Section 3

Protection Criteria for the Tropical Rain Forest in East Kalimantan

- Especially on Vegetation and Mammals -

Contents

1. Introduction

The problem of protecting tropical rain forest is one of the most important subjects in the world at present, not only from the scientific point but also from the conservation point of the natural resources and environment. The present study was undertaken as a basic study for protecting the tropical rain forest ecosystem, easpecially for establishing protection criteria for ecosystem and designation criteria for reservation area.

Knowledge and information are indispensable, quite naturally, on the tropical rain forest ecosystem itself, in considering protection of the ecosystem in the tropical rain forest. However, we, the mankind, know it a little.

At the first step of our study, therefore, it was investigated the actual state of vegetation in East Kalimantan, where the most typical tropical rain forest in Southeastern Asia is left. The studies were conducted for four periods, three times during March through December, 1980 and once from August to September, 1981. So the data and information can be collected as much as possible. On the other hand, the fauna of higher animals, especially mammal fauna, was also investigated in the area in March, 1981.

This report deals with an outline of the results of investigation and study on protection of ecosystem in the tropical rain forest.

Chapters 1, 2 and 3, and Paragraphs (1) and (3) in Chapter 5 were written by Kiyoshi Okutomi of Tokyo University of Agriculture and Technology and Chapter 4 and Paragraph (2) in Chapter 5 by Takeo Kawamichi of Osaka Municipal University.

2. Outline of the investigation Area

The area investigated is centered by Samarinda, the capital of East Kalimantan. It includes the following six areas, those were investigated concretely in the field (Fig. 1).

(1) Samboja (=Bukit Soeharto)
(2) Kualasamboja
(3) Mahakam River Delta
(4) Lempake
(5) Sebulu
(6) Muarakaman-Semayang Lake

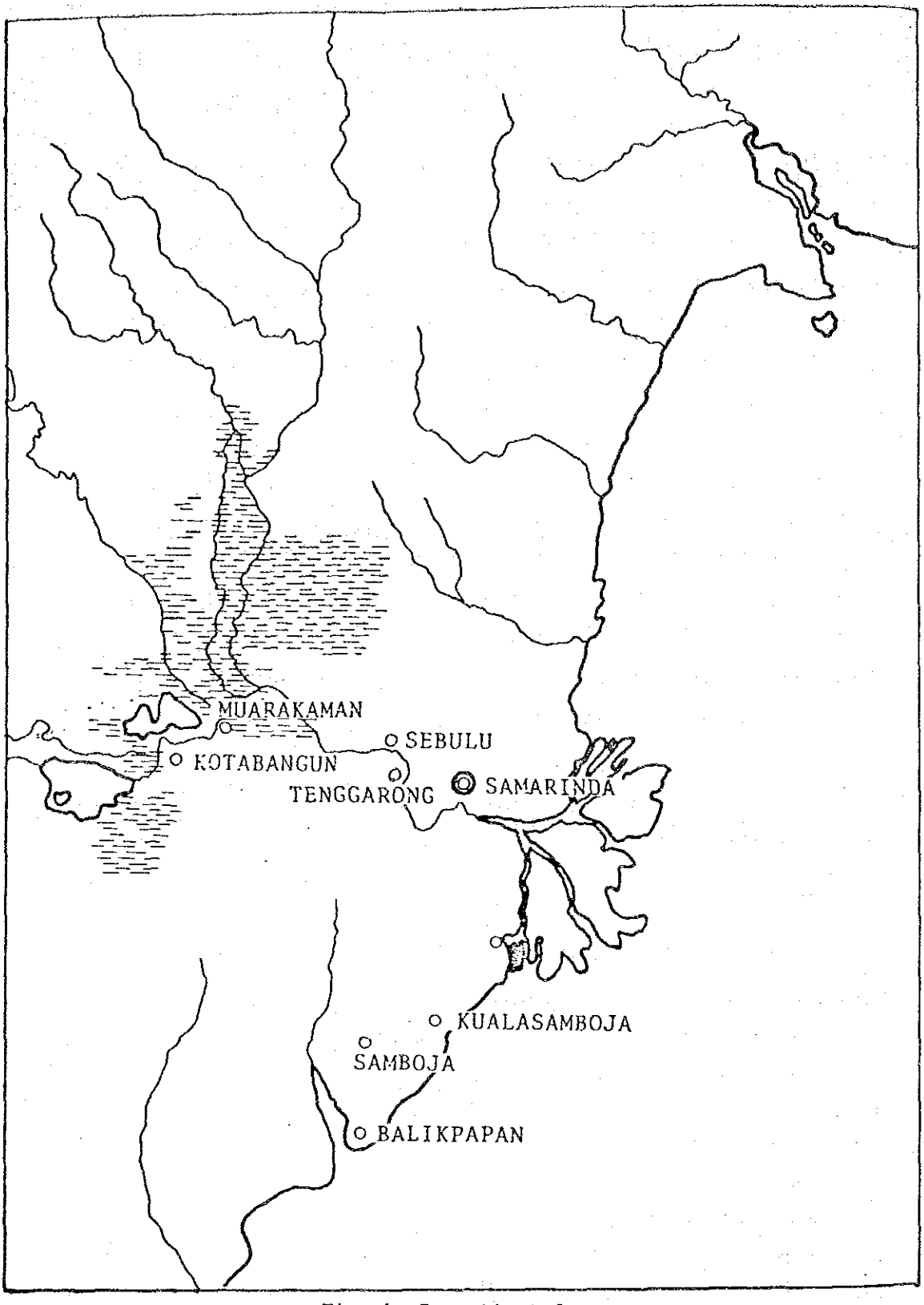

Fig. 1 Investigated area

The topography, geology, climate and other natural environment as a whole in East Kalimantan, including the investigated area, will not be referred to, because they were explained in Section 1 of this report.

The outline of the situations in each of the areas is given as follows:

(1) Samboja

Samboja here do not mean the neighborhood of Samboja Village but a whole area developed on an undulating land between Balikpapan and Samarinda along the winding highway of about 110 km in total, especially the experimental forest of Mulawarman University near Bukit Soeharto extending from 42 km point to 64 km point from Samarinda.

The topography of the area is that of an undulating land, as already stated, but the altitudes are not largely different each other and the minimum and maximum are 20m and 150m above sea level, respectively. The soil is mainly yellow podzolic soil.

(2) Kualasamboja

This area comprises the area near Samboja and Kualasamboja which are comparatively close to Balikpapan. The area near Samboja is undulating and in some part swampy. Kualasamboja is near seashore as its name shows.

(3) Mahakam River Delta

The Mahakam River branches about 20 km downstream of Samarinda, branching further into several streams to form a great delta which is 30 km - 40 km long and 60 km - 70 km wide, which is called the Mahakam River Delta. The topography of the area is such that the foot of undulation comes 200m - 300m to the river bank at the branching point of the river, or near the root of the delta, while the delta itself is completely flat and gets more swampy as it nears the river-mouth. The river water is naturally brackish. A part of the delta belongs to an oil land, and many oil extracting and transporting facilities are located.

(4) Lempake

This is also an undulating land in the suburb of Samarinda where an experimental forest of Mulawarman University is located. In one part, villages and farms of transmigrants from East Java are found.

(5) Sebulu

Sebulu Area embraces the left bank area of Mahakam River midstream, which is about 60 km upstream to the northwest of Samarinda; and the topography is undulating except a part of it near the river bank, where an alluvial land extends.

(6) Muarakam-Semayang Lake

Further upstream of Mahakam River as far as 40 km from Sebulu is Muarakaman. A large swamp is developed from here to upstream, and it is as large as 150 km south-north and 70 km east-west. Many lakes, large and small are scattered, including Semayang Lake which is the biggest in the area.

This area works as a retarding basin in the rainy season when the river rises, and the lakes expand, making it difficult to find the border of land and river. The houses of high floor type on the natural bank have water under the floor, and many of the bridge of small rivers are also submerged in the water. On the contrary in the dry season, the water goes out so much that a part of the bottom of lakes is exposed and the boats cannot sail.

3. Vegetation of East Kalimantan

(1) General View of the Vegetation in East Kalimantan

Before entering into a general view of the vegetation in East Kalimantan, let us make a general survey of its flora that is the base of vegetation.

Even now when the primary forests of tropical rain forest are going to disappear in a vast area, we are still far from grasping the whole picture of flora in Kalimantan (Iwatsuki et al., 1980). According to Van Steenis (1950, cited from Iwatsuki et al.), the number of botanical specimens collected in East Kalimantan and Northeast Kalimantan is

estimated about 11,800 in 1950; and the figure is far smaller than that in Northwestern Borneo (Sarawak), Brunei, or the former British territory, North Borneo (Sabah). However, thanks to the effort of the staff of Herbarium Bogorensis in Bogor, studies on plants of Dipterocarpaceae, that are prominent kind of useful trees in Southeast Asia which often thrive as the dominant species in East Kalimantan forest, have been developed considerably, in spite of the general ignorance. According to Dr. Kartawinata (1980) of the Herbarium, 9 genera and 128 species (the largest genus being Shorea, comprising about 60 species) were discovered up to the present. This makes us understand that Dipterocarpaceae plants are the most important component of the vegetation in East Kalimantan Region.

Turning our eyes to the vegetation in East Kalimantan, we found that the region constitutes the center of the tropical rain forest, especially tropical lowland evergreen rain forest, together with those in other districts in Borneo Island. And the main part of the rain forest is formed by dipterocarp forest, especially lowland dipterocarp forest (Shoreetea, tentative name), which covers the most part of the lowland. The forests are beautiful especially in the hilly lands in Sebulu and the north of Balikpapan. However, many of the lowland dipterocarp forests have already been lost and are going to be lost rapidly; and farms of shifting cultivation and normal cultivation are scattered in the cut land here and there, or young secondary forests cover the land. The tendency is marked in the whole area surrounding Samarinda, between Balikpapan and Samarinda, along the riversides of middle to lower reaches of the Mahakam River, etc., when the area with Samarinda as its center alone is surveyed.

Mangrove forest that is the characteristic vegetation in the tropical to subtropical zones in addition to the dipterocarp forest is widely distributed in the seashore and riverside in East Kalimantan, especially near Kualasamboja and in the delta and riverside of the Mahakam River. Nipa forest is also predominant in the delta of the Mahakam River.

In the large swamp in the middle reach of the Mahakam River, that embraces several lakes, swamp forest and swamp grassland occupy the land.

As previously mentioned, the dipterocarp forest develop on the land of zonal soil, while heath forest on the land of azonal soil, especially of the podsolized sand soil. The latter is distributed among the lowland dipterocarp forest as islands, and this is observed in Sebulu, samboja, etc.

In addition to the forests, the lowland of East Kalimantan, especially in the southern part, is covered by a secondary grassland where alang-alang (Imperata cylindrica) is predominant. Almost all of the secondary grassland is formed, it is believed, on the wasted land after shifting cultivation; and alang-alang grassland on a small scale, formed after shifting cultivation, is found everywhere outside the southern area.

The above-mentioned types of vegetation have been found by investigation or observation in the field, but according to Kartawinata (1980), montane forest is distributed, in addition, on high land of East Kalimantan and limestone forest on the limestone zone. Unfortunately, however, we were unable to investigate them during the visit.

(2) Method of Investigation

Sample lots were set in investigating forest stands as a rule, in the six investigating areas shown in the above paragraph, and the vegetation was analysed. The size and number of sample plots and items of investigation are shown in Table 1.

In addition, vegetations of several areas in East Kalimantan were observed from a car, boat, helicopter, etc., although the said investigation by means of sample lot was not undertaken.

Table 1 Plot and items of vegetation investigation (measurement)*

Plot name	Size	Number in a stand**	Plants measured	Items of measurement	Remarks
Plot	20mx50m or 20mx25m	1	Trees over 10cm D.B.H.	Tree name " height " D.B.H. " position (mapping in 1:100) " crown projection (mapping in 1:100)	
Subplot	20mx25m	2	Trees of 3 cm - 10 cm D.B.H.	Tree name " height " D.B.H.	Nested quadrat
Shrub Plot	5 x 5m	2	Trees under 3cm D.B.H. and over 1.5m height	Heights of all of the individuals, coverage of each of the species	Nested quadrat
Herb plot	1 x 1m	10	Shrubs under 1.5m height and herb	Average height of the species, coverage of the species	Nested quadrat

* In cases of small-tree forest, scrub, herb community, etc., the method above is not adhered to, and some other means are resorted to.

** Number as a rule

(3) Description of Vegetation in the Area Investigated

1) Samboja

Both sides of the road in the area of Bukit Soeharto as the center, the forest has been almost clear-cut usually as far as 1 km from the road and sometimes 2 km, except in the area of a steep slope; and the remain is in a mosaic of shifting farm and young secondary forest, including scrub. The condition of mozaic differs by the place. Sometimes the farms are scattered as islands or spots among the secondary forest, and sometimes secondary forests are scattered among a farm. Around living houses, spotted along the road, pastures were found, although on a very small scale.

Tall forest with a physiognomy of primary forest extends usually further than said belt of secondary forest and shifting farm, that is, from 1km to 2km from the road inward. It is also left as islands among the secondary forest - farm zone on steep land.

However, these forests showing the physiognomy of primary forests are not necessarily the real primary forests. Primary forest that is free from human activity is rare, and most of the forests are old selective cutting forests. Especially, those forests, remaining in the secondary forest-shifting farm zone, are mostly the old selective cutting forests.

