THE GOVERNMENT OF MALAYSIA
THE STATE OF SARAWAK

MIRI-BINTULU

REGIONAL PLANNING STUDY

SUPPORTING REPORT

No. 3

FORESTRY AND CONSERVATION

—1974—

HUNTING TECHNICAL SERVICES LTD. LONDON

HOFF AND OVERGAARD COPENHAGEN

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C O N T E N T S

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C O N V E R S I O N S

Linear measure

1 mile	equals	1.609 kilometres
1 yard	equals	0.9144 metres

1 chain equals 22 yards

1 foot equals 0.304 metres
1 inch equals 25.4 millimetres or 2.54 centimetres

Square measure

1 square mile	equals	2.58 square kilometres
	equals	258.9 lectares
1 acre	equals	4046.8 square metres
	equals	0.404 lectares

Cubic measure

35.31 cubic feet	equals	1 cubic metre
1.273 cubic feet (true)	equals	1 hoppus foot

40 cubic feet (true) equals 1 shipping ton
63.7 cubic feet equals 1 ton hoppus
or 1 hoppus ton

1 ton (true) equals 1.43 cubic metres

Weight

1 ounce (16 drams)	equals	28.34 grammes
1 pound (16 ounces)	equals	0.453 kilogrammes
1 pikul = 133.33 pounds	=	60.48 kilogrammes
100 kati	equals	1 pikul

PART 1

FORESTRY

INTRODUCTION AND SUMMARY

TERMS OF REFERENCE

Forestry is given a minor role in the Terms of Reference; indeed the elements of the so called permanent forest estate are regarded as unencumbered land for agricultural development not withstanding the legal position. The revised scope of work states that "Forest exploitation will be the second major activity based on permanent forest reserves and timber cleared from land scheduled for future agricultural development. Processing of timber should be done within the region as much as possible. In line with the major emphasis on agriculture and forestry at least initially a first requirement is to develop a broad use classification of the whole area demarcating areas to be reserved for modern agriculture, traditional agriculture, permanent forest exploitation, conservation and mining. Particular attention should be given to the zonation between forestry and other land use and to the phasing of forest exploitation with land development in the semi-detailed master plan. In this connection it will be necessary for the Consultants to liaise closely with the Forest Department and the UNDP/FAO personnel."

The phasing of exploitation with land development tentatively beyond the semi-detailed plan area soon proved essential and was readily agreed to by UNDP/FAO Team. Also the enunciation of general plans, principles and policy for the Study Area as a whole has led to suggestions for some adjustment of FAO plans for wood based industrial development in the Bintulu area. On these two points the Terms of Reference have been exceeded.

SUMMARY

Forest policy aims at the highest possible sustained yield with emphasis on maintenance of the protective function inherent in conservation. Allocation of land suitable for agriculture leans heavily on forest land because of scarcity elsewhere. Forest types are described and resources valued and a permanent forest estate comprising all land unsuitable for any other purpose is forecast at over 60 per cent of the total Study Area. Swamp forests have been under sustained yield management for many years but hitherto Mixed Dipterocarp forests have been worked only for release of land for agricultural development: exploitation has been selective and wasteful because it has been orientated towards the export of raw logs. The multi-million dollar primary industrial development planned for Bintulu by the FAO Team is concisely described and economic implications discussed. Controls are suggested covering both agricultural release, permanent forest exploitation and silvicultural requirements. Phasing of forest and

agricultural development is described with a programme of action. Such pioneering with so small a department and so little knowledge of the silviculture of Mixed Dipterocarp forests behind it demands a massive effort in research and a bold expansion and restructuring of the Forest Department.

CHAPTER 1

CHIEF CONSIDERATIONS

1.1 FORESTRY OBJECTIVES

Forestry objectives are described in the statement of Forest Policy approved by the Governor in Council on the 23rd of December 1954 and are aimed at the highest possible sustained yield of timber and other forest produce from Forest Reserves and Protected Forest applied as far as may be possible to each district and not only to the country as a whole. The protective function of forest is to be maintained, even where the correct land use has still to be determined, and the utmost use of forests ensured before alienation of land. There is enjoinment not to allow sawmills to be built with a capacity beyond the source of supply and to foster the export trade but with priority on local trade. Forest and timber research has full support in most aspects and education receives special mention. These aims are still current with two important alterations: plantations were not mentioned but they now feature in a current policy declaration. The former declaration that Government interest in commercial exploitation will be limited to experimental projects became out of date on the constitution of the Sarawak Timber Industry Development Corporation with wide functions and powers (Sarawak Government Gazette XXVI No. 2 1973): the subject of a Working Paper (FAO 1972 d).

With agricultural development designed to settle people from other parts of Sarawak as a major theme of the development programme under the Terms of Reference and because land suitable for agriculture was found from the reconnaissance Soil Survey to be in short supply elsewhere, most of this development has had to be planned in land under forest. The co-ordination of forest activity with demarcation, road alignment, road construction and phased exploitation of finally allocated agricultural development areas must therefore be a major forestry objective in the Study Area. Forestry, in terms of manpower, will increasingly be secondary to agriculture, but in terms of gross regional product the reverse is true and one of the main objectives must be to see that this contribution is safeguarded far beyond the twenty year term covered by the plan. This introduces perhaps the main objective: conservation of natural resources for which forestry must be at the core.

The need for conservation of natural resources has been dramatically brought to the attention of the whole world by the sudden action of the main oil suppliers in not only using oil supply as a political weapon but in acting in a manner that suggests more care for the theorem of limits than the doctrine of growth: oil kept in the ground in a world of monetary inflation they seem to think is a better investment than oil exchanged even for gold. The argument can be applied to timber when it is remembered that a rotation of 100 years is

probably too short a time for natural replacement of the fine forests of Sarawak with anything remotely resembling them. At least if proposals to make National Parks are implemented as now given prominence in Part 2 of this Supporting Report, there will remain a physical record of the country's former heritage.

CHAPTER 2

FOREST RESOURCES

2.1 INTRODUCTION

The forest resources of the Study Area are in Forest Reserves, Protected Forests, Communal Forests and on land other than Native Customary Land or Titled Land. Under the Terms of Reference the task is to assess these resources and show how they should be re-classified in accordance with the principles of correct land usage. For this, the present resources must be described, catalogued and valued as they exist at present and as they will become if the development proposals are implemented and all land suitable only for forestry is incorporated into the forest estate as permanent forest. National Parks have, in the past, been regarded also as part of the forest estate.

2.1.1. Summary

Forest types are described and figures given for the resource value. The components of the present forest estate are catalogued. The method of land capability allocation between forestry and agriculture is described and projections for the future prepared which show that 53 per cent of the land in the Study Area should be in the permanent forest estate. Land which is now regarded as unsuitable for agriculture although now under shifting agriculture may one day be added to the forest estate and all land suitable only for forestry, exceeding 60 per cent of the total Study Area, would then comprise the permanent forest estate.

2.2 FOREST TYPES

Figure 2.1 illustrates the distribution of forest types and non forest found within the Study Area and is derived mainly from information published on the 1:250 000 scale land use sheets as noted on the figure. The forest types illustrated are peat swamp forest, hill forest and kerangas, and Table 2.1 shows the correlation between the terms used on these maps and the technical terms used in forest terminology for the interpretation of aerial photographs (Brunig, 1969).

Large areas of forest have been destroyed by shifting agriculture: "shagging" as the process has been termed from a combination of the first syllables of the two words (Donis, 1965). Currently published land use data for these areas of shagged land is based on 1963 to 1968 aerial photography. Where possible this information has been updated by the use of more recent photographs (many as recent as 1972) in compiling Figure 2.1.

TABLE 2.1 FOREST TERMINOLOGY CORRELATIONS

1:250 000 Scale Published Land Use Maps Classification (Sarawak Lands & Surveys Series 22, 1968/69	Technical Forest Terminology Classification
SWAMP FOREST	PEAT SWAMP FORESTS
Mixed Swamp Forest	Mixed Peat Swamp Forest
Alan	Shorea Albida Peat Swamp
Padang Paya	Padang Paya
	Padang Keruntum
DRY FOREST LAND	DRY LAND FORESTS
	Mixed Dipterocarp Forest
Hill Forest	Local Forest Types (Limestone, montane, sub-montane types)
Kerangas Forest	Kerangas
Riverain Forest	Riverain
Beach Forest	Beach Forest
SWAMP (PAYA) including Fresh and Salt water swamps, Mangrove and Nipah	Non-Forest Mangrove

