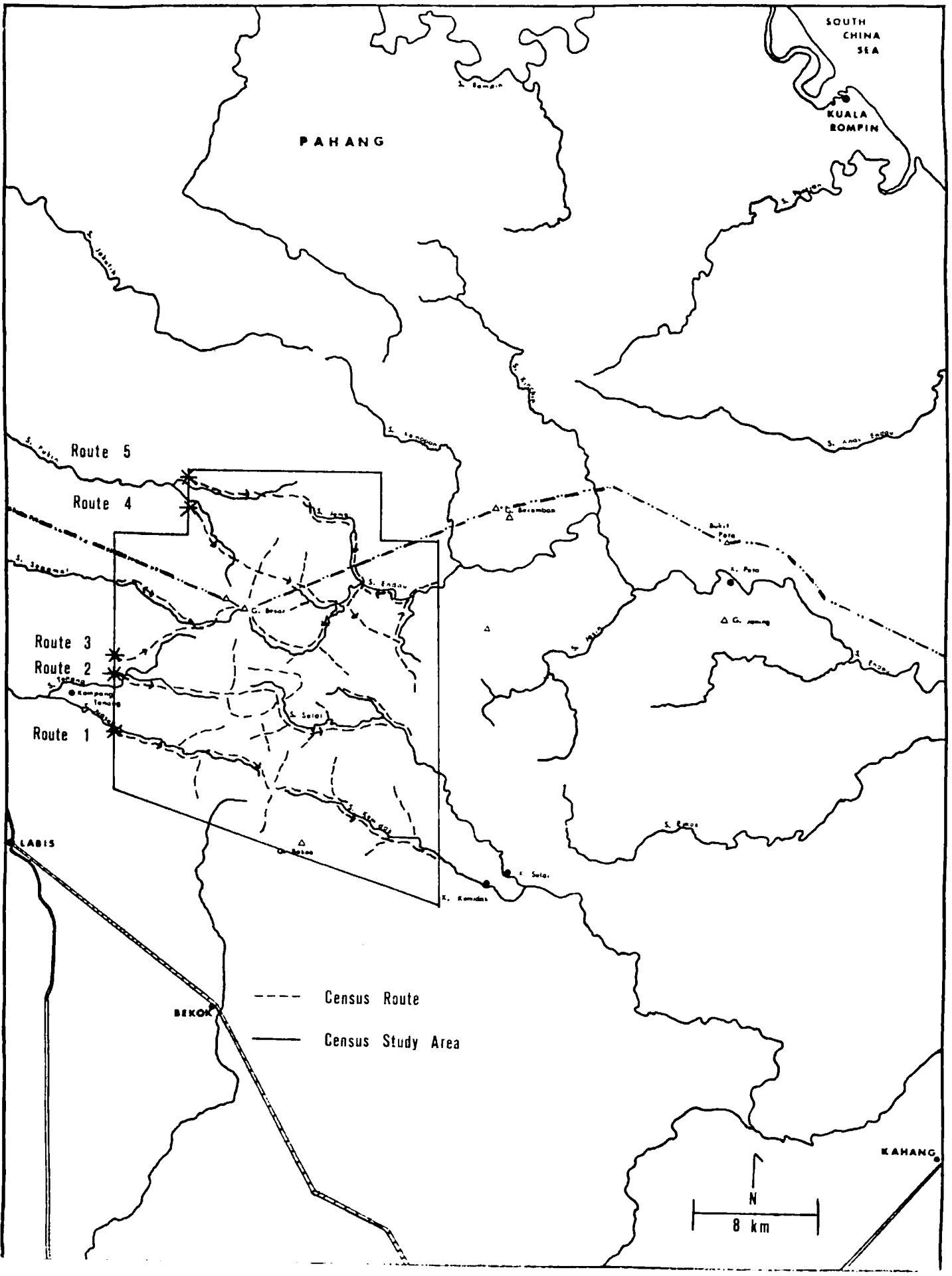

Fig 3 The location of survey routes used for censusing rhinos in the Endau-Rompin area.

trail north to the Sungai Segamat, then up the Sungai Segamat to the top of Gunong Pukin. The second portion follows up the Sungai Tenang to its source, then returning by the Sungai Redong directly to the south.