The situation in the area from the experimental forest, towards Balikpapan and turning to the left, to the village of Samboja is almost the same.

In Samboja, the investigation was carried out in 6 stands of primary forest, 3 stands of the old selective cutting forest, 4 stands of pioneer secondary forest, so that 13 stands in total.
Secondary grassland was also surveyed.

Table 2 Species composition of forest canopy in primary forest in Samboja

(Number of trees of 30m and over in height of 50cm and over in DBH)

Plot Area of plot (m^2)	SMB-1 1,000	SMB-2 1,000	SMB-3 1,000	SMB-4 1,000	SB-1 500	SMB-8 1,000
Shorea laevis	3	13	3	6	.	.
Shorea leprosula	1	2	1	.	.	.
Shorea ovalis	.	1	1	.	.	.
Shorea smithiana	.	.	2	.	1	.
Shorea sp.	.	2	.	.	.	.
Shorea accuminata	.	.	4	.	.	.
Shorea parvifolia	.	.	.	.	1	.
Shorea palembanica	.	.	.	.	1	.
Dipterocarpus grandiflorus	.	2	.	.	.	.
Dipterocarpus confertus	.	.	.	.	1	.
Dipterocarpus cornutus	.	.	.	.	2	.
Ochanostachys sp.	1	.	.	.	.	1
Palaquium sp.	.	1	1	.	.	1
Parkia sp.	1	.	.	.	.	.
Algaia sp.	1	.	.	.	.	.
Quercus sp.	.	1	.	.	.	.
Strombosia sp.	.	1	.	.	.	.
Prombosia sp.	.	1	.	.	.	.
Flacourtia rukam	.	1	.	.	.	.
Baccaurea stipulata	.	.	1	.	.	.
Santiria sp.	.	.	1	.	.	.
Dialium sp.	.	.	.	1	.	.
Canarium sp.	.	.	.	1	.	.
Sindora sp.	.	.	.	1	.	.
Borneodendron sp.	.	.	.	.	1	.
Gymnacranthera forbegii	.	.	.	.	1	.
Eusideroxylon zwageri	.	.	.	.	.	2
Nauclea sp.	.	.	.	.	.	1
Eugenia sp.	.	.	.	.	.	1
Coccoseras bornensis	.	.	.	.	.	1
Dillenia sp.	.	.	.	.	.	1
Unknown species	.	.	.	.	1	.
No. of species	5	10	8	4	8	7
No. of spp. of Dipterocarpaceae	2	5	5	1	5	0
No. of spp. of Shorea	2	4	5	1	3	0
No. of spp. of Dipterocarpus	0	1	0	0	2	0
No. of trees	7	25	14	9	9	8
No. of trees of Dipterocarpaceae	4	20	11	6	6	0
%. of trees of Dipterocarpaceae	57	80	79	67	67	0

(A) Primary Forest

Table 2 shows collectively the species constituting the forest canopy (all trees of 30m in height and taller or of 50cm in DBH and larger) in each plot of the 1,000 m^2 (20m x 50m) or 500 m^2 (20m x 25m) in 6 primary forest stands. It is evident in the table that species of Dipterocarpaceae is remarkably predominant in 5 stands, except in one stand (SMB-8) where Eusideroxylon zwageri (Ulin) was dominant, the forests can be called dipterocarp forests.

Table 3 shows the height distribution of tree with the height of 10cm and taller in 6 primary forest stands in Samboja. In one stand, some tree were taller than 50m. Most of the stands were composed of trees of 50m in height or shorter. The height of 10m - 20cm was the largest in number. The heigher the tree height classes, the smaller the number of the trees.

Table 3 Height distribution of trees in primary forests in Samboja (All trees of 10m in height and taller in the plot size of 500m^2 in SB-1 and 1,000 m^2 in other plots)

Plot	Height (m)						Total
	10-20	20-30	30-40	40-50	50-60	60<	
SMB-1	15	6	2	.	.	.	23
SMB-2	18	15	15	6	3	.	57
SMB-3	14	12	7	4	.	.	37
SMB-4	23	8	7	2	.	.	40
SMB-8	12	7	5	1	.	.	25
SB-1	18	9	6	2	.	.	35

i. Dipterocarp forest

As has been explained, five out of the six stands of primary forest investigated in Samboja Area were dipterocarp forests.

In the five stands, the forest canopy was composed of 27 species, but 11 of the 27 species (41%) were of Dipterocarpaceae (see Table 2). Observation by the stands shows that the rate of Dipterocarpaceae species among all of the canopy species was 49% in average (25 - 63%), and this rate shows that Dipterocarpaceae is remarkably predominant in the forest canopy of the dipterocarp forest in the area, viewed from the number of species as well as from the number of standing trees.

Although the number of Dipterocarpaceae species is large, the number of the genera is only two, Shorea and Dipterocarpus. Eight of the eleven species belong to genus Shorea, which is overwhelming. For the species, Shorea laevis is the most dominant, being succeeded by S. leprosula, S. ovalis, S. smithiana, and S. accuminata respectively.

Dividing the dipterocarp forest by the dominant species, the forests can be classified into three types, Shorea leavis forest (SMB-1, 2, 4), Shorea laevis-Shorea accuminata forest (SMB-3), and Dipterocarpus cornutus forest (SB-1); and among them Shorea laevis forest is the largest in number.

ii. Eusideroxylon zwegeri (Ulin) forest

On the other hand, one of the stands (SMB-8) of primary forest, shown in Table 2, is a forest where Eusideroxylon zwageri (Ulin) is the most predominant. However, the degree of dominance is not very high, and many trees of other species are present. Eusideroxylon zwageri, that is the dominant species, is what is called Borneo Ironwood. This plant is not dipterocarp species but appears in the dipterocarp forest of East Kalimantan lowland quite usually (Kartawinata, l.c.). In fact, this SMB-8 stand can be called Eusideroxylon forest when viewed partially; but the plant occurs, in many cases, in the second layer or lower, and its degree of preponderance is not very high. On the other hand, Shorea ovalis and S. leprosula occur in the stand although they were not listed up due to their being small in size; and many other species occur similarly to the case of lowland dipterocarp forest. Therefore,

Eusideroxylon forest such as this stand can be regarded as one of the varieties of lowland dipterocarp forest, although the dominant species is not species of Dipterocarpaceae. Kartawinata (l.c.) also did not regard this kind of Eusideroxylon forest as an independent vegetation type but included it in the lowland dipterocarp forest.

Ulin timber has been the most useful wood in East Kalimantan, being used since old times. Therefore, the trees have been selectively cut as explained later, and it is rare that the trees grow in crowds in an easily accessible place. Quite naturally, resembling the Samboja Area, it is extremely difficult to find a big stand of primary forest occupied by Ulin.

(B) Old Selective Cutting Forest

It has been explained, forest with physiognomy of primary forest can be found everywhere in the area along the road side from Samarinda to Balikpapan (Table 4). However, if some one enters into the forest, he can easily find, in most of the forests, old stumps of a large diameter; and this shows that the forest was cut selectively in the past. Thus, it is rare that one can find a real primary forest that has never been cut selectively. Lands of a steep inclination that is not suitable for shifting farming was covered with a primary forest at first sight, but the forest was cut selectively in most of the cases. The degree of cutting is low, however, being at 40 - 50 trees/ha. as revealed by the number of stumps; and Eusideroxylon zwageri (Ulin) is usually the species that was cut.

Table 4 Species composition of forest canopy and stumps in old selective cutting forest in Samboja (see Table 2)

Plot Area of plot (m^2)	SMB-5 1,000	SMB-6 1,000	SMB-7 1,000
Standing tree			
Eusideroxylon zwageri	2	.	2
Dipterocarpus sp.	1	1	.
Flacourtia sp.	1	.	.
Shorea sp.	1	.	.
Shorea laevis	.	3	.
Coccoseras sp.	.	1	1
Eugenia sp.	.	1	.
Dipterocarpus cornutus	.	1	.
Shorea ovalis	.	1	1
Shorea accuminata	.	1	.
Gluta sp.	.	1	.
Chisochetong sp.	.	.	1
Litsea sp.	.	.	1
Parkia sp.	.	.	1
Shorea leprosula	.	.	2
No. of spp.	4	8	7
No. of trees	5	10	9
Total No. of trees over 10cm in DBH	34	29	30
Stump			
Eusideroxylon zwageri	No data	2	1
Shorea smithiana		1	1
Shorea parvifolia		1	.
Scorodocarpus sp.		1	1

Table 5 shows the height distribution for all of the standing trees of over 10m in height in 3 stands of the forest investigated in Samboja Area. Comparison of the table with Table 3 showing height distribution of trees in primary forest in the same area reveals that the two forests are composed of trees of lower than 50m in height, but that trees of 30m - 40m and 40m - 50m height classes in the selective cutting forest are smaller than in the primary forest in number. This is considered to be the result of the trees of the classes being cut selectively.

Table 5 Tree height distribution in old selective cutting forest in Samboja (all trees are over 10m in height, the plot size is 1,000m^2)

Plot	Height (m)							Total
	10-20	20-30	30-40	40-50	50-60	60-70	70<	
SMB-5	20	12	1	1	.	.	.	34
SMB-6	16	5	4	.	2	2	.	29
SMB-7	15	11	1	1	.	.	.	28

(C) Secondary Forest and Scrub

Various types of secondary forests are seen on both sides of the road from Samarinda to Balikpapan. However, these are all young forests and are in the stage of scrub in many cases. This indicates that cutting of primary or old selective cutting forests were taking place in the area recently, followed by abandoning of the shifting cultivation.

In this area, various types of secondary forest and secondary scrub, especially of different ages, are distributed in small segments. This seems to indicate that the land was being abandoned by people after shifting cultivation different years ago respectively.

In Samboja Area, Macaranga forest and Piper forest were investigated as secondary forest and Melastoma scrub as secondary scrub. In addition, scrub or small tree forest with predominant Trema are often found near the road from Samarinda to Balikpapan, but no investigating data has been obtained.

i. Macaranga forest (SMB-9 and SB-101)

Two types of Macaranga forests, M. triloba forest and M. gigantea forest, are distributed in the area.

M. triloba forest gave the following data as a result of investigation of all trees of over 10 cm in height in a plot of 10m x 50m.

Macaranga triloba : 15 trees (15 - 30cm in diameter)
Macaranga gigantea : 4 trees (14 - 30cm in diameter)
Dipterocarpus cornutus: 1 tree (70cm in diameter)

Two species of genus Macaranga grow side by side, but M. triloba is predominant overwhelmingly, forming a nearly pure forest of the species. The tree of Dipterocarpus cornutus of 70 cm in diameter and 30m in height in the stand may be a remain from the primary forest which was almost cut clearly.

M. gigantea forest, that is the another Macaranga forest in the area, gave the following data for the trees of over 10m in height in a plot (SB-101) of 5m x 20m.

Macaranga gigantea:	2 trees	(9 - 11 cm in diameter)
Macaranga triloba :	1 tree	(13 cm in diameter)
Mallotus sp :	1 tree	(8 cm in diameter)

Although the number of trees over 10m in height was small, trees of 6m - 9m in height were counted 25 in the 100 m^2 plot, showing that the forest was younger than the other one, Macaranga triloba forest mentioned above. The trees of 6 m - 9 m in height consisted mostly of Macaranga gigantea, as was the case with the upper layer of the forest, with a number of Mallotus paniculata and Endospermum sp. accompanying.

Macaranga triloba and M. gigantea that are dominant species of a Macaranga forest are sun trees and pioneer trees in the secondary succession. Therefore, these Macaranga forests are the typical pioneer forests in the area and cover the remain of the primary forest felled. Trema forest is similarly one of the pioneer forests.

ii. Piper aduncum scrub (SB-2)

Piper aduncum scrub is a scrub of about 5m in height where Piper aducum occupies predominantly and forms a pure community. The dominant species Piper aduncum has the property to multiply the stem, and the number of trunks in the plot of 10m x 10m was 88 while that of the individuals 42, meaning that individuals have about two trunks in average. The forest is so densely covered with large ferns that one cannot enter the forest easily. The forest seems to be a pioneer forest on the rather humid and nutritious habitat.

iii. Melastoma malabathricum scrub (Karamunting)

This type of scrubs was formed on cut-over area or shifting farm with poor nourishment, and the height of scrub is 1m - 2m, and it is accompanied by ferns of a large size. They are regarded as one of the pioneer communities, but they are considerably stable, and the progress of the secondary succession seems to be slow. They are distributed everywhere near the road from Samarinda to Balikpapan.

(D) Grassland

Grassland of Imperata cylindrica (alang alang) forms the main body of the secondary grassland in the area. They are often found in the abandoned shifting farm, but they spread in patches, seldom being into a community as large as that of southern part of East Kalimantan. Other kinds of plant can seldom invade into the Imperata grassland, and the community is maintained in pure state with stability.

2) Kualasamboja

The area between the village of Samboja and the coastline and the whole area with Kualasamboja as the center show a landscape that is completely different from the above-mentioned whole road line of Samarinda-Balikpapan. Near Samboja-Kualasamboja, the land has been inhabited from old times, and the forest and other nature have been changed by human acitivity, so that natural forest and even selective cutting forest of high trees can hardly be found. Most of the forests are ruined into secondary forest or heath forest, and also planted coconut palms are often found here and there. The land may otherwise be an abandoned farm or extensive farm covered with alang alang.