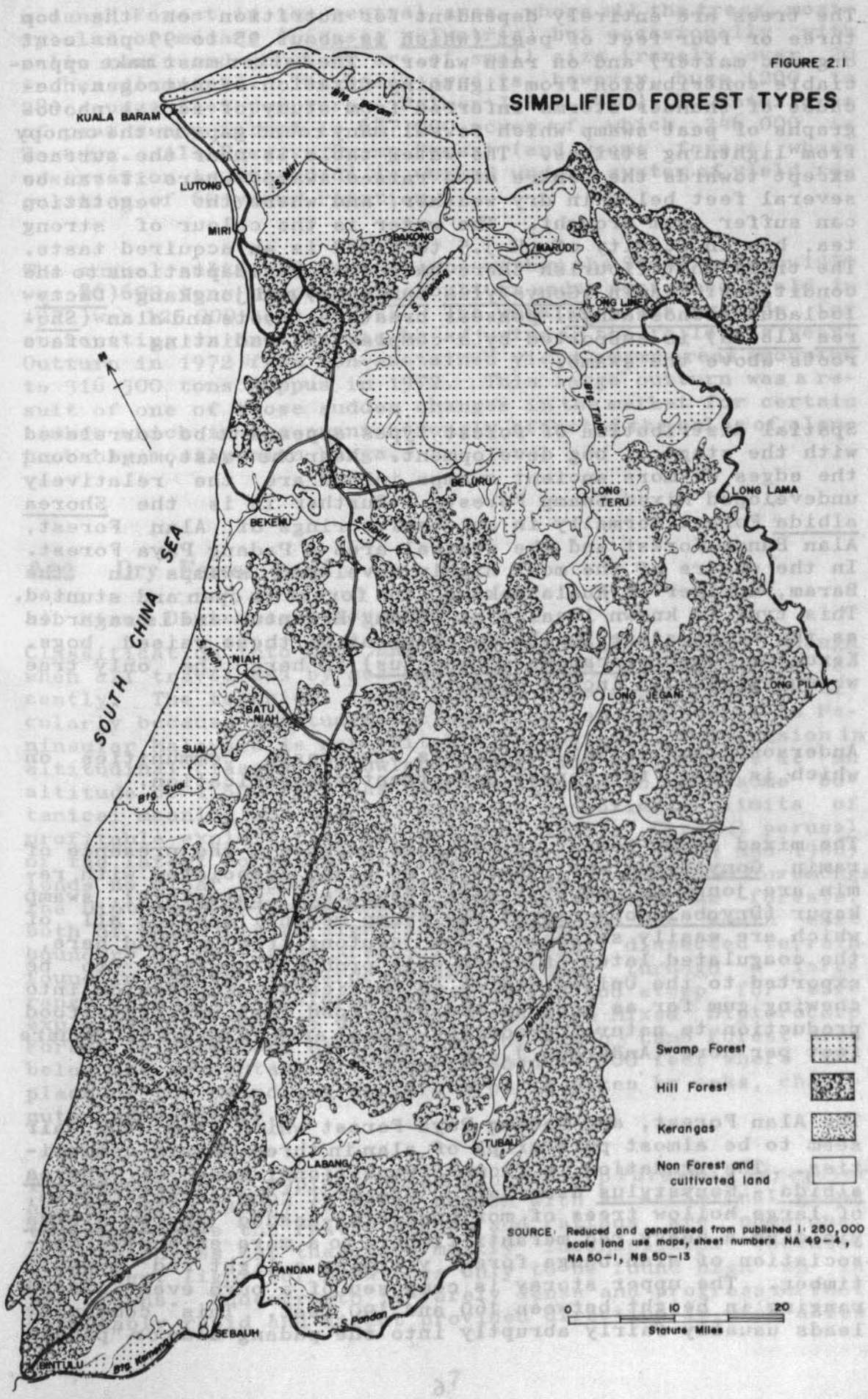
2.2.1. Peat Swamp Forest

Most of the flat land near the coast is covered by peat swamp forest with extensions inland adjoining the major rivers. Over much of a swamp area the underlying marine or alluvial deposit is below sea level particularly towards the centre. Accurate levels across a typical peat swamp have shown the surface to be domed. The peat is of organic material in which are branches, roots and trunks of trees, in various states of decomposition and heavily compacted below the water table. In the anaerobic conditions of a water logged swamp fallen leaves accumulate faster than they are decomposed. Living and dead roots add to the depth of peat.

From radio carbon dating (Geological Report, 1959) and pollen analysis, peat has been shown to accumulate at an average rate of about one foot in 100 years. In an area investigated near Marudi on the Baram river mangrove pollen was found at the base of the peat (35 to 40 feet, though depths of 80 feet have been recorded) indicating that the site was probably near the coast about 4 500 years ago. The present coast is 30 miles away so the Baram delta would appear, from a simple calculation, to have moved seawards at a rate of 35 feet per year during the last 4 500 years. Thus pollen-analysis indicates that the horizontal pattern of vegetation types found on the ground is also likely to be found in a vertical succession in the centre of these raised bogs (Anderson J.A.R.,1963).

FIGURE 2.1

SIMPLIFIED FOREST TYPES



The trees are entirely dependent for nutrition on the top three or four feet of peat (which is about 95 to 99 per cent organic matter) and on rain water. The latter must make appreciable contribution from lightning fixation of nitrogen, because of thunder storms inferred from study of aerial photographs of peat swamp which reveal many round gaps in the canopy from lightning strikes. The water table is near the surface except towards the centre of a raised swamp, where it can be several feet below in dry weather, and where the vegetation can suffer from drought. The water is the colour of strong tea, has an acidity of pH 3.5 to 4 and is an acquired taste. The trees that flourish there have obvious adaptations to the conditions: ramin (Gonystylus bancanus) and jongkang (Dactylocladus stenostachys) possess breathing roots and alan (Shorea albida) is supported by a complex of radiating surface roots above the swamp.

Spatial distribution of forest types appears to be correlated with the stage of bog development. Near the coast, and round the edges of more ancient swamps inland are the relatively undeveloped Mixed Swamp Forests. Further in is the Shorea albida Forest normally in successive rings of Alan Forest, Alan Bunga Forest and the central area of Padang Paya Forest. In the centre of the most highly developed swamps in the Baram, upriver of Kuala Bakong, the forest is open and stunted. This type is known locally as Padang Keruntum and is regarded as the final stage in the development of these raised bogs. Keruntum (Combretocarpus rotundatus) is here the only tree which exceeds 12 inches diameter.

Anderson J.A.R.,(1961) describes six phasic communities on which is based the Forest Department classification.

The mixed swamp forest is valuable because of the presence of ramin, Gonystylus spp; there is no alan. Associated with ramin are jongkong, sepetir paya (Copaifera palustris), swamp kapur (Dryobalanops rappa) and swamp meranti species all of which are easily saleable. The jelutong tree is found here, the coagulated latex of which will probably continue to be exported to the United States of America for conversion into chewing gum for as long as the pure food laws restrict food production to natural products. Basal area is about 160 square feet per acre (Anderson J.A.R., 1961).

The Alan Forest, and Padang Paya Forest which from the air seem to be almost pure crops of alan in three phasic communities. The gradation is from a transitional zone of Shorea albida - Gonystylus association often of considerable depth, of large hollow trees of moribund stag-headed Shorea albida yielding a heavy red meranti timber, to a more extensive consociation of alan bunga forest yielding a light red meranti timber. The upper storey is composed of a pure even canopy ranging in height between 160 and 190 feet. This community leads usually fairly abruptly into the padang alan or "padang

medang" Forest in the central area, where all the trees, mostly alan or medang (Litesea palustris) but occasionally with relic ramin and jongkong are of small size (rarely over 20 inches diameter). The basal area is, however, huge (200 to 280 square feet per acre - Palmer J.R., 1970). The total area of peat swamp forest is 687 000 acres of which 346 000 is Reserve. All Reserve Swamp Forest (and some forest whose reservation is intended) is worked under a system of yield regulation of 60 years rotation.

The annual sustained yield coupe within the Study Area in 1971 was 86 600 tons hoppus. The outturn under sustained yield in 1972 was 125 000 tons hoppus. The working plans provide for overcutting in one year to be adjusted in the following year. Outturn in 1972 from non-sustained yield swamp areas amounted to 316 300 tons hoppus in 1972. This large outturn was a result of one of those sudden changes in the market for certain timber which in the event strongly affected the sales of alan, probably mostly alan bunga.

2.2.2 Dry Forest Land

a) Mixed Dipterocarp Forest

Classification into Hill and Swamp Land was natural enough when all travel was by sea or river as in Sarawak until recently. The technical terms are now more appropriate particularly because altitudinal classification applicable to Peninsular Malaysia is not suitable for Sarawak. Subdivision in altitudinal classes of lowland forest and hill forest at an altitude of 1 500 feet has been considered to have some botanical meaning and also to mark the approximate limits of profitable exploitation (Browne F.G. 1955). Careful perusal of the latest botanical evidence (Ashton P.S. 1964 and 1968) lends no clear support to an altitudinal classification amongst the Dipterocarps below the montance and submontane forests, both of which figure significantly only on the south east boundary of the Study Area. In the highly dissected terrain found in Sarawak Dipterocarp can be found through a large range of altitudes slopes deemed by FAO too steep for safe exploitation (over 35 degrees). The term Mixed Dipterocarp Forest is therefore used for most of the Dry Land Forest Area below the submontane altitude of about 4 000 feet where the place of the dwindling Dipterocarps is taken by oaks, chestnuts and conifers.

The structure of typical Mixed Dipterocarp Forest is irregular and the main canopy is often uneven with an occasional giant towering above the rest. Lianes and rattans are numerous, also epiphytes but these are mostly inconspicuous because sufficient light for growth is only to be found high up in the crowns. Undergrowth is rarely dense and progress on foot reasonably rapid and direct provided direction is, for a few

moments, changed slightly so as to veer past areas of denser undergrowth that can be foreseen by looking out for lightening of the canopy ahead.

The FAO inventory at timber group level for Mixed Dipterocarp Forest on slopes less than 35 degrees (considered the limit of economic tractor logging) records 614 species (179 dipterocarp) from 213 genera and 61 families. The non-dipterocarps account for only 30 per cent of the net volume over 18 inches reference diameter (diameter at 4.3 feet above ground or just above buttresses) and are mostly too scattered to be currently marketable.

This great diversity of trees makes profitable working difficult. FAO lists 81 timber species of the more important commercial types. They include trees yielding heavy hardwoods, such as selangan batu; medium hardwoods, such as kempas kapur and keruing; and light hardwoods such as meranti. The total estimated net commercial volume is, according to F.A.O., (see Section 2.4 for definition) of the order of 20 true cubic tons per acre from 18 inches plus diameter (15.7 tons hoppus per acre). Exploitation in the past has rarely yielded more than 10 tons per acre, hoppus, on an average because too often only the floaters were extracted and few logs below 20 inches diameter were included. The non-dipterocarps, though occupying 30 per cent of the volume are a "major forestry problem facing the State at the present time" (F.A.O., 1973). Present yields of merchantable timber which rarely exceed 10 tons per acre, are no indication of the possibilities when local processing of logs take place and more species and smaller sizes become marketable.

The main untapped forest resources are the subject of Working Paper 19 produced by the Forest and Forest Industries Development Project of the Food and Agriculture Organisation of the United Nations, Kuala Lumpur (F.A.O. 1973 (b)).

The three FAO industry units located in the Study Area total 630 000 acres of which 454 000 acres are classed as high volume density forest. The total net commercial volume is estimated at 462 086 000 cubic feet (true) averaging 1 020 cubic feet per acre (16 tons hoppus per acre). Virtually all other mixed dipterocarp forest in the Study Area easily accessible or soon to be easily accessible by road has been or is being exploited under licence (excluding, of course, National Parks). Outturn from these licenced forests reached a peak in 1968 during accelerated exploitation to release land for agricultural development. Only one area Niah Forest Reserve, is being worked under a rotation restriction; here the annual coupe is 64 000 tons hoppus on a theoretical rotation of 70 years (1972 outturn 66 100 tons hoppus). In general one can say that at present rates of logging mixed dipterocarp forest exploitation in existing licence areas will be completed in 6 or 7 years excepting in so far as salvage fellings are permitted and are practical.

b) Kerangas Forest

Kerangas is a comprehensive Iban term to describe land unsuitable for growing hill rice. Several types can be distinguished. In general white sand is a feature, covered by a thick layer of humified vegetable litter (mor) and the drainage is impeded by a sometimes hard cemented humus or humus-iron pan very dark in colour and occasionally several feet below the surface in soils described until recently as giant podsols. The soil lacks nutrients, is acid in reaction and water draining from it is the colour of strong tea as in peat swamp forest. Near towns like Kuching and Miri the Chinese often clear the land for crops but the fertility is soon exhausted and it reverts to valueless scrub forest.

Current policy discourages applications for this type of land except for residential purposes.

Highly specialised soils are characterised by single species domination and Kerangas is no exception. The characteristic species is ru ronang (Gymnostoma nobile or, to the more conservative Casuarina nobile). Other typical trees are:kerangas kerangas (Hopea spp.), enkabang rusa (Shorea Stenoptera, yielding a small sized illipe nut rich-in-oil, and Kawi(Whiteodendron moultonianum).