4. Route IV - this route begins at Sungai Ulu Pukin near the timber camp with road access by way of the logging road from the Mile 13 road. Initially, this route follows up the Sungai Ulu Pukin, then over the main ridge and down the Sungai Dakul to the Sungai Endau. From here, this route follows up the Sungai Endau to its source. The return trip can be made by way of the Sungai Selai and Tenang trails to Kampung Kepoh.

5. Route V - this route begins at the headwaters of the Sungai Chapau. Road access is by an old logging road along the Sungai Pukin from the Mile 13 road. This route follows the old logging road along the Sungai Chapau east over the main ridge, then down the Sungai Jemai to the Sungai Endau. From here, this route follows up the Sungai Endau to Kuala Mempernak, then directly east along a compass bearing to Sungai Semerong. Next, this route follows down the Sungai Semerong back to Sungai Endau. The Sungai Endau is followed downstream to near Kuala Kemapan before returning upstream along the river to Ulu Chapau.

4.3 Problems in Estimating Rhino Abundance

The previously discussed census method has several limitations. Much variation can be found in the size of rhino tracks depending on the soil substrate and terrain. Tracks made in soft soil tend to be expanded, sometimes more than 0.5 cm, and not well defined for accurate measurement. These rhinos have considerable flexibility in the movement of their laterial toes. While climbing in steep terrain, the rhinos tend to pull their toes inward for a better grip. Likewise, when moving down a slope the rhinos will spread their toes in a braking movement. Thus a track width frequency distribution will be skewed to the left when an animal is walking uphill and to the right when walking downhill. The frequency distribution of tracks on level terrain will approach a normal distribution with adequate sample size. If all tracks have been measured in soft soil, the frequency distribution would be shifted 0.2 to 0.5cm to the right.

Human error in track measurement is another problem encountered in this census method because several people are involved in taking the measurements. Unless tracks are measured consistantly, it is difficult to compare track series. The observer must also be careful that only rear foot tracks are recorded, because the rhino's front feet are usually 1.0 to 1.5 cm wider than the rear feet. No significant differences in the size between the right and left feet have been found so all rear tracks are pooled together.

The small range in size of rhino tracks limits the number of individuals that can be separated based only on track width measurements. Rhino tracks encountered during this study have ranged from

12.5 to 22.5 cm in width with most tracks ranging between 18.0 to 20.5 cm. Thus a maximum of about 10 adult rhinos can be separated based only on differences in track size. If a rhino population exceeds 10 single adult individuals, the accuracy of this census method declines and alternative methods will need to be developed.

Weather conditions greatly affect the results of the census. Heavy rain washes away all tracks and dry weather results in the tracks being difficult to locate in the hard ground. Ideally, it would rain heavily a few days before the survey to remove all old tracks, then only light rain on the following days of the survey.

4.4 Results

4.4.1 Census Survey 1980

The 1980 rhino census survey was conducted from 9 to 15 September. A minimum count of 8 adult rhinos was obtained during this survey. The location and median width measurements of each track series are shown in Figure 4. If the minimum number of counted animals is increased by 25% to allow for incomplete coverage of the study area, the present number of rhinos in the study area can be estimated to be 10 animals. Based on a 400 km^2 sample area, the density of rhinos would be 1 animal per 40 km^2. All of the animals appear to be sub-adults or adults (range 18.2 to 20.0 cm) based on the track measurements. Generally, the results from this census were good even though heavy rain fell on the second and fourth days which may have washed out some tracks before they could have been recorded. Also, several of the personnel were unfamilliar with the routes or measurement methods. Routes 3 and 4 may not have been