Here and there along the coastline, tall forests of mangrove in bands can be found, but they are not of a large width. Besides they are often cut and changed into secondary mangrove forests.

Near the village of Samboja, going somewhat in the country, a stand of riverside forest, a stand of heath forest, and a stand of tall swamp grassland were investigated. In addition, near the coastline of Kualasamboja, mangrove forest was observed.

(A) Riverside Forest (KSB-101)

A forest near a river was investigated. The forest floor is covered with water to a depth of about 3m in the rainy season, while the water recedes into groundwater in the dry season; and the height of forest was about 8m. The forest canopy was mostly occupied by Eugenia sp. with accompanying Glochidion sp. and Carallia sp. On the floor, Bambam and Rutun were predominant.

(B) Heath Forest (Kerangas Forest) (KSB-103)

The heath forest of about 2.5m in height on an immature soil, rich in silica sand, between Samboja and Kualasamboja consisted of the following species.

Scrub layer:	Tristania obovata	4	(coverage, same in the following)
	Glochidion sp.	2	
	Eugenia spicata	3	
	Dactyloclados sp.	1	
Herb layer:	Dryopteris sp.	+	
	Cyperus sp.	+	

(C) Swampy Tall Grassland (KSB-104)

The huge swamp between Samboja and Kualasamboja is covered with the tall grass, and the component species are as follows:

Herb layer:	Gleichenia linnearis	4
	Cyperus sp.	3
	Melastoma malabathricum	2
	Lygodium sp.	1

Omitted hereafter

(D) Mangrove Forest (KSB-102)

On the coast to the east of Kualasamboja, sparse forests of mangrove are formed in bands. They are composed of the following species:

Tree layer: (30m in height, 30% in vegetation cover)
Avicennia sp. 3.3 (degree of coverage, sociability)

Small tree layer: (7m in height, 20% in vegetation cover)

Avicennia sp.	1.1
Bruguiera sp.	1.1

Shrub layer: (2m in height, 70% in vegetation cover)

Avicennia sp.	3.3
Burguiera sp.	1.1

Herb layer: (0.2m in height, 10% in vegetation cover)

Avicennia sp.	1.1
Bruguiera sp.	1.1

Thus the mangrove forests are composed only of Avicennia and Brunguieria from the floor to the forest canopy, and the structure is extremely simple.

3) Mahakam River Delta

The vegetaion in the delta of Mahakam River mouth consists mostly of mangrove forest and nipa forest. Arrangement of the two kinds of forests depends on the distance from the mouth of the river. Near the sea, nipa forest predominates, and at the tip of delta, the land is covered by nipa forest as far as one can look out. Going further up from the mouth, nipa forest is replaced gradually by mangrove forest, and at the root of the delta, mangrove forest alone can be seen.

i. Nipa forest

The nipa forest near the mouth of river is a pure nipa forest of 7m - 8m in height with sporadic accompaniment of Helitea sp. and large palm in single tree, towering high up the forest canopy of nipa.

The nipa forests in the central part of delta are nipa forest physiognomically, but a closer look reveals that evergreen broad-leaved trees are mixed to a considerable extent. The following is an example (HD-101).

Tall shrub layer: (6m in height, 100% in vegetation cover)

Nipa fruticans	5.5
Bruguiera sp.	1.1
Rhizophora sp.	1.1

Low shrub layer: (2m in height, 10% in vegetation cover)

Nipa fruticans	1.1
Heratiera sp.	1.1
Nephelium sp.	+

Herb layer : (0.5m in height, 1% in vegetation cover)

Nipa fruticans (K)	+

ii. Mangrove forest and riverside forest

On the riverside of Mahakam River Delta, mangrove forest and riverside forests, composed of trees other than mangrove, are formed intermittently.

The mangrove forest consists mostly of Sonneratia caseolaris (Ranbei), some of which grow as high as 10-odd meters.

In addition to said nipa forest and mangrove forest, forest of Gluta renghas (Rengas) of Anacardiaceae is dominant as riverside forest. It is formed on the riverside in band, and the trees are inundated to the middle of trunks in the high water period, while the upper half of the root system is exposed in the low water period. Sometimes, on the land side of the Gluta forest, mangrove forest is formed, showing a zonation.

In the delta, in the middle to upper reaches, cultivated areas are found here and there. In such cases, mangrove forests are left on the shore in rows, with its inside being cut clear towards the interior of delta, to form rice field. In the area just before Mahakam River runs into the delta, cultivated area can often the seen, where rice fields extend from the riverbank inwards via alluvion to the foot of undelation in the inland. A part of Mahakam River delta belongs to the oil field area, where mangrove forest on the riverside is cut and many oil extracting and transporting facilities are constructed.

4) Lempake

The area surrounding the experimental forest of Mulawarman University is mostly occupied by group of villages, farms, cut-over area, young secondary forests, etc., but the experimental forest is preserved in a large area. Many of the forests are old selective cutting forests or secon-

dary forests, but primary forests can be found only after entering far from the road.

We investigated here two stands of old selective cutting forest, four stands of secondary forest, and one stand of pioneer scrub, seven stands in total.

(A) Old Selective Cutting Forest

Also, in Lempake Area, it is difficult to discriminate primary forest from old selective cutting forest by the physiognomy and the composition. In other words, the effect of selective cutting has been lost in the forest canopy and forest floor, the only difference is that old stumps are left. Therefore, in the cases of stumps, not being found or their being lost by decaying, the forest must be regarded as a primary forest.

Species composition of the two stands (LP-1, LP-4) of old selective cutting forest investigated is shown in Table 6.

Table 6 Species composition of forest canopy and stumps in old selective cutting forest in Lempake Area (see Table 2)

Plot Area of plot (m^2)	LP-1 500	LP-4 500
Standing tree		
Shorea smithiana	1	.
Quercus sp.	1	.
Endospermum biadenum	1	.
Litsea sp.	1	.
Eugenia sp.	.	1
Shorea parvifolia	.	1
Shorea repidota	.	1
Coccoseras bornense	.	1
No. of sp.	4	4
No. of trees	4	4
Total no. of trees over 10cm in DBH	40	27
Stump		
Eusideroxylon zwageri	3	2

The constitution of the forest canopy is heterogeneous in composition, but species of Shorea seems to be predominant. (S. smithiana in LP-1, and S. parvifolia and S. repidota in LP-4).

As a result, the forest can be called a Shorea forest from the condition of the forest, but stumps of Eusideroxylon were found in each of the stands, it is estimated that the forest was a mixed forest of Shorea and Eusideroxylon before cutting. Also in Lempake Area, this kind of selective cutting forest seems to have increased by utilization of Ulin from old times, as is the case in said Samboja Area.

Table 7 shows the height distribution of trees for the two stands of selective cutting forest in Lempake (all trees over 10m high).

The number of trees in 30m - 40m and 40m - 50m height classes are remarkably small, as is the case in the selective cutting forest in Samboja Area; however, no comparison with a primary forest was made due to the lack of analysis for the latter.

Table 7 Height distribution of tree in old selective cutting forest in Lempake (all trees over 10m high, 500m^2 plot in both of the stands)

Plot	Height (m)					Total
	10-20	20-30	30-40	40-50	50<	
LP-1	31	5	2	1	.	39
LP-101	13	7	2	2	.	24

(B) Secondary Forest

In the experimental forest in Lempake, cut-over area and abandened farms were found here and there where secondary forests were formed.

i. Litsea-Pternandra forest (LP-101)

The young secondary forest is located in a plain about 60 m above sea level that can be reached by 30-minute walk from

Lempake road. It abounds in trees of 10m-10-odd m height. In the forest, about 3m-long stakes were found standing, and they were of split wood and were estimated as old supports for growing pepper. Thus the forest was estimated as a secondary forest formed on a remain of abandoned pepper farm.

The plants forming the forest canopy (10m - 20m high) were as follows (number of trees of over 10m high, occuring in a 20m x 10m plot):

Litsea sp.	4
Pternandra azures	3
Eugenia lineatum	2
Shorea parvifolia	2
Macaranga hypoleuea	2
Schima sp.	2
Shorea leprosula	1
Macaranga gigantea	1
M. triloba	1
Eugenia sibulanensis	1
Other 12 species	1 each

Thus the composition of the secondary forest is complex, and it is different from other secondary forests such as Macaranga forest and Trema forest where they are composed of overwhelmingly dominant plant such as Macaranga and Trema.

ii. Macaranga swamp forest (LP-102)

In the somewhat large and flat swamp in Lempake Experimental Forest near a mountain, a small tree forest with trees of about 13m high was observed. The land has many canals and is humid, and it is probably an abandoned rice field.

The height of trees in the forest is about 13m, as stated above, and the species that constitute the forest canopy are as follows: (number of trees of over 10m high in a 10mx10m plot, LP-102)

Macaranga triloba	5
Mallotus paniculata	2
Elaeocarpus sp.	2

Glochidion sp.	2
Cryptocarya sp.	2
Macaranga gigantea	1
Other 5 species	1 each

Most of the trees are 10m - 14m high, forming a stratum; and a small number of trees are towering out of the stratum. These higher trees have a larger DBH, and they are probably remaining trees, uncut from the original primary forest.

The forest contains many trees of Macaranga triloba, and this would mean that the species can grow not only on land of suitable moisture but also in excessive moisture in this forest to be pioneer trees. This is also proved by the fact that Macaranga triloba forms a pure secondary forest even in another stand (LP-103) of excessive moisture.

iii. Nauclea swamp forest (LP-2)

As already explained, Lempake Area is inhabited by immigrants from East Java; and rice fields are opened in swamps. In the unutilized swamps near the rice field, secondary swamp forests, consisting of hygrophytes, are found. Investigation of one (LP-2) of the stands revealed that the predominant species is Nauclea orientalis of about 15m in height which is accompanied by Macaranga prunosa, M. hypoleuca, Mallotus paniculata, Ficus sp. etc.

(C) Pioneer Secondary Scrub

In the comparatively newly abandoned farms and other farms in the area, scrub with predominance of Melastoma malabathricum is formed to cover the land surface.

5) Sebulu

Sebulu Area is reached by sailing Mahakam River 60 km to 70 km north-northwest from Samarinda, and it occupies the whole area of the Mahakam River middle reach to the left of the river, where undulation extends. Our investigation at this time was just for observation of vegetation,

but five stands of a forest were analyzed. The following is an outline of vegetation in Sebulu Area.

As a whole, useful trees have been cut in the area near forest roads almost completely, except a part of the area, between 30 km point on the new forest road and 40 km point where cutting is going on. The uncut area is considerably large, and we can see one of the outstanding lowland dipterocarp forest in Southeast Asia. The forest near the point, investigated by Osaka Municipal University team in 1980 - 1981, is especially good. On the other hand, near 18 km point, a heath forest, that is distributed only in the limited areas of Southeast Asia, such as coastal terrace in North Borneo, east coast of Malaya, east coast of Sumatra, and southwest Ceylon, can be seen growing as a large island in lowland dipterocarp forest.

On the other hand, between the undulation and the Mahakam River, swamps are developed in bands, forming swamp grassland.

In Sebulu Area, immigration is still going on, although in a small part, and cutting, burning, and clearing of forest into farm are carried out.

(A) Primary Forest

i. Shorea forest (SEB-1)

The principal species of constitution of the primary forest near 40 km point of the new forest road is as follows (number of trees in 25m x 20m):

Shorea smithiana	2 (65m and 50m in height)
Shorea ovalis	2 (65m and 45m)
Shorea leprosula	1 (38m)
Canarium littorale	1 (38m)
Durio dulcis	1 (38m)
Eusideroxylon zwageri	1 (35m)

Large trees of genus Shorea are predominant, while large trees of Eusideroxylon (Ulin) are accompanying; and the forest is one of the typical lowland dipterocarp forest in East Kalimantan. No trace of selective cutting could be found there. Three height-DBH distribution for trees of over 10cm DBH and over 10m in height in the stand is as shown in Table 8.

Table 8 Correlation between distribution of tree height and trunk diameter in primary forest (Sebulu-1, 500 m^2) in Sebulu Area

		Height (m)						Total
		10-20	20-30	30-40	40-50	50-60	60-70	
DBH (cm)	10 - 20	13	2	.	.	.	.	15
	20 - 30	2	2	.	.	.	.	4
	30 - 40	.	1	1	.	.	.	2
	40 - 50	.	.	2	.	1	.	3
	50 - 60	.	.	.	.	.	.	0
	60 - 70	.	.	.	1	.	.	1
	70 - 80	.	.	.	.	.	.	0
	80 - 90	.	.	.	.	.	.	0
	90 -100	.	.	.	.	.	.	0
	100 -110	.	.	.	.	.	1	1
	110 -120	.	.	.	.	.	.	0
	120 -130	.	.	.	.	.	.	0
	130 -140	.	.	.	.	.	1	1
	140 -150	.	.	.	.	.	.	0
	150 -160	.	.	.	.	.	.	0
	160 -170	.	.	1	.	.	.	1
	Total	15	5	4	1	1	2	28

ii. Shorea-Eusideroxylon forest (SEB-3)

The forest is a mixed one of Shorea and Eusideroxylon, and the principal trees of constitution are as follows (number of trees in 20m x 25m):

Shorea ovalis	2 (70m and 60m in height)
Shorea leprosula	1 (50m)
Eusideroxylon zwageri	2 (both 30m)

In the uppermost layer, Shorea predominates, and in the second layer Eusideroxylon is predominant.

iii. Tristania forest (Heath forest) (SEB-2)

Heath forests in Sebulu were investigated by Kartawinata in 1980 in detail, and three communities of Cratoxylon glaucum-Dactylocladus stenostachys, Eugenia palembanica, Ilex hypoglauca, and Shorea ovalis-Eugenia accuminatissima were identified.