Most heath forests are of little commercial value but in some areas bindang (Agathis alba) is found. The timber fetches high prices in Australia but unfortunately accessible supplies are mostly exhausted. Individual areas of heath forest are small but the total is about 40 square miles within the Study Area.

c) Riverain

Riverain or "riparian" forest is a type of Mixed Dipterocarp Forest on strips of flat land along banks of rivers, rarely extending to half a mile and known in Sarawak as emperan. The soils are less in fertile than those of the hills behind. The original vegetation has usually all been destroyed by cultivation in spite of the theoretical protection on the immediate river bank provided by the Land Code. On this type of land the enkabang tree (mostly Shorea macrophylla) flourishes naturally or has been planted and produces the valuable though erratic crop known as illipe nut.

d) Beach Forests

Beach forests, Mangrove forests and Nipah are of insignificant importance in the Study Area.

2.3 THE FOREST ESTATE

The Forest Estate in Sarawak comprises Forest Reserves, Protected Forest and Communal Forests. These are finally gazetted after detailed enquiry into existing rights under Native Customary Law. Their function is well expressed in a statement of Forest Policy frequently to be found in Departmental Annual Reports. This statement is based on a declaration approved by the Governor in Council on the 23rd December 1954. Briefly forests are reserved as a permanent source of timber and other forest produce, the safeguarding of water supplies and conservation of climatic and physical conditions. Protected Forests differ from Forest Reserves in allowing wide rights to all people of Sarawak to take forest produce for their own domestic use but not for sale or barter. A Protected Forest may also be constituted where protection of soils is required but where intensive management for productive purposes is impractical because of unsuitable terrain or poor quality vegetation. A Protected Forest is also mentioned as a convenient method of protection in little known territory where the correct use of all the land cannot yet be determined. Communal Forests are set aside at the clear desire of a settled community for woodland to satisfy domestic needs for forest produce. They are under the control of the Administration, not the Forest Department.

Many countries distinguish between Protective Forests and Productive Forests but not Sarawak. This leaves the forest administration to decide what particular precautions to take in dangerous localities to prevent undue erosion. The cost of logging on land with slopes over 35 degrees probably would prevent exploitation. Nevertheless catchment areas where special precautions should be taken need clear declaration and delineation in control maps.

Forest policy has only now in 1973, been officially altered to take into account plantations and, except for experimental research plots, there are none in the Forest Estate.

2.3.1 The Existing Forest Estate

The components of the Forest Estate within the Study Area are given in Table 2.2 which also consolidates future allocations recommended. The distribution of the present Forest Estate is shown in Figure 2.2.

2.3.2 Future Allocation

The projected changes in area of the Forest Estate have now been determined on the basis of the Terms of Reference which require a classification by demarcation of all areas to be reserved for modern agriculture, traditional agriculture,

FIGURE 2.2

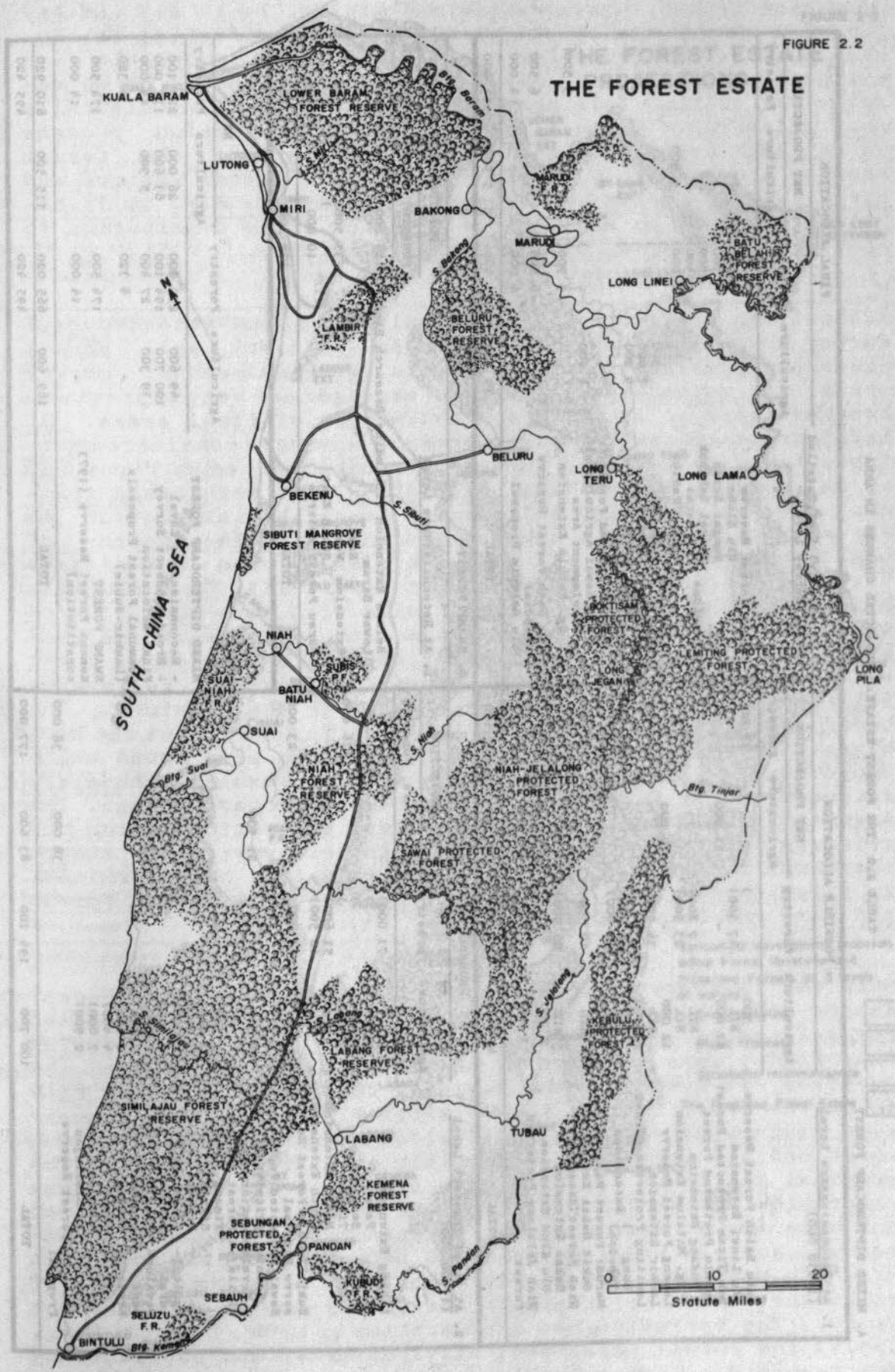

THE FOREST ESTATE
KUALA BARAM
LOWER BARAM FOREST RESERVE
Sg. Miri
Sg. Baram
LUTONG
MIRI
BAKONG
MARUDI F.R.
MARUDI
BATU BELAH FOREST RESERVE
LONG LINEI
Sg. Bakong
BELURU FOREST RESERVE
LAMBIR F.R.
N
BELURU
LONG TERU
LONG LAMA
BEKENU
Sg. Sibuti
SIBUTI MANGROVE FOREST RESERVE
SOUTH CHINA SEA
BOKTISAM PROTECTED FOREST
LEMITING PROTECTED FOREST
LONG PILA
NIAH
SUBIS P.F.
SUAI NIAH F.R.
BATU NIAH
ONG JEGAN
SUAI
Sg. Niah
Brg. Suai
NIAH FOREST RESERVE
NIAH-JELALONG PROTECTED FOREST
Brg. Tinjar
SAWAI PROTECTED FOREST
Sg. Similajau
Labang
Sg. Jhelong
KEBULU PROTECTED FOREST
LABANG FOREST RESERVE
SIMILAJAU FOREST RESERVE
TUBAU
LABANG
KEMENA FOREST RESERVE
SEBUNGAN PROTECTED FOREST
PANDAN
Sg. Pandan
KUBUO F.R.
SEBAUH
SELUZU F.R.
BINTULU
Brg. Kemena
0
10
20
Statute Miles

TABLE 2.2 THE FOREST ESTATE: PROJECTED CHANGES IN AREA

A. MIXED DIPTEROCARP FOREST

1. At Reconnaissance Level (1:250 000)

	POSSIBLE ALLOCATION		NET PROJECTION	
	Agriculture	Forestry	Agriculture	Forestry
Batu Belah Forest Reserve	500	)		17 000
Ulu Linei Extension	NIL	17 500)		
Bok Tisam Protected Forest	11 000	-	11 000	
Kebulu Protected Forest				
Pudang Extension	NIL	7 800)		
Sg. Matalum Extension	NIL	23 500)		
Labang Forest Reserve	12 000	-	12 000	
Lambir Extension	NIL	34 500		34 500
Lemiting Protected Forest	20 200	-)		
Bong) Extensions	NIL	30 000)		49 800
Temedoh)	NIL	40 000)		
Marudi Forest Reserve				
Bukit Dabai Extension	NIL	10 500		10 500
Niah Forest Reserve				
Bakas Extension	NIL	86 900)		84 000
Ulu Klad Extension	2 900	)		
Niah Jelalang Protected Forest	3 000		3 000	
TOTAL	49 600	250 700	26 000	227 100

2. At Broad Transect Level (1:100 000)

	PROBABLE FINAL ALLOCATION		NET PROJECTION	
	Agriculture	Forestry	Agriculture	Forestry
Labang Extension		71 000)		
Paroh	11 000	)		
Sedulang	3 100	)		
Timkar	3 000	)		116 000
North Extension		51 600)		
South Extension		10 500)		
Bukit Takuja Forest Reserve Proposal		23 000		23 000
Sawai Protected Forest				
Kabatu Agricultural Development Area	21 500		21 500	
Similajau Forest Reserve				
Timong	4 100)			
Sigrak	13 200)			
Timkar	3 200)			
Agricultural Development Areas: S. Mekasi	1 000)			
Takau	9 000)			
Nyal	7 800)		62 100	
Perihas	7 200)			
Kawang	2 300)			
Semba	4 400)			
Suruba	7 000)			
T. Similajau	2 900)			
Ulu Segu Forest Reserve Proposal			38 000	38 000
TOTAL	100 700	194 100	83 600	177 000

3. At (mostly) Semi Detailed Soil Survey Level

	FINAL ALLOCATION		NET PROJECTION	
	Agriculture	Forestry	Agriculture	Forestry
Niah Forest Reserve				
Ulu Kleba		1 100)		
Sungai Seras		700)		
Extensions: Sungai Sebubok		800)		
Ulu Seras		400)		
Sungai Pahibe		8 200)	5 900	
Agricultural Development Areas: Niah S.E.	300	)		
Telabit	7 600	)		
Jatan	9 200	)		
Sawai Protected Forest				
Sg. Sawai Agricultural Development Area	2 200	)		
Sg. Kebulu Extension		5 700)		3 500
Ulu Saeh Forest Reserve Proposal		6 500		6 500
Ulu Selepin Proposal		4 000		4 000
TOTAL	19 300	27 400	5 900	14 000