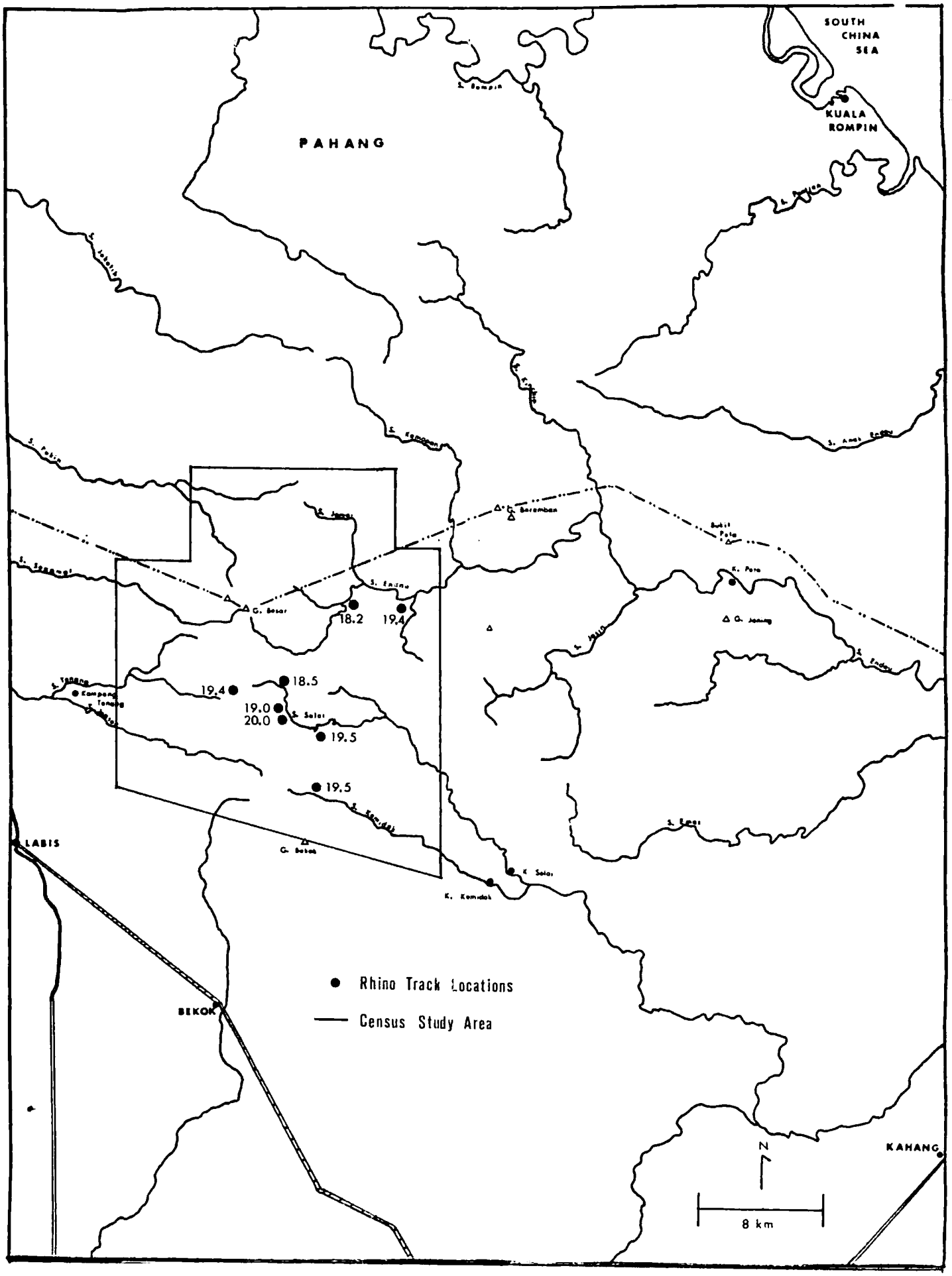

Figure 4 The locations of all recent rhinos tracks encountered during the September 1980 Census Survey. The median width measurement of each track series is given with the location.

adequately covered and a couple of the track series were difficult to evaluate because of wide variation in track size.