We investigated two stands that were occupied predominantly by Tristania obovata of 10m - 20m in height.

The principal species of constitution of stand (SEB-2) were as follows:

1st small tree layer (10m, 40%)

Tristania obovata	4.4
Eugenia sp.	2.2
Cotylelobium flavum	1.1
Vaccinium sp.	1.1
Tristania sp.	1.1

2nd small tree layer (5m, 40%)

Tristania obovata	4.4
Tristania sp.	3.3
Eugenia sp.	2.2
Callophyllum sp.	2.2
Cotylelobium flavum	1.1
Calamus sp.	+.1
Glochidion sp.	+.1

Shrub layer (1.5m, 50%)

Omitted

Herb layer (50cm, 70%)

Omitted

Moss layer(5cm, 50%)

Omitted

As explained above, heath forests in Sebulu exist as islands in lowland dipterocarp forest. However, one of the "islands" was cut by about a half, and the heath forest was destroyed. This was confirmed by comparison of the present state with the distribution map of heath forest, drawn by said Kartawinata. The clearing of forest was carried out with anticipation of cultivation, which was abandoned after the land being found to be unsuitable for farming, according to what has been told. At present, the land is showing white sandy soil mostly of silica sand. It is not clear why the land that is as poorly nourished as to give heath forest was selected for farming; but we strongly feel that studies on proper utilization of land is important (See Part I).

(B) Selective Cutting Forest, Secondary Forest and Others

Observation from a helicopter shows that selective cutting forest occupies a considerable area of Sebulu Area, but no data were available this time. Pioneer secondary forests were observed along forest roads in stripes, but no analysis was possible either this time.

(C) Swamp Grassland

Swamp grassland is formed on the swamp between undulated land and the Mahakam River, and the predominant species there is a species of Scripus with accompaniment of Phragmites and other true grasses, ferns, and orchids in small numbers. It is a grassland as a whole, but small scrubs are formed here and there in patches.

6) Muarakaman-Semayang Lake

Large and small lakes and swamps are scattered upstream of Mahakam River from Muarakaman village at the middle reach of the river, and the whole surrounding area forms a huge swamp.

The vegetation in the swamp is that of a swamp grassland of a large area, surrounding the lakes and that of swamp forests surrounding the grassland. The border between the grassland and the swamp forest is not necessarily concentric, but swamp forests are formed as islands, to be scattered in the grassland. In some parts, swamp grassland is formed

as an ialand in the swamp forest. In some other parts, both are formed in mozaic.

Although the area is called a swamp, it is not flooded all year round, and the difference in water level is large between the rainy and the dry seasons. Therefore, the areas of lakes change remarkably by the seasons, and some of the lakes show their bottoms in dry season. The width of river also changes largely, and the river banks are submerged in the water in rainy season except those in high places. The area outside the banks is flooded in a large area. Thus many forests are land forests in dry season but are covered with water in the rainy season.

The swamp forest and grasslands in this area can be reached with great difficulty, and a sufficient investigation was not done in our two excursions. The outline of the investigation is as follows:

(A) Riverside Forest

Along the waterway in this area, Gluta renghas and Coccoseras sp. are found in numbers. They grow in thin stripes on the banks along the rivers. They are not mixed very much with each other and grow separately. Coccoseras is flooded by 2m - 3m in the rainy season, while in the dry season, they are found on the banks exposed. In the dry season, the aerial roots are exposed, but in the rainy season, the root system and a large part of the trunks are submerged in water, showing the forest canopy alone. On the other hand, Gluta grow in the flat on top of the banks, and their lower parts are submerged in water in the highest water but not in other periods.

(B) Swamp Forest

Along the mainstream of the Mahakam River and its branches upstream of Muarakaman, swamp forests and grasslands are distributed in mozaic. An example of composition of the swamp forest is as follows:

i. Swamp forest near Sabantulung (MK-2)

Small tree layer (10m in height, 60% in vegetation coverage)

Barringtonia sp.	coverage	4
Eugenia lineata		2
Aglaia sp.		+

Hopea sp. +

Unknown tree 1

Shrub layer (3m, 20%)

Barringtonia sp. 2

Aglaia sp. +

Herb layer (1m, 100%)

Oryza sativa var. fatua (?) 5

(water depth in dry season: 20cm)

ii. Swamp forest near Kotabagung (MK-4)

Tree layer (20m, 70%)

Gluta renghas coverage 4

Small tree layer (10m, 30%)

Eugenia sp. 3

Barringtonia sp. 2

Dillenia excelsa 1

Shrub layer (3m, 30%)

Barringtonia sp. 2

Oncosperma sp. 2

Dillenia excelsa 1

Herb layer (2m, 100%)

Omitted

(Depth of water in dry season: 10cm - 20cm,
Depth of water in rainy season: 50cm - 60cm)

(C) Swamp Grassland

The center of vegetation in the swamp is swamp grassland that occupies a vast area in Muarakaman-Semayang Lake Area. The vegetation in the area was not investigated in detail, and the following is an outline.

The main body of vegetation in the grassland is composed of grasses consisting of species of Cyperus, Oryza, Juncus, Panicum, etc. and the grassland is of a true grass type. These plants grow sometimes as a mixture but generally by predominance of a certain species like a pure community. The tendency is especially strong with Oryza sp. and Juncus sp.

These swamp grasslands of true grass type sometimes are formed as seas of grass in a vast area, sometimes not so large as that in a swamp in undulating land. In the latter case, the swamp grassland gradually shifts into a grassland on hilly land with Alang Alang as its major plant.

Kartawinata (1980) stated that the swamp grassland in this area was formed as a result of repeated burning in the dry season and is of a similar nature to that of Imperata (Alang Alang) grassland on a dry land. Anyhow the vast swamp seems to have a possibility to be a large rice field zone.

(D) Riverside Grassland

On the banks of rivers in a gentle slope in the area, riverside grassland, occupied predominantly by plants of family Poaceae of a large size, is formed sporadically. They are mostly Phragmites grassland and Saccharum grassland, but their detailed data have not been available.

(4) Relationships between Vegetation and Human Life

1) Destruction and Disturbance of Vegetation

As the concrete and main factors of destruction and disturbance of vegetation in East Kalimantan, the following can be cited, as is the case in other districts. They are cutting of forest (clear cutting and selective cutting), shifting cultivation, normal cultivation, and accompanying factors that precedes, such as opening of forest road, plant construction, and formation of village by immigrants.

(A) Forest Cutting

The largest problem in the world at present, as regards conservation of the natural resources or natural environment in the tropical rain forest, is naturally cutting of the tropical rain forest.

Also in East Kalimantan, the tropical rain forests have been cut in many districts. Especially in the areas with Balikpapan and Samarinda as their centers, scarcely no primary forest is left as a large lot, and even a seemingly primary forest among rain forest is often an old selective cutting forest, as explained above.

On the low hills along the line connecting Balikpapan and Semayang Lake in the middle reach of the Mahakam River, and in the area to the north of Sebulu in the middle reach of the Mahakam River, very good forests, especially, of lowland tropical rain forests are still remaining in a wide range, but these forests are being cut, and the remaining area is dwindling.

Forest cutting in East Kalimantan is carried out by clear cutting and selective cutting.

Clear cutting is resorted to in lands near a village, for transmigration, comparatively near road, along a river, etc. And the land after clear cutting is used as farm, shifting cultivation, banana or pineapple farm, coconut palm farm, etc. This shows that the clear cutting is not for harvesting the timber as the main object but for utilization of the land for a purpose other than forestry, and the utilization is not always lasting, and the land is often abandoned.

Selective cutting is resorted to with an object of harvesting the timber. Therefore, only useful trees are cut; and the diameter of the trees is large. Ulin (Eusideroxylon zwageri) was the principal species of old selective cutting in East Kalimantan, and this can be estimated by the stumps left in old selective cutting forests in many districts (see 3-(3) - 1)).

At present, not only Ulin but also other useful trees, mostly Meranti of Dipterocarpaceae are cut selectively. And the limit of diameter for cutting is low, and the degree of cutting is high. Besides, the destruction and disturbance of forest are by far the greater than those in the age of the manpower cutting by construction of forest road in high density and mechanization of yarding and transporting of the timber. Addition of various other factors not expected can often destroy the forest nearly to the case of clear cutting. The remains of selective cutting are often left unattended to wait a natural recovery (see Section 2).

(B) Shifting Cultivation

Forests are often cut clear in East Kalimantan in order to utilize the land for shifting cultivation. Trees are cut towards the end of rainy season, and the trees not utilized are burned after sufficient drying in the dry season. At the end of dry season in late August, the burning often covers the sky with smoke as if it is covered by smog.

After burning, dryfield rice plant is cultivated usually, followed by banana, pepper, pineapple, etc. After burning of heath forest, pineapple is often found, and in the coastal district, coconut palm is often planted.

The shifting farms are often abandoned before long, and the land is covered with Imperata (Alang Alang), ferns, Melastoma, Trema, etc. and turns into secondary grassland or secondary scrub in many cases. It is often the case that cutting is made again before such recovery of vegetation is completed.

(C) Fixed Farming

On the land where shifting cultivation is couducted, the farming is abandoned a few years after cutting of the forest and burning, and the vegetation is recovered although it is of a secondary and of low grade. On the contrary, on the land where fixed farming is conducted, the cut-over area of the forest is cultivated and cultivation is continued semi-permanently. And the vegetation there is that of so-

called field weed community which lasts as long as the cultivation is continued. However, if the farming is abandoned due to loss of fertility or neglected, the land turns readily into a secondary grassland.

2) Recovery of Vegetation —— Dynamics of Secondary Vegetation ——

As to the possibility of the tropical rain forest, especially dipterocarp forest, restoring its original vegetation after its natural conditions are destroyed, we have no data to give a clear answer. However, we can at least say that the original vegetation that abounds in variety as in the existing primary natural forest would be very difficult to restore even after long years. The external shape may be regained, but the quality of the forest recovered will be pretty different.

The recovery of vegetation on the land after destruction or disturbance of vegetation, how it recovers and what kind of vegetation is recovered, depends largely on the quality and degree of impact given to the vegetation at the time of destruction or disturbance or thereafter. The conditions of recovery in vegetation that were observed in East Kalimantan, that is the dynamics of secondary vegetation, are as follows:

(A) Recovery in Selective Cutting Forest

Among the impacts given to primary forest, selective cutting is naturally lower in the degree of disturbance than that of clear cutting. This is especially true if the rate of selective cutting is low and, due care is taken in transportation of the timber not to disturb the forest.

However, in actual operation, selective cutting is directed to specific species that are useful, and a large area of forest must be operated in order to harvest a certain amount of timber, besides mechanical power being resorted to at present for transportation, the forest is often devastated.

As explained above, many old selective cutting forests can be found around Balikpapan and Samarinda. They look as if they are primary forest physiognomically, but stumps of Ulin (Eusideroxylon zwageri) are found here and there, showing that

they were cut selectively. Thus the old selective cutting forest has recovered so well in forest phase that it is difficult to discriminate from primary forest, if the decaying stumps are disregarded, but if one considers the quality of the forest, it is clear that it is different from the primary forest before cutting. Many of the old selective cutting forests are Shorea forests, but originally they must have been Eusideroxylon-Shorea forest.

In contrast to the old selective cutting, the present selective cutting operation has an effect on the vegetation as serious as that of clear cutting in some cases. Devastation of land by mechanical transportation of timber is also remarkable. Therefore, considerably long years seem to be necessary before the forest recovers up to the state of old selective cutting forests.

(B) Secondary Forest as Pioneer Phase of Secondary Succession

Near the road from Samarinda to Balikpapan, many small tree forests and scrubs are found, that can be regarded as pioneer phase of the secondary succession. The secondary succession is started on various lands such as areas of cutting natural forest, shifting farm, abandoned farms, etc.; but pioneer forests are formed on habitats of yellow to reddish yellow podsol soil after cutting.

The pioneer forests or pioneer scrubs in the area are small tree forest or scrub having Macaranga triloba, Macaranga gigantea, Piper aduncum, Trema orientalis, Melastoma malabathricum, etc. as dominant species. Among them, Macaranga triloba forest is the most predominant of small tree forests and Melastoma malabathricum scrub of scrubs.

(C) Durability (Stability) of Secondary Grassland

The secondary grassland formed on the cut-over area or abandoned farm is generally unstable and does not last for long. It usually shifts into a community of a higher level such as sun forest or sun scrub. However, in the districts of tropical rain forest in Southeast Asia, stable and long lasting

secondary grasslands are often observed. Imperata cylindrica (Alang Alang) is one of the typical ones, and changing of forest zone into grassland zone of this type is well-known.

This is not an exception in East Kalimantan. Especially in the area to the southwest of Balikpapan, a large grassland of Alang Alang can be seen. However in the area between Balikpapan and Samarinda and in the middle to lower reaches of the Mahakam River, it is not so large as to be called a sea of grass. This seems to mean that the artificial interference as the cause of transition into Alang Alang grassland was limited only to the area along the road and river.