B. SWAMP FOREST

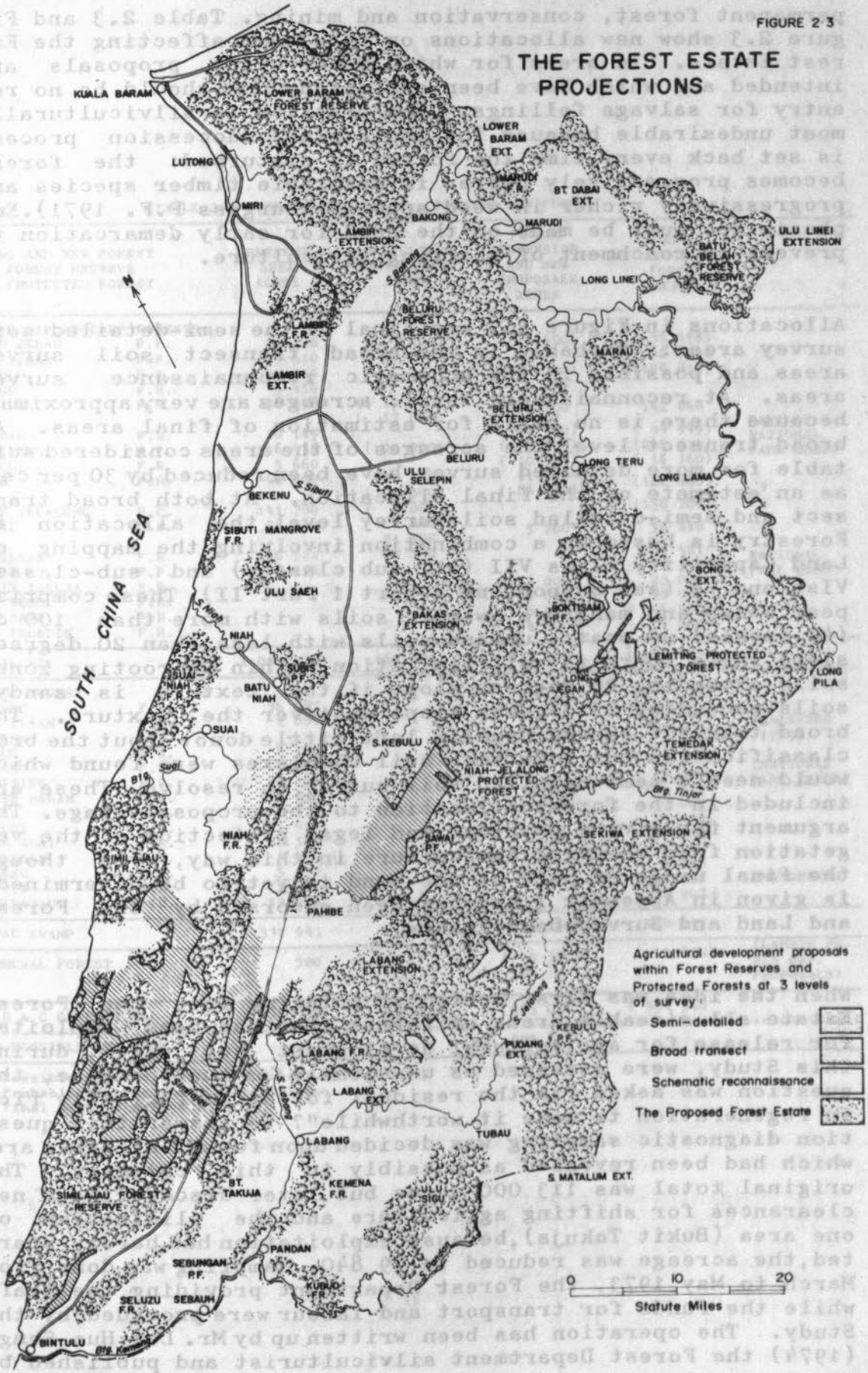
1. At Reconnaissance Level

	POSSIBLE ALLOCATION	
	FORESTRY	NET PROJECTION
Beluru Extension (including Research Block)	129 000	129 000
Lower Baram		
East	)	
Extension West	35 500)	35 500
South East	)	
Marau Forest Reserve	10 000	10 000
TOTAL	174 500	174 500

TOTALS				
	Agriculture	Forestry	NET Agriculture	NET Forestry
MIXED DIPTEROCARP FOREST				
- Reconnaissance Level	49 600	250 700	26 000	227 100
- Broad Transect Survey	100 700	194 100	83 600	177 000
Final allocation	19 300	27 400	5 900	14 000
Communal Forest Proposals (Lambir-Subis)	-	4 320	-	4 320
SWAMP FOREST		174 500		174 500
Kemena Forest Reserve (1973 constitution)	-	14 000		14 000
TOTAL	169 600	665 020	115 500	610 920
		495 420		495 420

FIGURE 2·3

THE FOREST ESTATE PROJECTIONS



permanent forest, conservation and mining. Table 2.3 and Figure 2.3 show new allocations on this basis affecting the Forest Estate. In areas for which Reservation proposals are intended and which have been exploited there should be no re-entry for salvage fellings. The practice is silviculturally most undesirable because the whole plant succession process is set back every time the forest is disturbed: the forest becomes progressively poorer in desirable timber species and progressively richer in weed species (Burgess P.F. 1971). Emphasis too must be made on the need for early demarcation to prevent encroachment of shifting agriculture.

Allocations in Figure 2.3 are final in the semi-detailed soil survey areas: probable in the broad transect soil survey areas and possible in the schematic reconnaissance survey areas. At reconnaissance level, acreages are very approximate because there is no basis for estimation of final areas. At broad transect level the acreages of the areas considered suitable for more detailed survey have been reduced by 30 per cent as an estimate of the final allocation. At both broad transect and semi-detailed soil survey level the allocation to Forestry is based on a combination involving the mapping of Land Capability Class VII (all sub classes) and sub-classes VIsw and Vs (see Supporting Report 1 Part II). These comprise: peat swamp and mangrove swamp: soils with more than 100 cm (40 inches) of peat: upland soils with less than 20 degrees slope where there is soil limitation within the rooting zone: soils exceeding 20 degrees slope if the texture is sandy: soils exceeding 25 degrees slope whatever the texture. The broad transect survey usually left little doubt about the broad classification but sometimes soil complexes were found which would need a semi-detailed soil survey to resolve. These are included in the forest allocation to the proposal stage. The argument for giving physical and legal protection of the vegetation from shifting agriculture in this way, even though the final usage of part of the land is yet to be determined, is given in Appendix I and has been endorsed by the Forest and Land and Survey Departments.

When the idea was first mooted of bringing into the Forest Estate all sizeable areas of forest that had been exploited for release for agricultural development but which, during this Study, were assessed as unsuitable for that purpose, the question was asked "is the residual forest sufficiently rich in regeneration to make it worthwhile"? To answer this question diagnostic sampling was decided upon for all sizeable areas which had been revealed as possibly in this category. The original total was 113 000 acres but later discoveries of new clearances for shifting agriculture and the elimination of one area (Bukit Takuja), because exploitation had barely started, the acreage was reduced to 79 840. Sampling was done from March to May 1973, the Forest Department providing the staff while the funds for transport and labour were provided by the Study. The operation has been written up by Mr. Lee Hua Seng, (1974) the Forest Department silviculturist and published by the Forest Department Kuching as Silvicultural Research Report No.6, 1973.

TABLE 2.3 THE FOREST ESTATE: PRESENT AND FUTURE

EXISTING AND NEW FOREST F.R. = FOREST RESERVE P.F. = PROTECTED FOREST		PRESENT AREA ACRES	AGRICULTURAL DEVELOPMENT ACRES	FOREST EXTENSION AND NEW PROPOSALS ACRES	NET TOTAL FOREST ACRES	
A. MIXED DIPTEROCARP FORESTS						
BATU BELAH	P.F.	22 458	(500)	(17 500)	(39 458)	
BOK TISAM	P.F.	73 310	(11 000)		(62 310)	
KEBULU	P.F.	93 515		(31 300)	(124 815)	
KUBUD	F.R.	3 456		3 456		
LABANG	F.R.	38 848	((12 000 (17 000	133 100	142 848	
LAMBIR	F.R.	10 149		(34 500)	(44 649)	PART OF NATIONAL PARK ELECT
LEMITING	P.F.	196 534	(20 000)	(70 000)	(246 334)	
MARUDI	F.R.	5 660		(10 500)	(16 160)	
NIAH	F.R.	42 500	17 100*	11 200*)	(120 600)	
			(2 900)	(86 900))		
NIAH JELALONG	P.F.	141 700	(3 000)		(138 700)	
SAWAI	P.F.	74 240	2 200*)	5 700*	56 240	
			21 500)			
SIMILAJAU	F.R.	296 521	62 100		234 421	NATIONAL PARK ELECT
SUBIS	P.F.	8 194			8 194	
BUKIT TAKUJA	F.R.			23 000	23 000	
ULU SEGU	F.R.			38 000	38 000	
ULU SAEH	F.R.			6 500*	6 500*	
ULU SELEPIN	F.R.			4 000*	4 000*	
TOTAL MDF		1 007 085	169 600	472 200	1 309 685	
B. SWAMP FOREST						
BELURU	F.R.	36 587		(129 000)	(165 587)	
BOK TISAM	P.F.	1 000			1 000	
KEMENA	F.R.	-		14 000	14 000	(GAZETTED 1973)
KUBUD	F.R.	8 128			8 128	
LABANG	F.R.	8 000			8 000	(NATIONAL PARK ELECT)
LEMITING	P.F.	15 286			15 286	
LOWER BARAM	F.R.	150 610		(35 500)	186 110	
MARAU	F.R.			10 000	10 000	
MARUDI	F.R.	11 579			11 579	
NIAH SUAI	F.R.	28 500			28 500	
SEBUNGAN	P.F.	4 200			4 200	
SELEZU	F.R.	5 150			5 150	
SIBUTI	F.R.	2 996			2 996	(MANGROVE)
SIMILAJAU	F.R.	59 906			59 907	
TOTAL SWAMP		331 943		188 500	520 443	
C. COMMUNAL FOREST		500		(4 320)	(4 820)	(LAMBIR SUBIS DEV. PROPOSALS)
A, B & C GRAND TOTAL		1 339 528	169 600	665 020	1 834 948	
NET POSSIBLE INCREASE				495 420		

Note: Possible figures shown in brackets.
Probable figures shown unbracketed.
Final figures marked thus *

The methods of sampling are fully described in the Research Report. Briefly the plots in each of which one leading desirable is chosen are 0.5 chain by 0.5 chain i.e. 1/40 th acre. The range of stocking (reckoning all 40 stocked as 100 per cent) was found to be from 41 to 67 per cent, average 54 per cent. None of the leading desirables were growing free from impedance. In Niah Forest Reserve, where one might expect different results, the figures in recent Sampling showed remarkable similarity (November 1972, Research Plot 53 Investigation 29): the range of stocking was similar and the average 57 per cent. There was similar concentration in the seedling and sampling size; only the degree of freedom from impedance differed significantly being 17 per cent against nil.

The silviculturist's conclusions are considered sufficiently favourable to recommend including the areas in the forest estate.

Details of the sampling areas are shown in Table 2.4 while their location and the resulting Reserve proposals are shown on Figure 2.4.