This year's results are similar to the 1977 and 1979 census surveys. This suggests that the rhino population density has remained fairly constant over these years. The actual median track sizes of counted animals from year to year is not consistant which indicates a movement of animals in and out of the study area.

4.4.2 Individual Surveys

Recent rhino tracks were recorded on 31 different occasions within the Selai intensive study area during this field season. An evaluation of these tracks series using only size criterion indicates that a minimum of 5 individual rhinos used this area over the 10 month period. These animals probably consisted of 1 subadult (17.0 cm) and 4 adults (18.5, 19.0, 19.4 and 20.0 cm). More than one animal of the same track size probably use this area and the census detected 2 animals of size 19.5 cm. The 19.0 and 20.0 animals were found together near the Selai base camp on 4 different occasions, but at other times they were in the same area travelling independently. This evidence suggests that these 2 animals were a female and male temporarily associating together, probably courting.

Tracks of a cow/calf pair in the Kemidak-Juaseh area were reported in March and June 1981 by local people and DWNP personel. These tracks were reported to be 19.5 and 15.0 cm respectively. I was unable to confirm the presence of this pair. This calf is the first reported young rhino to be produced in the Endau-Rompin since 1975 and an encouraging sign in

terms of the survival of this population.

4.4.3 Rhino Abundance in Endau-Rompin

The total number of rhinos presently occuring in the Endau-Rompin region can be estimated by projecting estimated rhino densities over the total occupied area. The density of rhinos in the 400 km^2 census area has been estimated at 1 animal per 40 km^2. Rhino density in the remainder of the region is known to be much lower, probably less than one half. If the density of animals in these areas is conservatively estimated to be 1 animal per 100 km^2, then the number of rhinos in the 1,300 km^2 of habitat outside the census area can be projected to be about 13 animals. Combining these estimates yields a total of 23 rhinos over the 1700 km^2 of remaining habitat. A more realistic estimate would be a range of 20 to 25 rhinos remaining in the Endau-Rompin region. This revised estimate does not reflect any increase in actual rhino numbers, instead the inclusion of additional information on distribution.

Even though 20 to 25 animals of such a rare animal remaining in the same area may be an encouraging sign for the survival of the species, the lack of reproduction indicates that this population is in serious trouble. The low density of animals may be preventing an adequate mixing of adult males and females for courting purposes. Another cause of the low reproductive rate may be a low quality diet. This aspect is further investigated in the next section of the study. If this species is to survive, a major and sustained effort will be needed to monitor the population and implement a conservation program.

Such a program may require the movement of additional animals to Endau-Rompin in order to increase

the size of the breeding population. If 20 to 25 animals is not a large enough breeding population, then scattered small groups of 2 to 5 animals which exist in other parts of the country do not have much future in terms of being a viable population of animals.

5. Food and Habitat Selection

5.1 Methods

Rhino tracks were followed to record information on feeding and habitat use. Fresh tracks were located by searching the 35 km^2 Selai study area from a network of foot paths. These trails were followed until the tracks were lost, usually 1 to 3 km. At each feeding site, defined as each individual plant eaten by a rhino, the following information was collected:

a) map location
b) site description (elevation, topography, slope)
c) habitat description (forest type, successional stage, canopy cover)
d) physical description of plant (form class, stem diameter, height)
e) method of feeding
f) amount of food removed (bites) by plant parts (young leaf, mature leaf, stem)
g) amount of food available (by plant part), and
h) distance from last feeding site.