It is well-known that stable and lasting grassland of Alang Alang is formed on the abandoned shifting farm. In fact, most of the Alang Alang grassland observed by us were formed on such habitats. However, on some of the abandoned shifting farms, Macaranga forest or Melastoma scrubs are formed by some unknown reasons. It is estimated that the difference in the soil, period of shifting farming, crops cultivated, method of cultivation, etc. caused the difference; and this is an open question to be studied in the future.

On the other hand, some facts have been observed that show that Alang Alang grassland is not always a lasting community. Namely, the lower layer of scrub with predominant Melastoma of about 2.5m in height was covered with dead Alang Alang by coverage 3, while live Alang Alang covering by coverage of 2 to 3 was weak and going to die. This is clearly the case of Alang Alang grassland, shifting into Melastoma scrub, and suggests that there is a difference in the stability among Alang Alang grasslands.

Anyhow, it would be one of the urgent subjects for an effective utilization of land in Southeast Asia, including East Kalimantan, to clarify the mechanism of the formation of Alang Alang grassland and the reason of its durability and to study and find a suitable means for reducing the durability.

4. Fauna in East Kalimantan —— Mainly on Mammals ——

Investigation of fauna is more difficult than that of flora because animals move and sightings of them are not frequent. Therefore, the investigation at this time was focused on the following three points that are expected to give some results by the short period survey for one month.

1) Listing up of mammals in East Kalimantan, 2) mammalian fauna after selective cutting of forest, and the effects of selective cutting on the population density in each species, and 3) trap hunting as relationships between man and animals.

(1) Method of Investigation

1) Sightings of Mammals and Inquiring Investigation

Encounters with mammals are low in frequency and just for an instant, and many mammals are nocturnal, all of which make their direct observation extremely difficult. Therefore, one or two persons randomly strolled in forests or on forest roads. Otherwise, we drove a car at a slow speed or sailed rivers on a speedboat, expecting to find animals. Observation was undertaken with a binocular telescope (x12) by day and at night (with the help of a head lamp). Daytime observation was centered in the early morning and evening, and night time observation during 18:00 to 21:00. Also we obtained information on the kind of animals living in the district and on the abundance from the inhabitants. Our investigation was made at five locations for several days to a week at each location (Sotek, Sebulu, Lempake, Samboja, and between Sebulu and river mouth delta along the Mahakam River). In Lempake and Samboja, facilities of the research centers in the Mulawarman University Forests were used. Small mammals were captured with wiremeshed box traps baited with banana.

2) Investigation of Trap Hunting by Local Hunters

From four professional hunters much information was obtained on various subjects: kinds and number of traps used, kinds of animals caught, actual numbers of captures, income, way of life, etc. The persons inquired were Mr. A in Sebulu and Mr. B in Samboja, and the other two (Mr. C in Lempake and Mr. D in

Sebulu) who had hunted in the past. Several leg traps and neck traps set in forests were investigated, and they kindly showed us how to set them, how the traps work and the knack of handling. Since bow trap is prohibited, they made a miniature and explained about its actual size.

(2) Mammalian Fauna and Their Abundance

1) Studies on Mammalian Fauna

The history of study on the mammalian fauna in Borneo was given by Medway (1977) in detail. Its modern review was given by Chasen & Kloss (1931), Davis (1962), Harrison (1964), and Medway (1965 , 1977); the mammalian fauna in Borneo Island has been almost completely clarified by their works.

Studies on mammalian fauna for the whole area of Indonesia can hardly be found. Recently, Van der zon (1979) listed up the mammalian fauna in each of the islands. There is a general book in English (Veevers-Carter 1979). The mammalian fauna of Borneo Island has been investigated more than that of other Indonesian Islands because of the energetic investigation by Medway, Harrison, and others in Malaysian North Borneo (States of Sarawak and Sabah) with comparison to mammalian fauna in Malay Peninsula.

In Borneo, description of species is nearly completed for medium to large-sized mammals such as Primates, Carnivora, and Ungulates. Small mammals such as Insectivora, Chiroptera, and Rodentia are large in number of species, and identification is difficult, and many of the animals have not been decided whether to regard them as an independent species or a subspecies. By a recent survey, 2 chiropteran species were recorded as first in Borneo (Kobayashi et al., 1980). However, according to Davis (1962), no valuable new species has been discovered since 1983, and no valuable discovery has been made since 1903 excepting for Chiroptera.

2) Mammalian Fauna in Borneo

Species of mammals distributed in Indonesia is extremely many. Van der zon (1979) listed up 501 species, 30% of which 156 species are endemic to Indonesia. Since 199 species are listed in Malay Peninsula (Medway 1969) and 263 species in Thailand (Lekagul & McNeely 1977), the number of species in Indonesia is 2 to 2.5 times as many as in other tropical countries.

Three factors can be involved for the abundance in species as follows: 1) Predominance of tropical rain forest where the large number of animal and plant species are found (Setting aside the reason why the number is large in the main forest). 2) Invasion of Marsupialia from Australian zone (47 species as a total of Monotremata and Marsupialia according to Van der zon), and 3) Presence of many isolated islands that promotes speciation (In Celebes, for example, more than 70% are endemic species).

According to Medway (1977), the number of species of land mammals in Borneo is 196 (29 families and 97 genera). Table 9 shows the numbers of species of land mammals endemic to Borneo and those common to Borneo, Java, Sumatra, and Malay Peninsula, according to Medway (1977), sixty-seven species of bats are excluded in the table. About 30% of the total are endemic to Borneo.

Similarities between Java and Borneo and between Sumatra and Borneo were compared. Thirty-nine species are common to the three islands (SJB, MSJB). Three species (JB, MJB) are common to Java and Borneo, while 39 species (SB, MSB) are common to Sumatra and Borneo. Such large difference will be due to: 1) Sumatra is closer to Borneo than Java, 2) Java is the smallest of Greater Sunda Islands and is located between Malay Peninsula and Australia, which make the number of species small, and 3) destruction of nature by the human being that is the greatest in Java.

Table 9 Distribution of land mammals living in Borneo
(B: Borneo, S: Sumatra, J: Java, M: Malay Peninsula)

	Range of distribution	Number of species	
Endemic to Borneo	B	35	27.1%
Endemic to Indonesia	SB	5	7.8%
	JB	2	
	SJB	3	
Common to Borneo and Malay Peninsula	MB	2	1.6%
Common to Borneo, Malay Peninsula, and Sumatra	MSB	34	26.4%
Common to Borneo, Malay Paninsula and Java	MJB	1	0.8%
Common to Borneo, Malay Peninsula, Sumatra and Java	MSJB	36	27.9%
Different ranges of distribution by different authors*		11	8.5%
		129	100.1%

* 2 species are possibly endemic to Borneo.

Of the 129 species living in Borneo, as many as 78 species (60.5%) are distributed also in Sumatra (SB, SJB, MSB, MSJB), and 73 species (56.6%) also in Malay Peninsula (MB, MSB, MJB MSJB). All of the species common to Borneo and the Asian continent are found in Malay Peninsula (Note: The distribution of Bos javanicus in Malay Peninsula is doubtful at present. Of the genera, genus Dendrogale of the family Tupaiidae is distributed only in northern Borneo and Indonesian Peninsula). Therefore, mammalian fauna in Borneo is apparently similar to that in Malay Peninsula and in Sumatra. These areas are included in the Oriental Zone as zoo-geographical sections. Malay Peninsula and Greater Sunda Islands are on Sunda Shelf of 40 fathom max. depth and are thought that they were connected by land by recession of the sea in Pleistocene (see

Sartono 1972).

The peculiarity of mammal fauna in Borneo in comparison with that in Malay Peninsula and in Sumatra is: 1) the absence of large Carnivora such as tiger and leopard and 2) the abundance of tupaid species (tree shrews, Tupaiidae, primitive primate often classified as Insectivora recently). There are 10 species in Borneo in which 6 are endemic, but only 3 in Malay Peninsula.

3) Number of Species Captured or Sighted

Table 10 shows a list of mammals sighted or captured in the present investigation. Animals captured in the five investigation locations were 6 species or 9 individuals, and those sighted 19 species or 42 times. Explanation will be given as follows for each of the orders.

Order Primates: Four species of the genus Tupaia or 7 individuals were captured with bait of banana. Two of the species could not be identified with the taxonomic keys by Lyon (1913), Harrison (1964), and Medway (1965). Our unidentified specimens were not externally identified as T. tana, T. glis, T. gracilis, and T. montana collected in Sabah in North Borneo (Kobayashi et al. 1980). T. splendidula having red tail were also sighted from a camp at 77 km from Sotek. T. minor was sighted once each in the university forests in Bukit Soehurto and Lempake, both moving on the ground and on fallen trees. Ptilocercus lowii, which is the only nocturnal tree shrew, was once moving busily on a tree in Soehurto university Forest at night. It has been believed to be distributed only in North Borneo, but our sighting suggests that it is distributed in the whole island.

Much time was spent for searching for Nycticebus coucang at night, but it was seen for four times only in the secondary forests at several km away from the timber company (K.T.I.) in Sebulu.

Two species of leaf monkeys were sighted; troupes of Presbytis rubicunda for five times and a troupe of P. cristatus (of less than 10 individuals) near Mahakam River Delta once. Nasalis larvatus inhabiting only in mangrove forests was sighted for

Table 10 List of mammals captured or sighted

	Sotek	Soeharto	Delta-Sebulu	Lempake	Sebulu
Order Primates					
Tupaia splendidula	O	OC			
T. minor		OC		O	
T. sp. 1		OC			
T. sp. 2				C	
Ptilocercus lowii		O			
Nycticebus coucang					O
Presbytis rubicunda	O	O		O	
P. cristatus			O		
Nasalis larvatus	(O)		O		
Macaca fascicularis			O		
Hylobates muelleri		O		O	O
Pongo pygmaeus				O	(O)
Order Rodentia					
Ratufa affinis				O	
Callosciurus					
Sundasciurus sp.		O			
Rhinosciurus laticaudatus		O		O	
Petaurista ? petaurista		O		O	
Rattus sp.		O		O	
Order Carnivora					
Mustela nudipes	O				
Viverra tangalunga	O				OC
Neofelis nebulosa		C			
Order Artiodactyla					
Sus barbatus	O	F		F	F
Tragulus sp.	F	F			
Muntiacus muntjak		F			F
Cervus unicolor	F	F			F
Bos javanicus	F				

O: Direct observation, D: Captured, F: Foot print

three times during a cruise from Samarinda to the river mouth; two were troupes and one was a solitary male. Mangrove forests more developed at the seashore of the Bay of Balikpapan than on the riverside of the Mahakam River, and Nasalis larvatus was said to be seen around Sotek. Macaca fascicularis was common between Sebulu and the river mouth.

The presence of Hylobates mulleri can easily be known by the peculiar cry in the morning and evening. In two sightings, they were moving in a pair. Two to three Pongo pygmaeuses lives in the university forest of Lempake (Two animals were found close to each other in one sighting). Dr. Takuo Yamakura (Osaka City University, Department of Biology) sighted it during botanical investigation between the immigrants village and K.T.I. Co., in Sebulu, and the interim report by the Third Group refers to their observation of an individual captured in Sebulu recently.

Order Chiroptera: No large cave is known in the area investigated. During investigation at night, solitary flight of bats was observed for several times. No flying-fox was sighted.

Order Rodentia: Rodents can roughly be classified into diurnal squirrels and nocturnal rats. Squirrels, especially genus Callosciurus, were commonly seen in secondary forests and in and around villages. A Ratufa affinis was found carrying nest material near the entrance of the university forest at Lempake. Nocturnal, flying squirrel Petaurista was common in secondary forests and near villages. Hystrix brachyura or Thecurus crassipiris was not sighted, but its threat snorting was heard at night along forest roads. Seventeen species of the genus Rattus are distributed in Borneo, some of which were sighted at night and captured with traps.

Order Carnivora: Viverra tangalunga in the family Viverrinae was commonly found in secondary forests and near villages. They walked calmly under the headlight of a car at night. An individual killed by a running car was collected. Two species of weasels were seen 12.6 km from Sotek. A Neofelis nebulosa captured with a leg trap was found in the university forest in Bukit Soehurto. These carnivores of a medium size are the

final consumers because of the absence of largersized predators like tigers.

Order Artiodactyla: Sus barbatus and Cervus unicolor were abundant in the primary forest as well as in the secondary forests. The former damages corn and banana in the shifting farms. At a point 22 km from Sotek and further 17 km along a branch road, most of the young trees of the genus Nuclea were found deprived of the bark by "horn sharpening". Footprints of Muntiacus muntjak and Tragulus sp. were also common, although they are not so many as those of the above two species. Foot prints of Bos javanicus were found on the same branch road.

As to Order Perissodactyla, Tapirus indicus has been extinct since the prehistoric age, and Rhinoceros sondaicus is not distributed. No trace of endangered Didermocerus sumatrensis was found.

(3) Vegetation as Wild Animal Habitats

The vegetation in which land mammals live in Borneo is 1) tropical rain forest, 2) Mangrove forest and 3) mountain area.

We need not consider the conservation of wild animals inhabiting undisturbed, tropical rain forests if no hunting is undertaken. In cities, villages, and shifting farms, only a few species of rats have adapted their lives to the human environments or rather thrive as pests. Habitats of wild animals worth conserving would be the secondary forest formed after cutting. Secondary forests after selective cutting are rapidly extending, but practically nothing has been known of the capacity for wild animals in the points of numbers of species and their population densities. This will further be mentioned at the later chapter.