TABLE 2.4 DIAGNOSTIC SAMPLING AREAS AND RESERVATION PROPOSALS

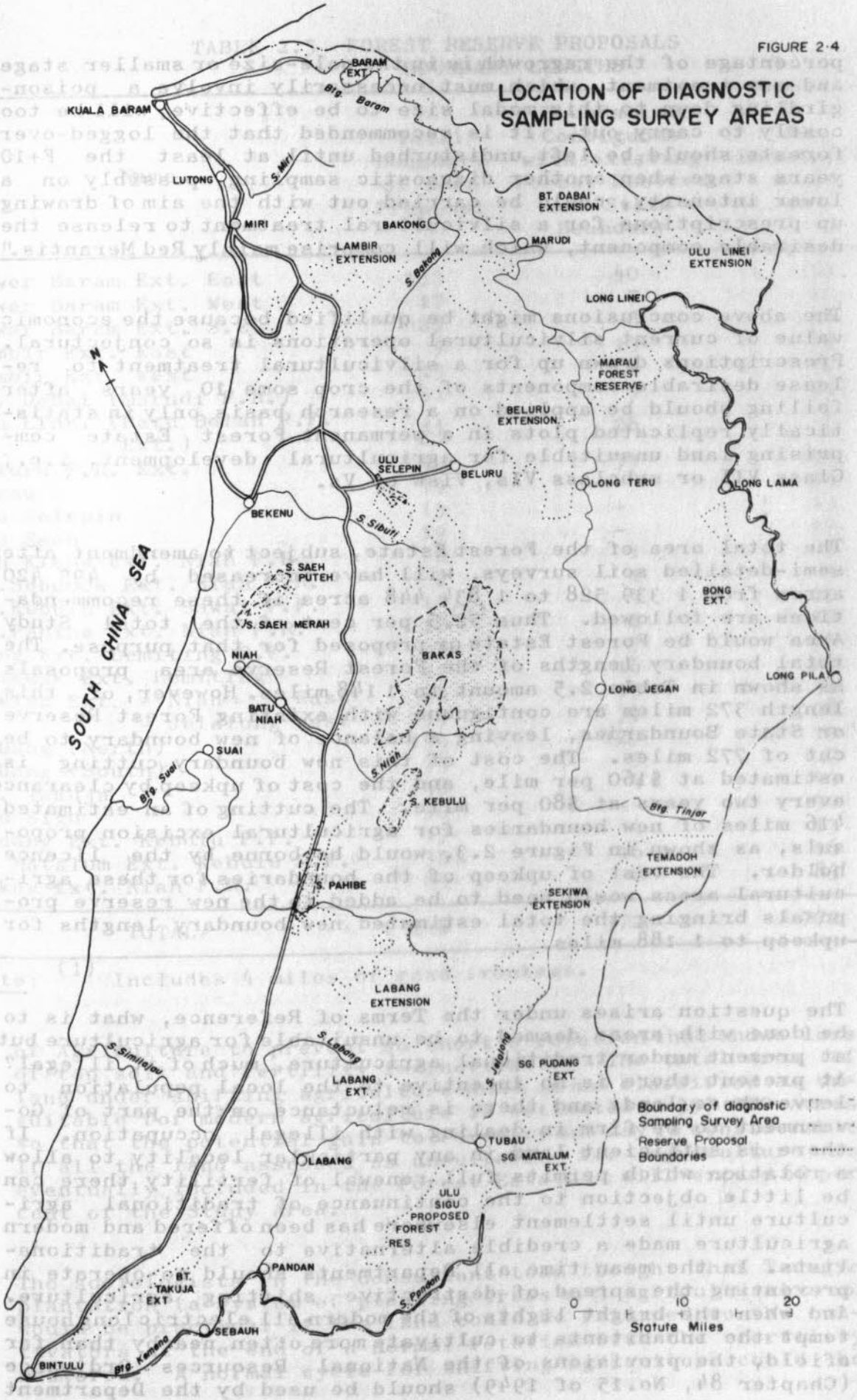
	Total area (acres)	Area for DS (acres)	Length of DS (chains)	Area of DS (acres)	Per cent	Area of F.R. Proposal (acres)	EXTENSION PROPOSAL/
1. Bakas	62 850*	21 510	4 370	218.5	1.02	86 900	Niah F.R.
2. Ulu Selepin	1 700	1 700	390	19.5	1.15	4 000	-
3. Sg.Saeh	5 880	5 880	1 120	56.0	.95	6 500	-
4. Sg.Kabulu	5 080	5 080	1 040	52.0	1.02	5 700	Sawai F.R.
5. Sg.Pahibe	4 330	4 330	1 010	50.5	1.17	8 200	Niah F.R.
TOTAL	79 840	38 500	7 930	396.5	1.03	111 300	

* This figure is larger than the "Area for D.S." because after broad transect and semi-detailed soil survey had been undertaken in 1973, some forest surrounding the original D.S. Area was found to be unsuitable for agriculture and therefore added to the F.R. proposal. In addition the area contiguous to the Bakas extension proposal to Niah Forest Reserve which is allocated to the Forest Estate in the Lambir Subis Regional Development Plan has also been included.

The silviculturist's conclusions, in greater detail are as follows:

"The logged-over forests under survey carry sufficient regeneration and old growth stems for a second timber crop. The results do not suggest the necessity of enrichment planting. Although a major portion of this regeneration is under suppression it is not recommended that a silvicultural treatment be carried out. This is mainly due to the fact that a large

FIGURE 2·4


LOCATION OF DIAGNOSTIC SAMPLING SURVEY AREAS
KUALA BARAM
BARAM EXT.
Brg. Baram
LUTONG
S. Miri
MIRI
BAKONG
LAMBIR EXTENSION
S. Bakong
MARUDI
BT. DABAI EXTENSION
ULU LINEI EXTENSION
LONG LINEI
MARAU FOREST RESERVE
BELURU EXTENSION
ULU SELEPIN
BELURU
LONG TERU
LONG LAMA
BEKENU
S. Sibuti
S. SAEH PUTEH
S. SAEH MERAH
BONG EXT.
SOUTH CHINA SEA
NIAH
BAKAS
LONG JEGAN
LONG PILA
BATU NIAH
SUAI
S. Hilir
Brg. Suai
S. KEBULU
Brg. Tinjar
TEMADOH EXTENSION
S. PAHIBE
SEKIWA EXTENSION
LABANG EXTENSION
S. Labang
S. Jelalong
S. Similigau
SG. PUDANG EXT.
LABANG EXT.
Boundary of diagnostic Sampling Survey Area
Reserve Proposal Boundaries
TUBAU
SG. MATALUM EXT.
LABANG
ULU SIGU PROPOSED FOREST RES.
PANDAN
BT. TAKUJA EXT.
S. Pandan
SEBAUH
BINTULU
Brg. Kemena
0 10 20
Statute Miles

percentage of the regrowth is in the pole-size or smaller stage and any treatment, which must necessarily involve a poison-girdling down to this modal size to be effective, will be too costly to carry out. It is recommended that the logged-over forests should be left undisturbed until at least the F+10 years stage when another diagnostic sampling, possibly on a lower intensity, could be carried out with the aim of drawing up prescriptions for a silvicultural treatment to release the desirable component, which will comprise mainly Red Merantis."

The above conclusions might be qualified because the economic value of current silvicultural operations is so conjectural. Prescriptions drawn up for a silvicultural treatment to release desirable components of the crop some 10 years after felling should be applied on a research basis only in statistically replicated plots in a permanent Forest Estate comprising land unsuitable for agricultural development, i.e., Class VII or subclass VIs, VIsw or Vs.

The total area of the Forest Estate, subject to amendment after semi-detailed soil surveys, will have increased by 495 420 acres from 1 339 528 to 1 834 448 acres if these recommendations are followed. Thus 52.5 per cent of the total Study Area would be Forest Estate or proposed for that purpose. The total boundary lengths of the Forest Reserve area proposals as shown in Table 2.5 amount to 1 148 miles. However, of this length 372 miles are contiguous with existing Forest Reserve or State Boundaries, leaving a balance of new boundary to be cut of 772 miles. The cost of this new boundary cutting is estimated at $160 per mile, and the cost of upkeep by clearance every two years at $80 per mile. The cutting of an estimated 416 miles of new boundaries for agricultural excision proposals, as shown in Figure 2.3, would be borne by the licence holder. The cost of upkeep of the boundaries for these agricultural areas would need to be added to the new reserve proposals bringing the total estimated new boundary lengths for upkeep to 1 188 miles.

The question arises under the Terms of Reference, what is to be done with areas deemed to be unsuitable for agriculture but at present under traditional agriculture, much of it illegal? At present there is no incentive to the local population to leave these lands and there is reluctance on the part of Government to be firm in dealing with illegal occupation. If there is sufficient land in any particular locality to allow a rotation which permits full renewal of fertility there can be little objection to the continuance of traditional agriculture until settlement elsewhere has been offered and modern agriculture made a credible alternative to the traditionalists. In the mean time all Departments should co-operate in preventing the spread of destructive shifting agriculture. And when the bright lights of the modern all electric longhouse tempt the inhabitants to cultivate more often nearby than far afield, the provisions of the National Resources Ordinance (Chapter 84, No.15 of 1949) should be used by the Department

TABLE 2.5 FOREST RESERVE PROPOSALS
BOUNDARY LENGTHS

Name	Total Boundary of Area Proposal	Boundaries Contiguous with existing Forest Reserve and State Boundary	New Boundaries to be cut
Lower Baram Ext. East	133	40	53
Lower Baram Ext. West	17	7	10
Lower Baram Ext. S.E.	21	8	13
Lambir Ext. East	9	13	36
Lambir Ext. West	13	1	12
Bt. Dabai (Marudi F.R.)	31	9	22
Ulu Linei (Batu Belah P.F. Ext.)	31	26	5
Beluru F.R. Ext.	230	31	199
Marau	19	-	19
Ulu Selepin	13	-	13
Ulu Saeh	19	-	19
Ulu Kleba Ext. Niah F.R.	8	1	7
Sg.Sebubok Ext. Niah F.R.	2	1	1
Sg.Kebulu Ext. Sawai P.F.	14	4	10
Sg.Pahibe Ext. Niah F.R.	18(1)	2	12
Bong Ext. Lemiting P.F.	32	7	25
Temedak Ext. Lemiting	41	16	25
Sekiwa Ext. - Niah - East	44	13	31
- Jelalong West	59	31	28
Labang (North)	144	125	19
Labang (South)	14	7	7
Bt. Takuja	48	4	44
Ulu Sigu	50	-	50
Pudang Ext. Kebulu P.F.	17	4	13
S. Matalum Ext. Kebulu P.F.	32	16	16
Bakas Ext. Niah F.R.	89	6	83
TOTAL	1 148	372	772

Note: (1) Includes 4 miles of road frontage.

of Agriculture to prevent so short a rotation that undue loss of top soil and fertility is inevitable. The total area of land under shifting agriculture which is now classified as unsuitable for modern agriculture is estimated at 397 000 acres so that the potential gain to Forestry one day is considerable. If all the land assessed as unsuitable for agriculture is eventually included in the Forest Estate it will exceed 60 per cent of the Study Area.