A leaf sample was collected from each food plant for later identification. These samples were pressed overnight then sealed in a plastic bag with alcohol until delivered to the Forest Research Institute, Department of Forestry for identification. In addition, samples of leaf and stem material were

collected from several food plants for chemical analysis. These samples were heated in a field oven at 55°C for about 1 hour the same day as collection, then placed in bags until delivered to Highlands Research Unit, Barlow - Boustead Estate, Kelang, Selangor. These samples were oven dried at 55°C, then ground to pass through a 1 mm screen before being analysed for nitrogen (N) content using the Kjeldahl procedure, phosphorous (P) using Vanado-Molybdate Calorimetry, potassium (K) using a flame photometer, and calcium (Ca) and magnesium (Mg) using an atomic absorption spectrophotometer. The remaining plant material was sealed in a plastic bag for shipment to the Phytochemistry Research Laboratory, University of Strathclyde, UK. Dr. Peter Waterman will further analyze the samples for fiber, total nonstructural carbohydrate, total phenolics, condensed tannins, alkaloids, and in-vitro dry matter digestibility.

Information on the availability of habitat parameters were gathered from transects placed in 4 physiographic types. Twenty points were marked at 20 m intervals along each 500 m transect. Each of these points was treated as a potential feeding site and the same site description information recorded. In addition, woody saplings within the rhino food size class (stem diameter between 0.8 to 3.1 cm) were enumerated at each point using the point-center quarter method. A local name was given to each sapling by my field assistant and these names will be compared with the identified food plants for scientific names. Some of these names will only be accurate to plant family but many will be accurate to genus. Information was also collected on the amount of available herbage at each plant and plant phenology (percentage of young leaves).

A sample of plants not recorded as rhino food plants was collected to use as a control for comparisions with the food plants. Mature leaf material was collected from the nearest non-food plant at alternate points along 3 of the transects. These samples will be anlyzed for the same chemical characteristics as the food plants.

5.2 Results

5.2.1 Food selection

Rhino trails were followed on 18 different occasions for a total distance of about 30 km. Altogether, 247 cases of rhino feeding on plant leaf or stem matter were recorded during this field season for a total of 333 cases over the course of this study. About 97% of the food plants were woody saplings, primarily juvenile trees. The remaining 3% consisted of woody climbers, frequently growing on eaten saplings. Sapling stem diameters at breast height ranged from 0.4 to 6.0 cm with 68% of the stem diameters between 0.8 to 3.1 cm The rhino's diet consists of roughly 75% mature leaf material and 20% stem (less than 5 mm in diameter). Young leaves were occasionally eaten, probably about 5% of the diet; but few young leaves are available in the forest understory. An additional 8 cases of feeding on fallen fruits were recorded, but these species have not yet been identified. Wild mango (Magnifera sp.) fruits appear to be a highly preferred food source. The percentage of fruit in the diet has not yet been determined.

The plant identifications are not complete at this time, but most samples have been identified to plant genus. The prelimary results have been summarized in Figure 5. Based on 321 samples, a total of 95 plant genera from 48 families have been recorded as

Figure 5. Food plants of the Sumatran rhinoceros recorded from the Selai study area within the Endau-Rompin region.

Plant family and species	Frequency (Total=321)
Aceraceae	
Acer laurinum	2
Actinidiaceae	
Saurauia sp.	3
Alangiaceae	
Alanguim ebenaceum	1
Amarantaceae	
Amaracarpus sp.	1
A. caudatus	1
Anacardiaceae	
Mangifera sp.	1
Anisophyllaceae	
Anisophyllea sp.	1
Annonaceae	
Goniothalamus sp.	1
Polyathia glauce	1
Tinomiscium petiolare	1
Araceae	
Homalonena rubra	1
Burseaceae	
Dacrodes laxa	1
D. rugosa	1
Celastraceae	
Bhesa paniculata	4
Glyptopetalum puticosum	2
Lophopetalum floribundum	1
Convolunlaceae	
Erycibe sp.	1
Dipterocarpaceae	
Hopea sp.	2
Shorea sp.	1
S. leprosula	1
S. parvifolia	2
Ebenaceae	
Diospyros sp.	5
Elaeocarpaceae	
Elaeocarpus sp.	1
E. petiolatus	1
Euphorbiaceae	
Andidesma sp.	1
A. cuspidatum	1
A. velutinosum	1
Aporosa sp.	7
Baccaurea lanceolata	1
Cheilosa sp.	2
Croton laevifolius	1
Elateriospermum sp.	1
Glochidion sp.	1
G. hypoleucoria	1
Macaranga sp.	8
M. triloba	1
Phyllantus rotundifolia	1
Pimelodendron griffithianum	1
Trigonopleura sp.	1
T. malayana	1
Fagaceae	
Lithocarpus sp.	1
Quercus oidocarpa	3
Flacourtiaceae	
Flacourtia sp.	2