Inhabitants in the mangrove forests are completely different from those in the tropical rain forests. Presbytis cristatus and Nasalis larvatus inhabit practically mangrove forests only. The latter is endemic to Borneo and is a peculiar primate. In Sabah, others are abundant on the riverside of the mangrove forests and small branches of rivers (Furuya 1976). Small mammal fauna is not well-known.

Animals living only in the mountainous area,regarded by both Harrison (1964) and Medway (1977) as independent species, are two three shrews Tupaia montana and Dendrogale melanura and six species of rodents, Glyphotes simus*, Sundasciurus jentinki, Dremomys everetti, Rattus baluensis*, R. alticola, and R. baeodon*. They are all small mammals and endemic to Borneo (Those with asterisks were found only on Mount Kinabalu). Because of their limited habitat preference, their distribution ranges and the total population should be small.

(4) State of Forest Wild Animal Utilization by Man

In order to utilize the wild animals living in the forests, natural resources sufficient for regeneration of the amount utilized must be maintained. If the rate of utilization is as high as to spend the "capital", or if no positive means of utilization such as introduction of artificial breeding is introduced, it is not "utilization" but it should be called "plunder". In this respect so far as the forest being utilized is concerned, there is nothing other than plunder in Kalimantan. In the age when primary forests corresponding to "capital" existed beyond plunder areas, or in such regions, the "utilization" would have been to the extent not to spend the capital.

There is no restriction against capturing and killing wild animals, especially mammals and birds. The means of capturing is trapping or expelling by dogs because possession of firearm is not permitted except for the army and police. The object of killing is 1) as proteinic food, 2) protecting shifting farm, 3) as a pet animal, 4) for medicine or charm (horn and tusk of rhinoceros), etc.; and in addition, the number of animals killed just because they were found is not small. Since trapping is the usual means, the trapping method and the preys will be mentioned.

1) Capture by Trap

Two kinds of traps are used: wire trap and bow trap. The wire trap has two types; leg trap, binding legs, and neck trap, binding neck. The trapping procedures are as follows:

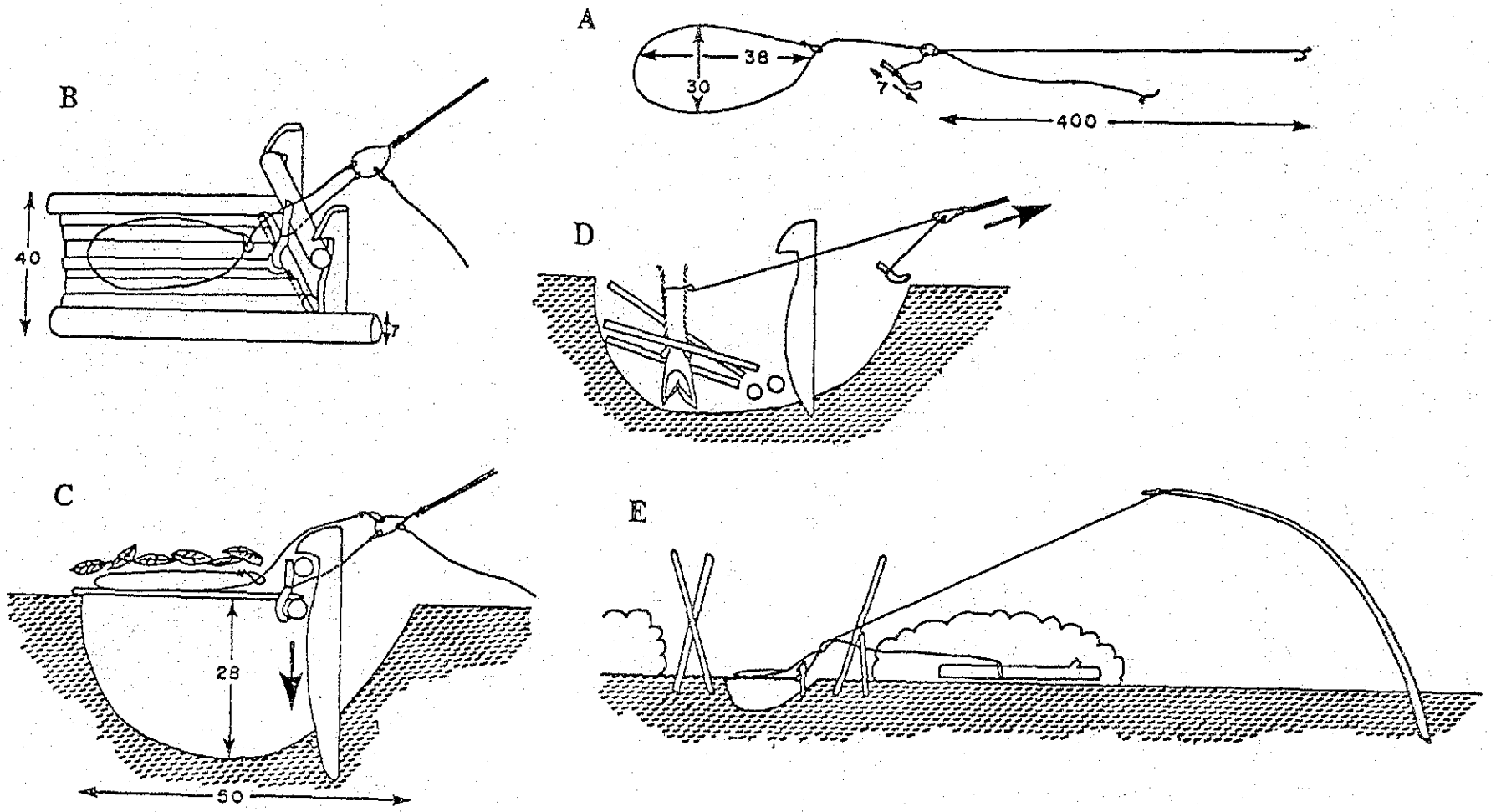

Fig. 2 Leg trap

(A) Leg trap (Jerat kaki): A in Fig. 2 shows the wire part of the trap. The wire of about 5mm in diameter consists of a loop that works to bind, as long as 105 cm if stretched, and a stretching part 400 cm - 500 cm long. At the connecting part, a stopper of ironwood (sanktan) is bound with a thin but strong wire.

E shows the conditions of setting. The wire is bound to the tip of a pole at the right end of the figure. The pole, 5 cm - 7 cm in diameter and about 300 cm long, is thrusted. Palawan may be the best wood for the pole.

Branches of trees are set on both sides of the loop by crossing into X so that the animal will pass just on the trap. The trap is set on an animal trail, narrow human road, or at the end of a fallen tree (It is dangerous if set on a human road, and some people weaken the tension of the wire).

B shows the state of setting in an oval ring. Thin branches or plates are arranged close to one another but without connection, the loop is placed on the floor and then fallen leaves are scattered for camouflage. Comparatively thick branches are placed on both sides, so that the animal would keep out of them and step on the floor where the loop is set.

C shows a sectional view. One end of branches forming the floor is placed on the ground, while the other end on a branch placed perpendicular to the floor branches. Two branches of the same thickness are laid in a distance of a few cm on two piles, called petik, of ironwood. The two branches are held by a stopper to which the wire is bound at the center (see also B). When an animal steps on the floor, the branch slides down along the pile, and when the stopper is disconnected, wire is pulled by the bent pole, and the loop contracts to catch the leg (see D). The pitfall is gradually thinner at the right end so that the stopper will not be caught by the ground and can fly freely.

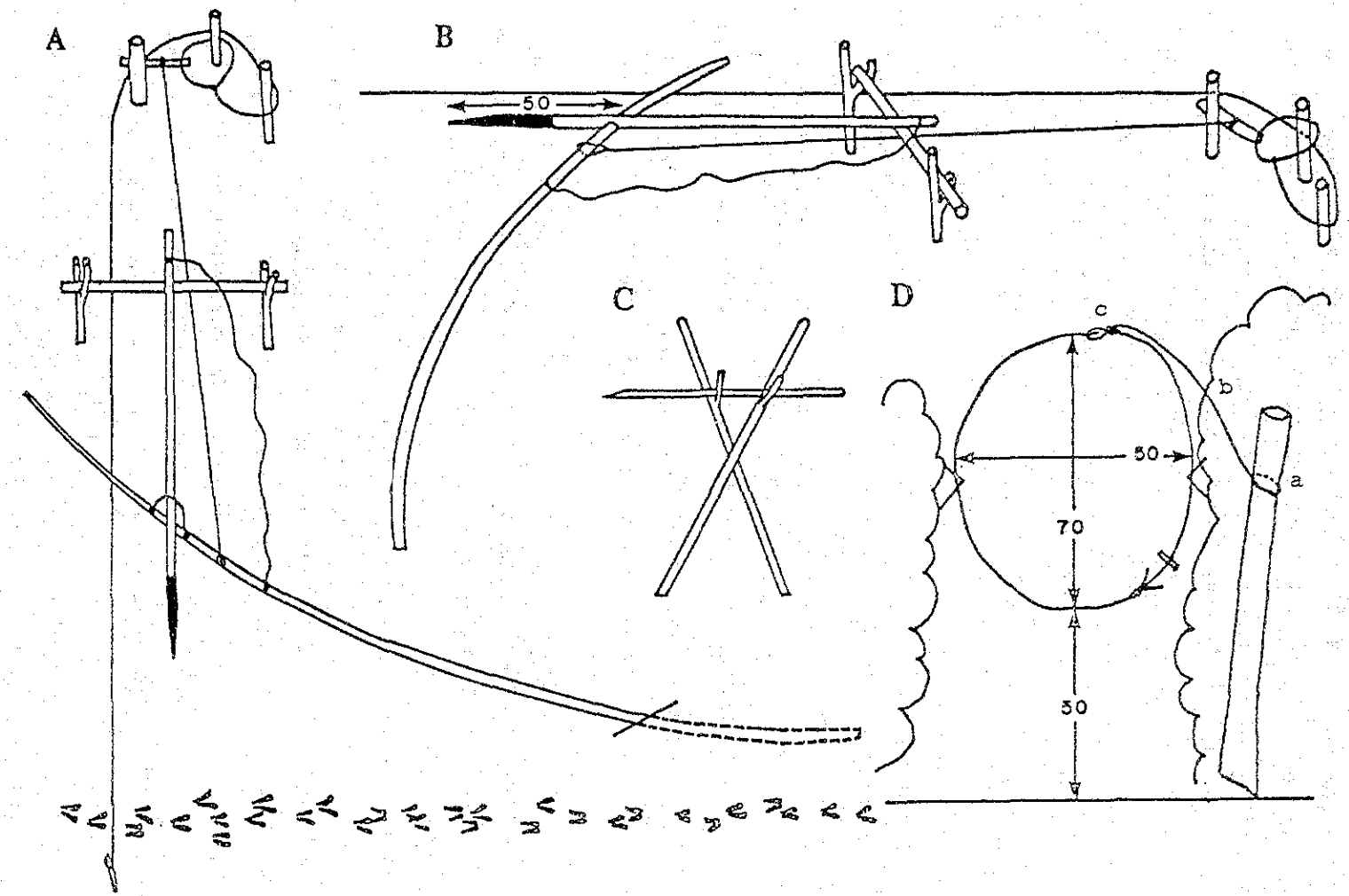

Fig. 3 Bow trap (A-C) and neck trap (D)

From the connection of the wire, another wire is connected to extend, and a log of 250 cm long is bound on the end (see A). This log was seized in the bush in case of the animal getting out of the trap after struggling.

(B) Neck trap (Jerat leher): Fig. 3D shows a neck trap. It was set on a narrow road passing through a bush of fern like a tunnel. The trap was made of wire of 3 mm in diameter. The noose tightens as the animal sticks its neck, and the knot (a) passes through (b) and stops at stopper (c) made of ironwood. Owing to action of the stopper, the noose does not tighten than the thickness of the neck, to prevent the animal from suffocating. To prevent the loop from getting loose, hard wire (b) in V shape is tied on. The wire is tied on a log, standing on the ground loose, and the animal is caught by the bush after dragging the log. The stems of the nearby fern are bent and inserted into the untwisted wire, so that the loop does not swing.

(C) Bow trap (Jerat panah, Hurler trap): This is a device for shooting an arrow automatically when one touches a line of wire stretched on an animal trail, and it is extremely dangerous. The wire is set at 20cm in height above ground. When an animal pulls the wire by the leg, the small loop is pulled, the stopper is disconnected, and the arrow, pulled by the wire, is launched. The arrow (tombak) set on the bow hits the animal. The arrow is connected with the bow, and the animal cannot flee from the place. The shaft of arrow is made of ironwood or bamboo, and the arrowhead of metal is made of ironwood or bamboo, and the arrowhead of metal is inserted on the shaft. The height of the target is set at 40 cm above ground in case of Sus barbatus and 80 cm in case of Cervus unicolor. The length of arrow is 300 cm and the arrowhead is set at 250 cm distant from the animal trail. The bow is 400 cm long and is set by thrusting into ground by 50 cm at a distance of 200 cm from the animal trail. The bow trap used in Sarawak is similar in construction (Meluda 1964).

On the road in front and behind the trap at a distance of 2m, signs shown in Fig. 3C are placed. No poison is usually applied on the arrowhead, but tribe Dayak sometimes uses a poison (obat). It is a sap of tree ipo, Antiaris toxicaria Lesch, and the animal may die within a minute. Another poison used for running in a stream to catch fish, Tuba kapur, Derris elliptica Benth, is said to be effective.