The sociologists in the Consultant team thought that Taungya plantation (a system of planting trees with agricultural crops) would be practical if the land could be returned to the cultivators at the end of a normal rotation with the fertility restored. A normal cycle for shifting agriculture could be

about 15 years which would limit plantations to short term cellulose crops involving fertiliser treatment to maintain fertility. In Peninsular Malaysia fertiliser treatment is found necessary with clear felling and planting on better soils than we have available in the Study Area. Erosion, too is so great a hazard in pine plantations on steep land that such land is to be avoided (FAO 1972 a). Peninsular Malaysia is experiencing other difficulties. Pulp plantations need high accessibility and high productivity (FAO 1971). An area of 150 000 acres in one block on undulating ground with a mean annual increment to the crop of at least 250 cubic feet per acre per annum is required. Also for the processing sufficient water is needed to absorb pollution as well as supply the basic needs of the plant. There is evidence that Pinus caribaea var. hondurensis on a good site, with phosphate fertiliser could yield 300 to 350 cubic feet per acre per annum. Such highly productive, highly accessible land relatively free from erosion perils could only be found in Sarawak, if at all, at the expense of agriculture.

Long rotation plantations would be acceptable to the Ibans so the sociologists say, if new land could be allocated or sedentary agriculture became acceptable. This is a possibility for the far distant future. Taungya plantations of this kind are highly successful in other parts of the world where there is a strong demand for the kind of land offered for sedentary agriculture, an acceptance of the obligations by the farmers and sufficient discipline in the community to deal with recalcitrants (Lamb A.F.A. 1964).

Communal Forests have not figured appreciably in the Study's Forest Estate. Those that have been established elsewhere in the Division offer no more advantage to the rural population than can be found in other forest not far away; but no doubt the pinch will come. One or two forest exploitation licence holders have left islands of forest for unofficial longhouse communal forests of 100 to 160 acres which have been appreciated. Similar allocation of forest enclosures are planned in Agriculture Development areas. These enclosures would be under the control either of the Sarawak Land Development Board or the Agricultural Development Unit both of which should have access to the advice of the Forest Department (see Supporting Report 2 Part III). It is too early to say whether such areas should be included in the Forest Estate; but if management proves successful they certainly should be.

2.4. EVALUATION

The use of aerial photographs for stratification of the forest was by no means new to this country when the cluster method of inventory sampling was introduced to Sarawak by the FAO (Hindley 1971). In the technique used by the Forest Department (1961), forest type, terrain and density classes were

determined and transferred to maps at 1:50 000 scale. Random selection of strip lines (with a restrictive minimum interval of thirty chains) were also transferred to the map. Location of strip lines in the field was done entirely from the prepared maps as, in practice, no photos were taken into the field. The data was compiled by strata within strip lines after ground measurements were completed and the results used to make corrections of strata boundaries on the maps. This worked satisfactorily in swamp forest where a type was contiguous and covered large areas; but yielded less successful results when an area consisted of small micro-classes that characterise most of the hill forests. Difficulties were often encountered in plotting of the lines. The beginning and end of the base line would be closed to indentifiable points on the map; but the actual location of the line (using a ranging system) might be irregular between these points, and the sampling lines themselves fixed relative to the base, might well be yet more indeterminate at the far end of the line. Furthermore in practice a line happening to fall in non-typical forest gives undue weight to it. Although the base lines are chosen for the majority of enumeration lines to cross topographical features yet, being cut parallel, a number could fall along the length of a stream valley. The practice of regarding a ten chain length of strip line as a single plot theoretically allocated to a strata during enumeration did not help greatly because allocation from ground observation alone is rarely possible, whereas uncertainties of the actual location of the strip on aerial photographs makes later allocation very difficult. A major source of error in strip sampling is failure to maintain correct strip width, though a similar sort of error can creep into the variable plot system used by the FAO team with failure to check border-line trees.

Hindley (1971) lays stress on the importance of doing photo interpretation of stratification before sampling. This may reveal errors to be corrected but assists objectivity. The Forest Department seems to find no difficulty herebecause the range in volume per interpretation has apparently been found so far to be no more than the range dividing the strata volumes. Indeed, recently, in certain lowland sites, stratification (after elimination of areas too poor to sample) has been found unnecessary as not significantly reducing the variation. This results in a saving of time and money because fewer samples are needed.

The results for Similajau Forest Reserve (FAO Inventory Unit 2) show a sampling precision for net industrial stem wood volume of $\pm$ 6.84 per cent at 95 per cent probability level but this figure could not apply to a subdivision of the total area. This restricted value of the unit inventory is fully recognised and a more intensive inventory is planned for each of the industrial sub units (five year period) when they come up for exploitation.

All the swamp Forest Reserves have been inventoried under the old system and the specific composition and total growing stock determined. The Reliable Minimum Estimate is usually calculated but the mean figure is used to determine the volume of the annual coupe on a rotation of 60 years. The old swamp volume tables, based on species and girths, but not height and with only a broad percentage reduction for defect in named species, are blamed for some over cutting becoming apparent; the use of the mean figure instead of the Reliable Minimum Estimate might rightly share the blame. A combined volume and area control is now used in the Miri portion of the Study Area and features a desk calculation of the remaining growing stock every five years to show whether an adjustment of the annual coupe is necessary.

The FAO method is programmed for computer use and printed-out tables of volume are available. There are 28 tables as described in the Inventory (FAO 1973 a) but only Net Industrial Stem (NIS) wood volume tables need concern us as these are used to determine the net commercial volume in estimates of yield from the Bintulu area. The NIS volumes (as do the Sound Industrial Stem wood volume (SIS) and Gross Industrial Stemwood volume (GIS)) refer to clear, straight, relatively knot free sections and exclude sections which from the exterior can be classified as non merchantable. The definition for merchantable and non merchantable in the inventory closely follows the correct Forest Rules and Regulations and NIS volumes are obtained by deduction of any section with less than a five inch radius of sound wood. The Inventory volume tables have been prepared with great attention to detail (over 5 000 trees were destroyed in the process). The net commercial volume is this NIS volume reduced to cover marketability under existing circumstances less a factor for harvesting and other wastage or loss. How exactly the figures are determined is not divulged but in general it seems to amount in inventory unit 2 to 60 per cent of the NIS volume. A general assumption backed up by a number of figures on harvesting intensity on three areas, Tubau, Tatau and Niah (FAO 1972) (two of them in the Study Area) gives a much poorer picture being only 43.4, 44.5 and 47.5 per cent respectively. That the log output was entirely for export and that the investigation took place during a period of falling log prices does not fully explain the low proportion of NIS volume actually removed. Forest Department closing reports are available for the study of intensity of harvesting. Allowing for the unreliability of these reports as disclosed by inspectorate checking, the volume of merchantable timber remaining after exploitation for log export only rarely exceeds two tons (hoppus) per acre which suggests a harvesting percentage of 80 which is now shown to be optimistic. Fluctuating values of timber make it worth while for expert appraisal of the forest to be cleared for agriculture. However the difficulty in stratification of remnant forest for statistical purposes and the relatively low value of the remaining timber could not be expected to justify a standard inventory in a country with such investment opportunities as described by FAO (1973 g). The value of such forest is likely to be most appreciated by estates which retained enclaves for estate needs.

CHAPTER 3

FOREST RESOURCE DEVELOPMENT

3.1. INTRODUCTION

The development of Forest Resources in accordance with policy objectives demands an understanding of current practice and careful study of the evidence on which to base future action. There is much experience in swamp forests but little in Mixed Dipterocarp Forests as a basis for planning. Drawing on evidence from Peninsular Malaysia and overseas experience, ambitious expansion plans for industrial development combined with exploitation of virgin forests both for permanent forests and release for agriculture have been prepared (FAO 1973 b).

3.1.1. Summary

Current practice is described and economic results discussed. A rotation of 70 years is recommended for control of export logging licences in permanent hill forest though preferably exploitation should be postponed until roads make industrial logging possible. The untapped resources for industrial logging development are considered from a summary of the FAO Working Paper 19 (FAO 1973 b) in which the economic results are discussed. An economic appraisal follows. Control methods are suggested which should cover exploitation both for agricultural release and for permanent forest exploitation but whether the ventures need to be quite as large as to risk prejudicing the sustained yield principle at District level is questioned.

3.2. PRESENT FOREST EXPLOITATION

3.2.1. Practice

The swamp forests in the Study Area have been under exploitation for a much longer time than the Mixed Dipterocarp Forests, Reserved swamp forests have a volume output limitation under a system of sustained yield based on a rotation of 60 years. The mixed swamps are under a silvicultural refining treatment and are expected to regenerate with a mixture more predominantly of meranti than the original forests which contained ramin, sometimes in high proportion. That the silvicultural treatment is worth while has not so far been deduced from the evidence of yield plots. The alan forests, now becoming more in demand constitute a major silvicultural problem as the species does not regenerate naturally and planting has so far been a failure.

The working of the Mixed Dipterocarp Forests at present under licence is still controlled essentially in the same way as