Plant family and species	Frequency (Total=321)
Gnetaceae	
Gnetum sp.	1
Guttifera	
Callophyllum sp.	2
Garcinia sp.	3
G. forbesii	1
G. griffithii	1
Hypericaceae	
Cratoxylum formosum	1
Icacinaceae	
Gonocaryum sp.	3
G. gracile	1
Medusanthera sp.	1
M. gracilis	7
Stemonurus secundiflorus	1
Lauraceae	
Cinnamomum sp.	1
Endiandra sp.	1
E. kirgiana	5
Litsea sp.	1
L. amara	2
L. nidularis	2
Nothophoebe sp.	1
Leeaceae	
Leea indica	1
Loganiaceae	
Fagraea sp.	1
F. racemosa	2
Leguminosae	
Cynometra cauliflora	1
Pithecolobium sp.	3
P. clypearium	1
Melastomataceae	
Melastoma sp.	2
Meliaceae	
Aglaia sp.	4
A. griffithii	1
A. tenuicaulis	1
Aphanamixis rohituka	1
Chisocheton sp.	1
Dysoxylum sp.	5
Moraceae	
Artocarpus sp.	1
A. elasticus	1
A. nitidus	2
A. rigidus	1
Ficus sp.	12
F. chartacea	3
F. depressa	1
F. fistrilosa	1
F. uriglandulosa	1
F. vasculosa	1
Myristicaceae	
Gymnacranthera forbesii	3
Knema curtisii	1
K. malayana	1
Myrsinaceae	
Aridisia sp.	1
A. colorata	3
A. oxyphylla	1
Maesa ramentacea	5
Myrtaceae	
Eugenia sp.	8
E. anisosepala	1
E. cerasiformis	1
E. densiflora	1
E. syzygioides	1
Oleaceae	
Chionanthus oliganthus	1
Linociera sp.	2
L. lamosa	1
Palmae	
Calamus sp.	1
Polygalaceae	
Xanthophyllum sp.	1
Rhizophoraceae	
Gynotroches sp.	1

Plant family and species	Frequency (Total=321)
G. axillaris	1
Pellacalyx sp.	2
P. saccardianus	1
Rosaceae	
Licania sp.	1
Prunus arborea	37
P. grisea	1
P. malayana	5
P. odirata	1
P. polystachya	2
Rubiaceae	
Gardenia sp.	4
Lasianthus sp.	7
Pavetta indica	13
Randia sp.	2
R. scortechini	2
Timonius sp.	1
Urophyllum sp.	4
U. glabrua	1
Rutaceae	
Acronychia porteri	1
Atalantia roxburghiana	1
Luvunga sp.	1
L. scandens	1
Tetractomia sp.	1
Samydanceae	
Homalium sp.	2
Sapindaceae	
Mischocarpus sp.	2
Pometia sp.	2
Xerospermum wallichii	5
Sapotaceae	
Madhuca korthalsii	1
Palaquium sp.	3
P. hexandrum	2
P. rostratum	1
Payena lucida	2
Simaroubaceae	
Quassia indica	1
Straceae	
Styrax benzoin	1
Symplocaceae	
Symplocos sp.	1
Theaceae	
Adinandra sp.	1
A. acuminata	2
Ternstroemia penangiana	1
Tiliaceae	
Grewia sp.	4
G. paniculata	1
Urticaceae	
Gironniera nervosa	1
G. subaequalis	1
Verbenaceae	
Callicarpa sp.	1
Clerodendrum sp.	2
C. villosum	3
Congea forbesii	1