Of the three kinds of traps above, leg traps are most frequently used because of the safety, efficiency, and easiness of handling. It is useful for Sus barbatus damaging corn and banana in shifting farms. The dangerous bow traps are still used against the prohibition, and one must be very careful in walking in forests. A case of a man being killed by the trap about a year ago was heard in Lempake.

2) Capturing by Expelling by Dogs

Animals are expelled out of a forest by a few dogs and are killed by lancing. The lance was made of wood with an iron head.

3) Hunting and Economy

The sizes of animals captured by traps are medium to large. Cervus unicolor* and Sus barbatus* are the main preys, but Muntiacus muntjak*, Bos javanicus*, and Hystrix brachyura* or Thecurus crassipiris* also caught. On rare occasions, Neofelis nebulosa and Helarctos malayanus are caught. Animals with asterisks are eaten as protein source. Sus barbatus is not eaten in Kalimantan where most of the inhabitants are Moslems, but eaten by Chinese and Japanese living in the towns of Samarinda and Balikpapan.

Mr. B, making living by traps, sets 33 neck traps and 28 leg traps at the same time. June, 1981 was a month of large capture, when Sus barbatus, large and small, were captured as many as 11 in total. One Neofelis nebulosa and a bird of the name haruwai was captured in August, and one Cervus unicolor and two Sus barbatus in September. He sells the deer meat to a merchant in a bazaar. It weighs 40 kg - 50 kg per animal, and

the price is 1,500 RP/kg. The weight of wild pig meat is 30 kg - 40 kg/animal, and the price 1,000 RP/kg, according to him. The merchant sells the deer meat for 2,000 - 2,500 RP/kg and the wild pig meat for 1,250 - 1,500 RP/kg.

(5) Changing of Fauna and Wild Animal Population

The change in the fauna and population of wild animals should be mentioned separately in three divisions; tropical rain forests, mangrove forests, and mountain districts. The mountain districts have not been investigated.

Of the mammals living in primary forests, many species may decrease in the number of individuals or be eradicated locally by felling of the forest, but some others may not be affected very much or even increase in the number. It was almost impossible for us to estimate the degree of effect for each of 200 species distributed in Borneo. However, some suggestions were obtained during our investigation.

1) The Effects of Indonesian Selective Cutting on the Fauna

Methodologically, the effect of selective cutting can be estimated, by comparison of the mammalian fauna and their population densities in primary forests and secondary forests. A large scale selective cutting with extension of forest roads by mechanical power has been made for these 10 years. Therefore, faunal change along the forest road will represent that for the last decade. Investigation locations at Sotek and Sebulu meet this requirement. Lempake and Samboja were cut some years ago.

Table 10 shows only the results of observation in the secondary forests after selective cutting. Because of the absence of dry or semi-dry district such as savannah grassland in Borneo, secondary forests provide the habitats of mammals living in the tropical rain forest.

(A) The effect on primates: The following three points are considered.

1) Death during cutting operation, 2) Capture along the forest road for selling as pet, and 3) Deteriorated habitat conditions particularly for quality of food and extent of daily movements. Wilson & Wilson (1975) investigated the same area (ITCI - Weyerhaeuser Concession and Kutai Reserve) and obtained the following conclusion.

Presbytis rubicunda is not affected by cutting. P. frontata and Macaca nemestrina may leave the district temporarily during cutting. Hylobates muelleri survives if the selective cutting is not serious but prefers primary forest. Its population density does not always go down. Species that are most seriously affected by selective cutting and destruction of habitat are Pongo pygmaeus and Nasalis larvatus that are endangered species. The former is slow in motion, and can be killed during cutting operation or captured for a pet. Since its population density is very low anywhere and they are a solitary primate, even capture of small numbers will affect their mating and reproduction (Note: They were found in selective cutting forest during our investigation, but it was impossible for us to estimate the degree of affection to their population by selective cutting).

There are virtually no data for population change of primates before and after cutting. Marsh & Wilson (1981) proposed a hypothetical model for the population change of Presbytis sp. and Hylobates lar after cutting: Presbytis decreases in the number of individuals right after cutting and for 2 to 3 years, but recovers thereafter gradually. Hylobates lar maintains their number of individuals in the primary forest for 2 years after cutting, but loses it gradually 2 to 5 years after cutting, then gently recovers. However, both primates do not recover their population levels in the primary forest even after 30 years.

(B) The effect on ungulates: Didermocerus sumatrensis in danger of extinction will be life-threatening in cut areas. For Artiodactyla, cutting seems to improve their habitat conditions by the growth of underscrub on the forest floor. Local hunters told that their number of individuals reaches the maximum 4 years after selective cutting, then decreases owing to hunting. In the secondary forests investigated, footprints of Sus barbatus and Cervus unicolor were abundant. They live also in a small secondary forest, going to be isolated, such as Lempake.

Some people in Sotek and Sebulu stated that the sighting points of Bos javanicus retreat as the cutting advances. The following two reasons are considered on their disappearance at cutting areas: The animal is low in population densities but lives in groups, so that it is easily hunted to exterminate in the cut area, or the animal retreats because of their "shyness". In either reason, it is true that the total number of individuals is steadily decreasing.

For other animals, Wilson and Wilson (1975) state that the birds and squirrels living in the forest seem to be damaged to the serious degree.

2) The Effects of Mangrove Forest Cutting

In Kalimantan where the land transportation is still undeveloped as compared with North Borneo, water-borne traffic is important; and villages are developed on riverside. Developed mangrove forest cannot be found at present on the riverside of the Mahakam River, except in the river mouth delta zone; and this will be a result of a long history of cutting by man. Primates found only in the mangrove forest and surroundings are Macaca fascicularis, Presbytis cristatus, and Nasalis larvatus. Recently, mangrove is cut on a large scale in North Borneo for pulp resources, so there mammals must be under a deadly blow. Of these three species, Nasalis larvatus is affected most seriously by the destruction of mangrove forests (Wilson & Wilson 1975).

3) The Effects of Hunting

Trap hunting extends in the forest along the forest road of timber company as the forest road extends. The range of trapping is within several kilometers from the road. Mammals living on trees are damaged by selective cutting, and those moving on the ground are captured in a considerable number. Ungulates, except Bos javanicus and Didermocerus sumatrensis seem to increase their numbers over those in the undisturbed primary forest.

Most commonly captured Sus barbatus is left unutilized because of religious reason. Further, owing to traps capturing medium to large-sized animals indiscriminately, animals not increasing their number by selective cutting or those of originally small in number, such as Bos javanicus, Didermocerus sumatrensis and Neofelis nebulosa may suffer considerable damage.

In the mangrove forest, the habitat for mammals living only in riverside forests has been gradually destroyed although on a small scale. In addition, the number of animals captured as pet or killed by throwing a stone seems to be not negligible.

5. Protection of Tropical Rain Forest Ecosystem

(1) Protection of Tropical Rain Forest Ecosystem

1) Protection Criteria for Tropical Rain Forest Vegetation

In protecting tropical rain forest vegetation, two criteria must be established that are the center of protection. One is the criterion for selecting the plant community, or vegetation types, to be protected, and the other is the criterion for deciding protection level for the community to be protected. The latter is a criterion established using the result of evaluating community based on a certain criterion.

Fig. 4 shows a flowchart for the method of applying criteria for selecting communities to be protected, for evaluating communities, and for deciding protection levels.

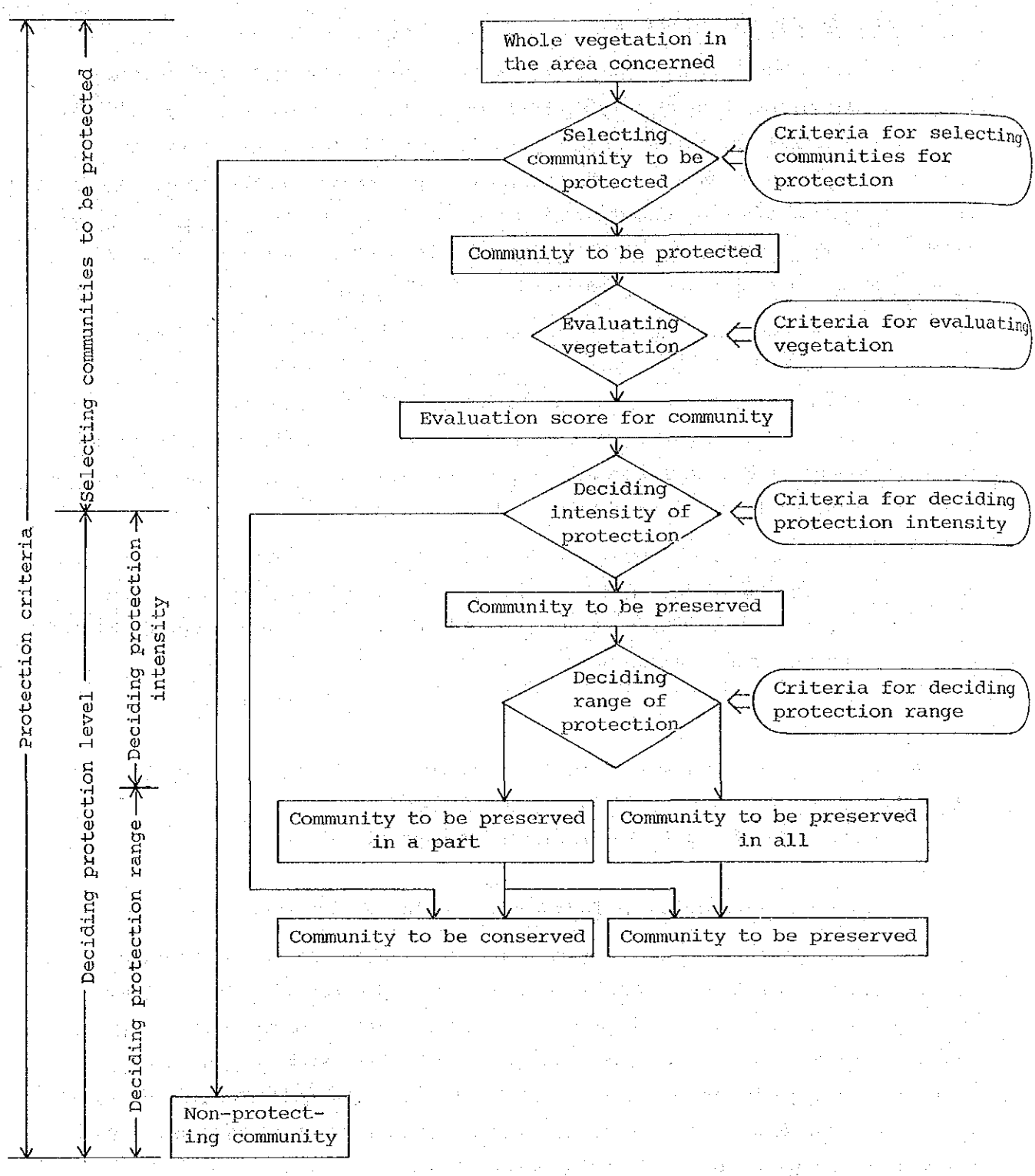

Fig. 4 Flowchart showing the method of applying various protection criteria in vegetation protection

Table 11 The main forest formations of the tropical Far East (Whitmore 1975)

Climate	Soil water	Localities	Soils	Elevation	Forest Formation	
Ever-wet	Dry land	Inland	Zonal soils	Lowlands to 1200m Mountains (750)1200-1500 m (600)1500-3000 (3350)m 3000(3350)m to tree line	1. Tropical lowland evergreen rain forest 2. Tropical lower montane rain forest 3. Tropical upper montane rain foerst 4. Tropical subalpine forest	Tropical rain forests
			Podzolized sands Limestone Ultrabasic rocks	Mostly lowlands Mostly lowlands Mostly lowlands	5. Heath forest 6. Forest over limestone 7. Forest over ultrabasic rocks	
	Water table high (at least periodically)				8. Beach vegetation	
		Salt-water			9. Mangrove forest	
		Brackish water			10. Brackish-water forest	
		Fresh-water	Oligotrophic peats		11. Peat swamp forest	
			Eutrophic (muck and mineral) soils	Almost permanently wet Periodically wet	12a. Fresh-water swamp forest 12b. Seasonal swamp forest	
Seasonally dry	Moderate Annual shortage				13. Tropical semi-evergreen rain forest	
	Marked annual shortage				14. Tropical moist deciduous forest 15. Other Formations of increasingly dry seasonal climates	Monsoon forests

2) Criteria for Selecting Communities for Protection and An Example of its Application

The tropical rain forest community to be protected could be described in short as, "Representative and typical formations of tropical rain forest on various types of habitats in the tropical region". Table 11 shows the principal formation of forest in tropical East East.

In the region of East Kalimantan with Balikpapan, Samarinda, and Nuarakaman as the center, that was investigated this time, the following forest formations among those enumerated in Table 11 are distributed (The numbers show those in the Table 11).

(1) Tropical lowland evergreen rain forest
(2) Heath forest
(9) Mangrove forest
(10) Brackish water forest (nipa forest and others)
(11) Peat swamp forest
(12a) Fresh water swamp forest
(12b) Seasonal swamp forest

Some of these formations, in East Kalimantan, occupy a huge area in the primary conditions full of variety even at present, while some others are rapidly decreasing in number under the effect of human activity. It would be ideal to designate all of such forests as communities to be protected and try to preserve them perfect by suitable protective means, but it is clear that the idea is unrealistic. Therefore, it is desirable to select as many communities as possible and protect them.