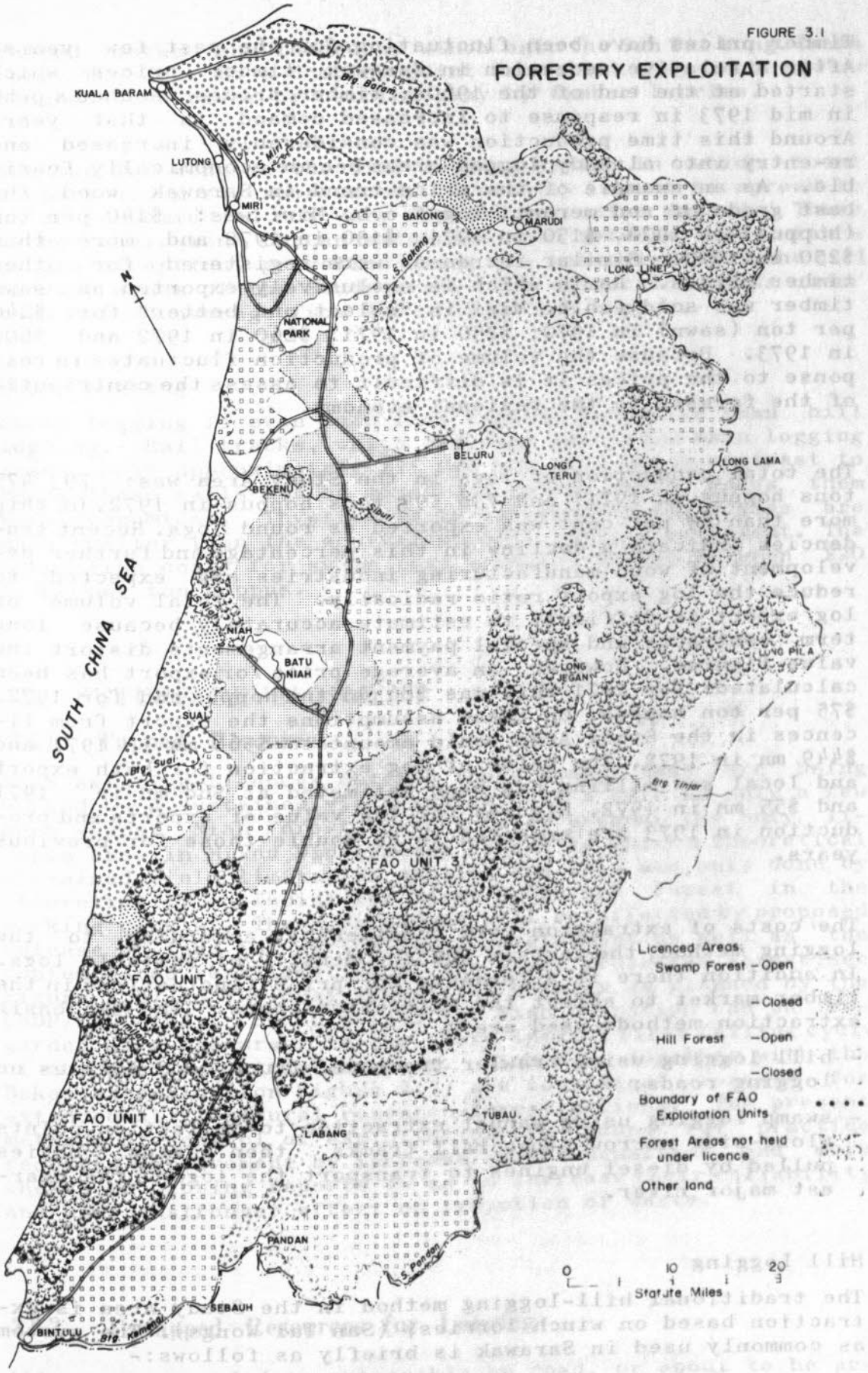
the swamp forests: by the "Permit to enter coupe". The method has been described (Walker F.S. 1968) and is flexible enough to be applied both to Reserved Forest working on a basis of sustained yield and to orderly exploitation of forest prior to release of land for agricultural development.

The present system of control in Mixed Dipterocarp Forest is particularly directed to prevention of waste during exploitation of forest to be released for agricultural development. Waste from cross cutting below the logging point and high stumps is comparatively rare; but the log standards for the export trade are higher than the merchantable standards enforced by the Forest Department: species are limited and only a limited proportion of sinkers can be extracted by raft. Buyers have their own graders and the Japanese in particular change the grade to suit the market so augmenting waste when the market is in a downward phase of the cycle. Such a market depression coincided with a study undertaken in 1972 by the Industries Development Project to determine the relationship between Net Industrial Stem wood volume as defined by the Inventory and actual volumes extracted by commercial logging operation FAO (1972 g). The Study was done in three licence areas of which two, Niah and Tubau, are in the Study Area. Because the study covered a period when prices dropped and demand fell to a point that many logging operations in Sarawak ceased work the chief value is in determining the methods for future studies. There are yet valuable conclusions to be drawn and one is that the exploitation management must have much closer control over the actual felling and extraction and waste avoidance. Another point for analysis is the load limitation for equipment to handle the largest logs: very fine large logs are sometimes left because they are too heavy to handle.

3.2.2. Economic Results

The present forest area under licence for commercial exploitation amounts to roughly 1 080 000 acres of which approximately 360 000 acres are hill forest concessions and 7 200 000 acres swamp forest. As mentioned above an overwhelming part of the Mixed Hill Dipterocarp Forest licences will expire within the next five to six years and large scale logging within most of these areas will not be carried out after this time - that is within the time scale of this Study. Figure 3.1 shows the location of licence areas (both swamp and hill forest) distinguishing forest opened and unopened to exploitation. The location of FAO Industry Units is also shown. The exploitation of the swamp forest areas under present licence will be continued over a longer period. Of the swamp forest area under licence only 65 000 acres have been logged up to now and though the remaining 655 000 acres are only partly suitable for commercial log extraction, a considerable timber resource of swamp forest species still remains.

FIGURE 3.1


FORESTRY EXPLOITATION
KUALA BARAM
Big Baram
S. Miri
LUTONG
MIRI
BAKONG
MARUDI
S. Bakong
LONG LINE
N
NATIONAL PARK
BELURU
LONG TERU
LONG LAMA
BEKENU
S. Sibuti
SOUTH CHINA SEA
NIAH
BATU NIAH
LONG PILA
LONG JEGAN
SUAI
Big Sual
Big Tinjar
FAO UNIT 3
FAO UNIT 2
FAO UNIT 1
S. Lobang
S. Melaing
TUBAU
LABANG
PANDAN
S. Pandan
SEBAUH
BINTULU
Big Kemena
Licenced Areas
Swamp Forest – Open
– Closed
Hill Forest – Open
– Closed
Boundary of FAO Exploitation Units
Forest Areas not held under licence
Other land
0
10
20
Statute Miles

Timber prices have been fluctuating for the past few years. After a relative recession in Sarawak timber prices which started at the end of the 1960s, timber prices reached a peak in mid 1973 in response to increased demand in that year. Around this time production was considerably increased and re-entry into already logged areas became economically feasible. As an example of the price trend in Sarawak wood, the best grade of red meranti log f.o.b. Miri was: $140 per ton (hoppus) in 1970, $150 in 1971, $130 in 1972 and more than $250 in 1973. Similar increases were registered for other timber prices. Ramin which is exclusively exported as sawn timber was sold f.o.b. Miri in "select and better" for $240 per ton (sawn) in 1970; $250 in 1971; $260 in 1972 and $600 in 1973. Because the volume of production fluctuates in response to the prices it is difficult to assess the contribution of the forests to the regional economy.

The total production of logs in the Study Area was: 793 475 tons hoppus in 1971; and 738 595 tons hoppus in 1972. Of this more than 80 per cent was exported as round logs. Recent tendencies indicate a decline in this percentage and further development of wood manufacturing industries are expected to reduce the log export ratio radically. The total volume of log export is difficult to estimate accurately because long term contracts and special payment arrangements distort the value figures. However, an average price for export has been calculated: for 1971 this was $86 per ton hoppus and for 1972, $75 per ton hoppus. On these assumptions the export from licences in the Study Area would amount to $566 mn in 1971 and $449 mn in 1972. The value of log extraction for both export and local saw milling has been estimated at $68 mn in 1971 and $55 mn in 1972. Figures for the value of exports and production in 1973 are expected to be double those for previous years.

The costs of extraction vary considerably according to the logging method, the terrain and the density of suitable logs. In addition there is a tendency for price fluctuations in the timber market to affect the extraction costs. The two basic extraction methods used are:-

- hill logging using crawler tractors, trucks and lorries on logging roads;
- swamp logging using manual extraction to collection points along-side narrow gauge rail tracks, then using bogies pulled by diesel engines to transport the logs to the nearest major river.

Hill Logging

The traditional hill-logging method in the Study Area is extraction based on winch lorries, (San Tai Wongs). The system as commonly used in Sarawak is briefly as follows:-

Tracks are bulldozed by crawler tractors from the main road to the closest possible point of each stump. The trees are

felled, bucked and loaded by winch onto the San Tai Wong. These carry the logs to a dumping point from which they can be either floated down-river or carried away by timber lorries.

The San Tai Wong is the hill logging system in which local loggers are most experienced. Generally it must be agreed to be an economic and not very capital intensive method. There is no requirement for an extensive road network and, with a single exception, gravelled roads are non-existent in the hill licence areas of the Study Area. The extraction costs under this method average from $40 to 45 per ton hoppus.

Swamp Logging

Swamp logging is even much less capital intensive than hill logging. Rail tracks, which are used instead of main logging roads, cost approximately $25 000 per mile but in contrast to roads these rails can be moved and reused which makes them very economical. Investments in locomotives and bogies are much smaller than the equivalent hill logging equipment. The extraction costs for swamp logs normally ranges between $20 to $25 per ton hoppus.

3.3. FUTURE DEVELOPMENT

3.3.1. Tapped Resources

Most existing licences outside those swamps that are being worked on a sustained yield system have a life of only a few more years. Niah Forest Reserve is at present the only licence area in Mixed Dipterocarp Forest to which a theoretical sustained yield limitation applies and this was only done by theoretically including the Sawai Protected Forest in the working circle. The arrangement will be affected by proposed release of land for agricultural development as well as the contemplated re-allocation of the Sawai Protected Forest (see Figure 2.3) to the Suai industrial complex as planned by the UNDP/FAO Study. So in effect the Niah operation can be regarded as a precursor to the short initial first felling cycle of the Suai industrial complex. Niah F.R. together with the Bakas extension (on Figure 2.3) are convenient forests for extended silvicultural research investigations. The present methods of control of exploitation are sound but practice requires improvement by increase in the penalties and more checks on closing reports so as to increase their reliability and have a stronger effect on reduction of waste.

3.3.2. Untapped Resources for Logging

All areas regarded as accessible by road, or about to be accessible by road are either under licence or within the compass of the Bintulu based industrial proposals (FAO 1973 g).

Other areas of Mixed Dipterocarp Forests with untapped resources are to be found in Niah Jelalong P.F., Bok Tisam P.F., Lemiting P.F., Batu Belah F.R. and Kebulu P.F. (and proposed extension). Government has resisted great pressure to issue timber licences in these reserves ever since the pledge given to the FAO to issue no more licences until the Forest Inventory was completed. Now we must expect the Baram areas, which are accessible for rafting, to be licenced immediately as recommended by FAO (1972 c), unless government can be persuaded to hold back areas which stand a chance in the next ten years or so of having linking roads to the Miri Bintulu trunk road. The proposed road system links with a length of 110 miles all this area, (estimated to have a loggable acreage of 250 000 acres) with the Miri Bintulu road. A length of 80 miles of this route is planned for agricultural development and will also be invaluable for logging. The middle link of 30 miles, from Long Jegan joining up with the Jelalong extension of the Labang Tubau road, ought easily to be justified on industrial considerations. This would provide, for the area concerned, all the benefits of public highway transport for the harvesting of the crop and reduce the amount of selective logging for export which is so well known to be nationally disadvantageous as compared with industrial conversion in this country. The benefit to the economy from the forest operations and from industrial operations resulting from extraction of sinkers and saw logs below export grade are arguments in danger of being forgotten while listening to the arguments for earlier exploitation.

Selective logging in forest on land intended for agricultural development is objectionable because of the waste. In Forest Reserves and Protected Forest when the usage has been finally determined in favour of forestry there is not the same objection. Theoretically the operation could give promise of a short first post-virgin felling cycle; but until there are figures from research to confirm this possibility the annual coupe should be by area based on the full rotation for meranti: 70 years. D.S. samplings and yield plots would be established not later than ten years after the felling. The danger must be recognised that selective exploitation tends to increase the proportion of slowly growing trees thus increasing the prospect of ever lengthening felling cycles in the future. Re-logging should not be practiced as it is silviculturally undesirable.