food plants. This large number of plant species in the food plant list indicates that these rhinos are capable of utilizing a large number of plant species for forage. Alternatively, they may be selecting for high diversity in their diet. Many of the plant genera were recorded only once (41%) which indicates that they must be only minor food plants or rare species in the forest understory. By examining the more frequently used plants, a better understanding of the rhino's principal food plants can be obtained. About 30% (28) of the plant genera were recorded 4 or more times. Only 11 genera (12%) contained 6 or more cases. These plant genera (Prunus, Ficus, Eugenia, Pavetta, Macaranga, Medusanthera, Listea, Lasianthus, Aporosa, Aglaia and Palaquim) contained 42% of all feeding cases.

In terms of plant families, Rosaceae (15.8%), Rubiaceae (11.0%), Euphorbiaceae (9.7%), Moraceae (7.7%), Meliaceae (4.2%), Icacinaceae (4.2%), Myrtaceae (3.9%), and Lauraceae (3.9%) contained 60.4% of the total cases of feeding. A further analysis of the data will yield better information on the principal and preferred foods of this rhino.

5.2.2. Habitat Selection

The rhinos fed on plants growing in a closed canopy forest 58% of the time with old forest gaps (formed by tree falls) (30%), new gaps (10%), and open riverine area (2%) containing the remainder of the feeding cases. Thus small forest openings contained 42% of the feeding records. The transects indicated that old gaps contain only 11.5% and new gaps 4.5% of the potential feeding sites for a total of 16%. This data suggest that the rhinos are selecting small forest gaps for feeding, but still a majority of the feeding cases occur in closed canopy forest

Large forest gaps and open riverine areas are seldom used for feeding.

In regards to topography, 63% of the feeding cases were located in the stream bottom type with 29% on the adjacent lower slopes. Only 8% of the cases were recorded on the middle to upper slopes and ridge types. Availability information for these parameters are not available yet, but the middle and upper slope types contain a majority of the area. Thus a strong selection for areas adjacent to small streams for feeding was recorded. Preliminary evidence suggests that the rhino's preferred food plants may occur in higher densities in the streambottom and lower slope types, especially Prunus sp.

In terms of elevation, the feeding sites ranged from 200 to 800 m above level with most of the sites around 450 m. The percent slope was quite variable with most of the sites from 0 to 20% slope. Aspect did not appear to influence feeding.

5.2.3 Chemical composition of food plants

The mean crude protein, ash, and mineral composition of a selected number of rhino food plants is given in Figure 6. The food plants are higher in crude protein, ash, and mineral content than the sample of non-food plants. This [illegible] evaluation before any [illegible] be made [illegible] in appearance [illegible] plants [illegible]

to be done on the plant samples should yield much interesting information on the chemical characteristics of plants selected for food by the rhinos. Almost no work of this kind has been completed in the tropical rain forests of the Far East.

Figure 6 The nutrient content of Sumatran rhinoceros food plants collected from the Selai study site. The samples consist of only mature leaf materials. The control consist of samples of mature leaf material from a random collection of non-food plants growing in the study area. The results are expressed as mean values of percentage dry weight.

PLANT COMPOSITION
(% dry wt.)