In selecting communities to be protected concretely, the following categories can be enumerated as the selecting criteria:

Criteria for selecting community to be protected (case of forest community)

(1) Forest typically showing the characteristics of said formation or its lower unit. (typicalness)
(2) Primary forest or natural forest almost in primary conditions (forest, completely or almost free from selective cutting or other human activity). (naturalness)

(3) Forest formation or its lower unit that is rarely seen in the district. (rarity)

(4) Forest formation or its lower unit that is going to be exterminated or extremely rare in the district by reckless deforestation or other human acitivity. (danger of extermination)

(5) Other forest regarded as important, scientifically, for maintenance of the suitable environment for man, or other reasons. (other importance)

As some of the examples of forest formations or their lower units to suit the selection criteria, the following forests were singled out in the districts with Balikpapan, Samarinda, and Muarakaman as the centers respectively:

Example 1. Tropical lowland evergreen rain forest with Dipterocarpaceae species as the principal component to the north of Balikpapan: (Principal categories of selection criterion; (1) and (2))

Example 2. Rain forest, similar to the above in a part of Sebulu Area: (ditto; (1) and (2))

Example 3. Rain forest similar to the above in another part of Sebulu Area: (ditto; (1))

Example 4. Heath forest around Sebulu: (ditto; (1) and (3))

Example 5. Mangrove forest near Kualasamboja: (ditto; (4))

Example 6. Brackish water forest with mostly nipa in the delta of Mahakam River: (ditto; (1) and (2))

Example 7. A part of swamp forest around Semayang Lake: (ditto; (1) and (2))

Example 8. Old selective cutting forest in Lempake (ditto; (2))

3) Protection Level and its Decision Criterion

(A) Protection Level

Protection levels can be considered from two phases: intensity and range of protection.

The intensity of protection would be considered in two levels

(Okutomi, 1973): preservative protection (=preservation) and conservative protection (=conservation). They are protection levels but could also be called forms of protection.

a) Preservation

This is a level/form of protection where the vegetation to be protected is kept at the present natural state of vegetation "intact" or almost in the state. By vegetation is meant here each of the formations or its lower unit, and by "intact" a state of the plants as living organism under normal growth and death with gradual and local change in vegetation.

Generally speaking,primeval nature is stable in itself as a whole and self-maintaining to be left alone; and no special management against protection object itself (tropical rain forest formation) is necessary, except protection in a narrow sense against external destructive factors such as cutting, forest fire, and other unnatural actions and excessive damage by tree desease, insect, and animal that destroys the normal ecological balance (Okutomi, 1973).

Naturally in this level of "preservation", no direct utilization of the object (timber, for example) to be protected shall be intended.

b) Conservation

This is a level/form of protection where the nature (here tropical rain forest) is protected while it is utilized. Kira (1968) stated, "conservation means to control the system of nature within the normal elastic limit of equilibrium, so that the maximum harvest can be obtained from the system." As it is clear from the statement, it is a rational utilization of natural resources. In this level/form of protection, it comes to be a problem of how to obtain the maximum harvest while preventing depletion of natural resources. In this level, to a difference from the foregoing level, some change in the nature is allowed,

but excessive utilization that can damage the natural equilibrium is out of the question. For example, clear cutting of a tropical primary rain forest and succeeding shifting cultivation makes it difficult to recover the formations of tropical rain forest. Therefore, a rational utilization of nature should be within the range of possible and smooth regeneration of forest, and this would limit the selective cutting within a slight degree even in tropical forests.

Let us consider next the range of protection. There are cases where the marked community for protection in the specific area or point be wholly or partly protected, and there are several stages in the range of protection. In the case of the community occupying a huge area, a partial protection could be conceived, while a small area just for survival, a whole protection.

(B) Criteria for Deciding Protection Level

What kind of method should be resorted to in deciding the protection level, that is, intensity of protection, whether by preservation or conservation, and range of protection, wholly or partly, for the formation of tropical rain forest or its lower unit selected, by said criteria for selection, as the community to be protected?

a) Criterion for deciding protection intensity

The intensity of protection for the community selected to be protected should be decided by the valuableness of the community evaluated from every angle.

Evaluating the valuableness of a vegetation or plant community is a very difficult subject. Many methods of evaluation have been proposed, but nothing has been absolute as yet.

The valuableness of vegetation must be evaluated from many points of view, needless to say, of vegetation science, as habitat of wild animals, as elements of land-

scape, and various other aspects. Here as an example, the evaluation method from vegetation science, that is one of the most important aspect, will be explained as follows.

Table 12 shows an example of criterion for evaluating the valuableness of a vegetation community from the aspect of vegetation science.

Table 12 Criterion of evaluating valuableness (importance) of vegetation from vegetation science

Category	Score		
	2	1	0
Typicalness	Very representative and typical	Representative and typical	Not representative nor typical
Naturalness (primevalness)	Very high naturalness (primevalness)	High naturalness (primevalness)	Naturalness (primevalness) not high
Rarity	Very rare	Rare	Not rare
Danger of extermination	Great danger of extermination	Danger of extermination	No danger of extermination
Other importance	Very high	High	Not high

Table 13 Example of vegetation evaluation from the view point of vegetation science

Plant community	Score						Protection level**	
							Intensity	Range
	Typicalness	Naturalness	Rarity	Danger of extermination	Other importance	Total score	Preservation (P) Conservation (C)	Whole (A) Part (a)
A part of tropical lowland evergreen rain forest mainly of Dipterocarpaceae species in Sebulu	2	2	2	1	-	7	P	A
Another part of ditto	1	1	0	1	-	3	C	-
A part of heath forest in Sebulu	1	1	2	1	-	6	P	A
Remaining natural forest near Bukit Soehart	1	1	1	2	-	5	P	A
Old selective cutting forest in ditto	1	1	0	0	-	2	C	-
Mangrove forest near Kualasamboja	1	0	1	1	-	3	C	-
Nipa forest in Mahakam River Delta	2	2	0	1	-	5	P	a
Rain forest in the university forest in Lempake	1	1	1	0	2*	5	P	a

* Educational and scientific importance ** See text

Application of these criteria to tropical rain forests in several districts in East Kalimantan gives Table 13.

Now if the intensity of protection is to be decided by said evaluation of vegetation, the following methods can be conceived.

Evaluation of valuableness		Intensity of protection
One with score of 2 in any of the categories or of 4 as a total of the scores	⟶	Preservation
One with a total of scores at 2 min. but not included in the above	⟶	Conservation

The result of applying the above to the stands of forest shown in Table 13 is shown in the column of protection intensity in the same table.

b) Criterion for deciding the range of protection

The specific stand of forest that is decided to be protected at "conservation level" according to what has been described above should be protected at the conservation level for the whole extent.

On the other hand, the specific stand of forest that is decided to be protected at "preservation level" that is a more intensive protection form shall be under total restriction of utilization. Therefore, in case of the stand being of a huge area or stands of the same community being found in other districts, preservation of the whole area would be unrealistic; and a part of the area shall be protected under more relieved restriction by conservative protection, without protecting the whole area by preservation.

As one of the means (criteria) for deciding the range of protection, the following method can be conceived.

Appraising rarity and danger of extermination in evaluating valuableness		Range of protection (whole or a part)
One rated by score 2 in one or both categories	→	Whole preservation
Ones other than the above	→	Preservation and conservation for the rest in part

Application of the above to forest stands shown in Table 13 to be protected by preservation gives protection levels shown in the column for protection range in the table.

(2) Protective Policy and Animals to be Protected

In tropical rain forest where a great number of kinds of animal species live, the ecosystem of the forest would not be very much damaged even if some mammals exterminate. In fact some species are more or less lacking in some islands of Indonesia.

However, not only in Kalimantan but in Indonesia as a whole, there are many peculiar birds and mammals. If one considers the fact that the abundant wild animals in East Africa is one of the important sources for acquiring foreign money, protection of abundant wild animal is not necessarily against development of the country.

Usually the objects of protection are medium to large-sized peculiar birds and mammals and special and curious beasts; for it is the world-wide phenomenon that medium to large-sized birds and mammals which connect with particular habitats or environments are exterminating keeping pace with destruction of the nature.

Mammals to be protected are some of Primates, Chiroptera living in cave, Dermoptera, Pholidota, some of Rodentia, Carnivora, Perissodactyla, and Artiodactyla.

The following conditions can be conceived for the species to be protected: 1) species endemic to Borneo (especially those which have no closely related species), especially peculiar species, 2) species not endemic to Borneo but endangered, 3) scientifically valuable species, etc.

Actually the following species are listed up: Primates: Tarsius bancanus, Nycticebus coucang, Nasalis larvatus, and Pongo Pygmaeus; Pholidota: Manis javanica; Carnivora: Neofelis nebulosa; Perissodactyla: Didermocerus sumatrensis; and Artidactyla: Bos javanica.

For the areas of nature reserves to be established, the following conditions should be considered: 1) To have a huge primary forest behind the reserves, 2) To be accessible by land transportation. That Pongo pygmaeus and Presbytis aygula are not distributed on the southern side of the Mahakam River (Wilson & Wilson 1975) must be taken into consideration in establishing the nature reserves. Protection and restriction by enlarging the existing Kutai Nature Reserve (see Reksodiharjo et al., 1974) with addition of the surrounding secondary forests would be a plan that can be practiced immediately. Besides, mountain reserves may be necessary to establish, for mammals endemic to mountainous regions may possibly exist.

(3) Protection of Tropical Rain Forest as an Ecosystem —— as a subject of study in the future ——

We have explained our result of observation on the vegetation in East Kalimantan, especially formation of tropical rain forest, and wild animals there, especially mammals, with some considerations for their protections respectively.

However, it is needless to say that the nature is not a set of the constituting elements living independently, but it is existing as a unified system, or ecosystem. Therefore, protection of nature must be protection of ecosystem. This is the same in the case of the nature in the region of tropical rain forest that is dealt with in the present report. It must be a protection of ecosystem in the tropical rain forest.

Unfortunately, however, we were not able to discuss the subject as far as it should be, and we could only discuss on the vegetation and mammals among the constituting elements of the ecosystem of tropical rain forest, practically no discussion being given to other biological elements and inorganic elements such as atmosphere, water, soil, etc., and interrelation between the elements being practically untouched. However, the nucleus of the ecosystem in the tropical rain forest should be regarded

as the formations of tropical rain forest and the mammals, and in this regard, an outline of the nucleus of the ecosystem in the tropical rain forest in East Kalimantan has been grasped and some discussion on its protection has been given, we believe. We also believe that it is our future subject of study to analyze more widely and more in detail based on the present study and search for pertinent integrated means of protection based on the result, and an urgent investigation and study are waited for.

6. Summary

1) The present investigation and study deals with the protection of tropical rain forest ecosystem, especially fundamental study for establishing protection criteria; and it was carried out with East Kalimantan as an example where the most typical tropical rain forests are reserved in Southeast Asia.

2) The investigated area includes the whole area with Samarinda, the capital of East Kalimantan, as its center, and consists of Samboja (Bukit Soeharto) Kualasamboja, Mahakam River Delta, Lempake, Sebulu, and Muarakaman-Semayang Lake, six areas in all.

3) In each of said areas, vegetation of natural forests, selective cutting forests, secondary forests, secondary scrubs, natural grasslands, and secondary grasslands was analyzed or observed; and an outline of vegetation in each of the areas was grasped. As the formations of tropical rain forest occurring in the areas, tropical lowland evergreen rain forest, heath forest, mangrove forest, brackish water forest, peat swamp forest, fresh water swamp forest, seasonal swamp forest, etc. can be enumerated. Of the forests enumerated, tropical lowland evergreen rain forest (selective cutting forest) was predominant in Samboja, mangrove forest in Kualasamboja, mangrove forest and brackish water forest (nipa forest) in Mahakam River Delta, tropical lowland evergreen rain forest (selective cutting forest and natural forest) in Lempake, tropical lowland evergreen rain forest (virgin forest) and heath forest in Sebulu, and peat swamp forest, fresh water swamp forest, and seasonal swamp forest in Muarakaman-Semayang Lake, respectively. Especially the tropical lowland evergreen rain forest (dipterocarp forest) in a part of Sebulu is one of the outstanding forests in Southeast Asia.

4) Relationship between vegetation and man in the region of tropical rain forest, especially with destruction and disturbance of vegetation by man as the focus, was discussed.

5) Fauna in East Kalimantan, especially mammals, were investigated. Mammals captured in 5 districts of Sotek, Bukit Soeharto, Delta-Sebulu, Lempake, and Sebulu were 6 in species and 9 in individuals, and those witnessed 19 species and 42 times.

6) The effect of cutting of tropical rain forest and hunting on the change of fauna and wild animal populations living there was discussed.

7) Protection criteria for tropical rain forest ecosystem, especially for the vegetation, including selection criterion of community to be protected, evaluation criterion for vegetation, and criterion for deciding protection level, were set up, and their application to vegetation in East Kalimantan was attempted as a case study.

8) The species of animals to be protected in East Kalimantan were enumerated, and proposal was made for the measures for their protection, establishing *reserve area, for example.*

9) Need of protection of tropical rain forest as an ecosystem was stated, and examination of integrated protective measures for the ecosystem of tropical rain forest, including protective criteria for the ecosystem, was referred to as the future subject to be studied.

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