	Ash	N	Crude Protein	P	Ca	K	Mg
Food Plants	7.03	1.82	11.4	0.072	0.89	1.13	0.31
	(90)	(54)	(54)	(85)	(86)	(87)	(38)
Control	5.54	1.44	9.0	0.056	0.59	0.99	-
	(25)	(19)	(19)	(24)	(24)	(25)	(0)

Sample Size = ( )

Crude Protein = % N x 6.25

6. CONSERVATION

6.1 Threats to the Rhinos

6.1.1 Habitat Loss

The loss of rhino habitat through logging and land clearance remains a constant threat to the species. The total amount of habitat in the Endau-Rompin region continues to shrink as surrounding lands are exploited. At the present time, the proposed national park lands remain intact, but this area has never been officially gazetted as a protected area. Thus the future of the key rhino area in Malaysia remains uncertain. As more time passes before final action to protect the area occurs, pressure to exploit the timber resource will greatly increase. Actually, only about one half of the presently occupied rhino area lies within the proposed national park. The remainder of the rhino area is already under timber contracts. As this logging proceeds over the next few years, the disturbance to the habitat is bound to have a negative impact on a number of animals. The area of most concern is the 500 km^2 Lesong Tree Farm concession. Present information indicates that this entire block of forest contains rhinos, but it will be logged over the next 25 to 35 years. The opportunity does exist to minimize the impact of logging on the rhino population because in this concession the timber will be extracted in relatively small blocks (about 20 km^2 annually) over a a number of years. Also, road access to the concession is somewhat controlled and the key rhino areas will not be cut for several years. The status of primary forest land adjacent to the approved western park boundary in the State of Johor is not known. I have recommanded that all of this land be included within the proposed park.

According to my unofficial reports, land clearance for agricultural development along the western section of Endau-Rompin has been completed. This includes the Selanchar Complex oil palm estate in the Sungai Pukin area. The forest contained within Schemes 4 and 5 was cleared during February 1981. At this time, no attempt has been made to clear Schemes 7 and 8 which contain important rhino habitat. In February, rhino tracks were reported less than 1 km from the recently cleared land along the Sungai Jekatih. The protection of this area from poaching will be important for the continued survival of this animals.

All available information indicates that this species of rhino can not tolerate any major disturbance to their habitat. Agricultural areas are not used at all. Logging areas are avoided after the active timber extraction has begun and field work has shown that logged areas may not be used again for several years after the activity has stopped. More work needs to be completed in this area especially the long term affects of logging on a rhino population.

6.1.2 Poaching

Recently, no cases or evidence of rhino poaching in the Endau-Rompin area have been reported, but the true situation is difficult to determine. The southern section is being occassionally patrolled by DWNP rangers, but most of the northern sections have not yet been adequately surveyed much less patrolled. Access to the Selanchar and Lesong areas is good and several people living nearby have reported poaching activity on other game. My sources indicate that a large percentage of the neighboring human population is aware that rhinos occur in the Endau-Rompin area.

Apparently, most people are afraid to go rhino hunting because of the threat of getting arrested, especially while I'm working in the area.

I have attempted to make contact with most of the aboriginal groups living near the rhino areas to impress upon them the hazzards of rhino hunting. A potential rhino hunter would probably try to recruit these people for a hunt. Foot snares for wild pig are quite common in the adjacent secondary forest but generally these snares would be too small for a rhino.

The DWNP's ranger patrol system has been operating for several years now. A lack of equipment and facilities prevent them from being properly deployed for maximum effectiveness. The contruction of a guard post system along with the provision of suitable transport to get the rangers to the posts is essential for the system to become effective. At the present time, access is not controlled at any of the entry points. Hopefully, this system can be improved before any animals are lost to poaching.

6.2 Status of the proposed Endau-Rompin National Park

According to my knowledge, the status of the proposed national park has not changed since 1979. The Johor state government has approved about 490 km^2 to be reserved for the park, but this area has never been officially gazetted. Thus approval could be withdrawn at any time. Logging continues within the proposed park area along the lower Endau River in an old timber concession. No official action has ever been taken on the remaining 380 km^2 of land in the state of Pahang.

In October 1980, the DWNP published a preliminary draft of a management plan for the proposed national park. This plan was prepared by myself and contains sections on recommanded boundaries, guard posts, patrol system, land use zoning, administrative facilities, and visitor use development. The preparation of a final plan will depend on the direction of the Malaysian government, primarily whether the park is ever approved. Substantial monies are potentially available from the Malaysian government for the development of the park.