Kebulu P.F. (see Figure 2.3) is not really loggable by river and must therefore wait for extension of the road system before there can be major exploitation. Batu Belah can be logged but there should be no hurry to open it up at present.

3.3.3. Untapped Resources for Industry

A summary of the important parts of the FAO Working Paper (1973 b). This is given here because the whole of the uncommitted timber resources available for industrial development are defined in it.

3.3.3.1 General

The 600 000 acres of uncommitted forest available for development comprises 530 000 acres of flat to undulating land easy to log and the remaining 70 000 acres is in mountainous country difficult to log.

The volume estimates based on a minimum log diameter of 18 inches are confined to high to medium volume forest strata: swamp forest patches and Kerangas are excluded. Present marketable species only are included. Defects, logging damage and unavoidable waste have been allowed for to give the net commercial volume. The forest inventory figures give a precision in the estimate of net industrial stemwood volume (on which the net commercial volume estimates are based) of $\pm$ 6.84 per cent at 95 per cent probability level within Inventory Unit 2. Since Industry Unit 1 comprises only part of the Inventory Unit the volume estimates are statistically less accurate than for the inventory as a whole. Volume estimate for Industry Unit 2 are partly, and Unit 3, wholly determined by extrapolation from photo interpretation and must have even lower reliability.

3.3.3.2 Transportation Facilities

Daily air services using Fokker Friendship 27 aircraft connect with Kuching and Kota Kinabalu (Sabah) with stops at Sibu and Miri. Transport limitations are serious: in particular the lack of a port. The main road from Miri to Bintulu still lacks surfacing and permanent bridges. Design load limits are imposed by bridge design and speed restrictions by the Road Traffic Ordinance, 1960. The last remaining link between Bintulu and the Pan - Sarawak Trunk Road is 45 miles and when completed can channel logs and processed wood to Bintulu. Rivers no longer provide ready access to forests under working and log extraction is now road orientated so the sinker problem should soon be overcome. Lacking a port all logs are loaded at present from rafts on to small ships of 2 500 to 5 000 tons standing offshore. The small production of timber sawn for export is shipped from Bintulu by barge and must negotiate the Kemena river bar with an average high tide depth of 10.5 feet. The heavy cost disadvantage for shipment from Sarawak's only deep water anchorage (Tanjong Mani in the Rajang River delta) 200 miles from Bintulu and 470 miles from Singapore amounts to as much as $90 per 100 cubic feet.

3.3.3.3 Service Facilities

These are at present minimal in Bintulu but include a microwave radio link. Miri, 135 miles away, has equipment and servicing facilities.

3.3.3.4 Employment and Training

The Bintulu Study Area population (1970 census) is approximatedly 39 000 with the distribution of the estimated 10 000 employable males somewhat as follows:

Agricultural	42.5 per cent
Logging and Forest Industry	12.3 per cent
Other occupations	28.0 per cent
Unemployed	17.2 per cent
	100.0 per cent

The figure for logging probably includes many temporary residents from Sibu who, generally more productive, at present command higher wages than the locals. Priority for training at all levels is essential to the development envisaged as there is no pool of skills for local industrial recruitment which is expected to reach 2 500 full-time employment. Training facilities are available at the Forest Department Timber Research and Technical Training Centre, Kuching but additionally industry should train its own skills.

3.3.3.5 Overall Planning Perspective

The forests of the Bintulu Study Area, including areas under licence, are estimated to contain 558 mn cubic feet (true) of net commercial wood volume of good quality and with a high proportion of peeler grade logs of listed species in market demand. The aim of industry must be to remove all trees over 18 inches diameter which contain commercial wood and not, as in current practice, only logs for export (usually over 23 inches diameter and with only a limited proportion of sinkers). To utilise lower quality logs the essential mixture of high and low quality logs must provide a high average quality of manufactured output. Selective harvesting is rejected as not in the best interests of Sarawak. The incentive of log export should only be permitted after the industry is in operation. This log trade, initially required for the financing of new enterprises, must be completely phased out and domestic processing of primary resources made the major aim of the Government of Sarawak. Log export licences should therefore be annual and discretional and limited to 30 per cent of the log flow.

Processing enterprises such as these have an industrial base of applied commercial research at present completely lacking in local experience. Massive sales promotions are essential. The initial industry must be on a large scale. Jengka Triangle experience suggests the log intake of future complexes should not exceed 10 mn cubic feet per annum and Peninsular Malaysia experience with wood-based industries suggests initial establishment at growth points. Therefore the Study Area resource

flow is to provide a sustained log output between seven and ten mn cubic feet for each of the three independent manufacturing complexes building up over a period of five years and extending for a 25 year period. Each should be limited in log intake to eight mn cubic feet annually.

The long term forest resources available after completion of the agricultural conversion is estimated at 515 000 acres and "appears to have the capacity, subject to a suitable management regime, to maintain the log intake requirements of three complexes on a sustained yield basis". (FAO, 1973 b)

The three industry units finally chosen are in uncommitted forest analysed to produce for each a harvest pattern of eight to ten mn cubic feet a year at lowest cost delivered at industrial sites to be located at the most promising centres of future growth. These are:

(i) Bintulu: a government recognised economic growth point.

(ii) Near the junction of the proposed Labang - Tubau feeder road and the Miri Bintulu Trunk road and a centre of projected agricultural settlement.

(iii) Suai: The actual location could be any suitable site within the first seven miles along the Miri Bintulu road north of the point where the road crosses the Batang Suai. This will have excellent road connections to local markets and both Bintulu and Miri export points. The workers for the complex should live in Igang. Initially careful integration is required with agricultural development flows for which it is the centre.

3.3.3.6 Assumptions and Evaluation Criteria

The nucleus of phased industries growth is to be the modern sawmill designed for expansion as justified (plans for these mills must be submitted in advance). Plywood and other expanded processing are to be phased in only when careful evaluation proves they are practical. Independent design studies for specialised operations should be encouraged. Individual investors might do these early, but substantial expansion of Malaysia's overall plywood production appears unlikely until the 1980's. Two immediate resource uses are therefore recognised:-

(i) The entire log output converted to sawn timber.

(ii) Lower grade logs converted to sawn timber and high quality peeler logs exported.

The proposed licence conditions need careful consideration (FAO 1971). Each complex will be completely self contained with resources guaranteed for 25 years subject to a carefully

negotiated and prepared legal agreement followed by strict enforcement. Details of logging costings supported by numerous tables, are based on assumptions that there is control of harvesting by the industry and that the methods will be the same in all three complexes using no equipment yet untried in Sarawak; that training to an acceptable operational efficiency will be attained in five years: that equipment will not be under utilised: that tree length logging will be practised: that all trees of commercial species at a reference diameter (i.e. diameter at a height of 4.3 feet or above buttresses) of 18 inches will be felled, and that waste will be minimal. Trial use of articulated skidders is nevertheless recommended. Bucking and logging must immediately follow felling, alternatively species susceptible to borer attack must be sprayed to avoid degrade.

Export demand for high grade peeler logs is likely to increase and for lower gradelogs to decrease.Sawnwood export demand will remain good for high quality but disposal of the lower grade will be an increasing challenge which must be met. Further processing of lower grades is one possibility: no costings are given.

333.7 The Bintulu Complex

The total area of Industry Unit 1 is 176 000 acres of which 153 000 acres is stratified as high volume forest, i.e. 60 per cent of the crown canopy occupied by over-storey trees with 30 feet crown diameter or more. Net commercial volume is estimated at 1 030 cubic feet true per acre in trees containing a minimum 18 inches diameter 12 foot saw log. The estimated total net commercial volume is 158 mn cubic feet. Analysis by species groups and operational periods in Table 12 of the Working Paper suggests remarkably uniform volume per acre (the total range varying from 969 to 1 062 cubic feet per acre) both in total and for the main species groups: red and dark red meranti which constitute 48 per cent of the crop.

The terrain is divided equally between Classes I and II: flat to gently rolling or dissected broken hill country well distributed, so that increased logging costs are well spread. There are six operational planning sub-units or "periods" to supply four mn cubic feet annually in the first five years rising to seven mn cubic feet thereafter.The final siting of the manufacturing complex depends on Government's decision on the feasibility of a port at Tanjong Kidurong which lies seven miles north of Bintulu at the southern end of the industry unit.

Harvesting costs are estimated to range between $92.25 to $205.90 per 100 cubic feet, inclusive of road construction, road maintenance, royalties, fees and a 10 per cent contingency.

Felling, bucking and de-barking will be let on contract. The maximum skidding distance using track type tractors of approximately 180 horsepower is 40 chains and averages 20 chains. The loading of logs should be carried out by front-end loaders. Log transport calculations assume the use of trailer trucks with a payload of 22.5 tons.

The cost of forest roads can be carried by the logging operation because public roads provide access. Two classes of road are prescribed: Class 1 through the area of the operational period and Class 2 roads on a standard spacing formula based on volumes, skidding and road construction costs. Spacing varied from 39 to 60 chains, average 43 chains. Costings presuppose surfacing of all Class 1 and two thirds of the Class 2 roads. Surfacing costs assume that equal quantities of metal are obtained from the quarries at the 42.5 mile and the better material at the 65th mile from Bintulu. The capital cost estimates are for equipment for only one quarry. Material from the second quarry must be arranged privately.

3.3.3.8 The Labang Complex

The total area is 257 000 acres of which 174 000 acres are high volume forest. The distribution by terrain classes by percent is: Class I - 58, Class II - 38, Class III - 3 and Class IV - 1. The more difficult areas are small and unlikely to increase costs unduly. The estimated net commercial volume is 157 mn cubic feet. Average volumes per acre vary in the periods between 867 and 1 003 cubic feet. Forty-seven percent of the crop is red and dark red meranti.

The costing of forest roads and quarries is based on similar assumptions to those for the Bintulu complex. If the Tubau-Bintulu road were to be shortened by a more direct route than that through the timbered area re-definition of costing for a replacement access road system would be necessary. This could lead to a re allocation of the mill site.

3.3.3.9 The Suai Complex

The total area of Industry Unit 3 amounts to 197 000 acres of which 127 000 are in the higher volume forest density classes. The Unit comprises the whole of Sawai Protected Forest and the portion of Niah - Jelalong Protected Forest with natural extraction to the west.

The terrain varies from flat to low-rolling in the north west to steep high land in the north east. Road but not extraction costs take terrain differences into account.

The main road offers, at present, better service from Miri, 75 miles away than Bintulu, 53 miles. There is no public road network available for log extraction except possibly in later years. There are five operational periods supplying similar quantities to those in the other industry units but the plan envisages possible completion in only 23 years.

The estimated net commercial volume is 147 mn cubic feet based on analysis of limited applicability from Inventory Units 2 and 6 and extrapolation of data for intervening forests.

The crop uniformity of the operational periods located in the Bintulu and Labang complexes is repeated but the volumes per acre (between 778 and 955 cubic feet per acre in the five periods) are less.

3.3.3.10 Shipping

Alternative schemes for providing Bintulu with facilities for industrial trade, which are at present completely lacking, are considered. A bulk carrier service, at rates competitive to Conference line's shipment's from Straits ports, was found to be interested provided an efficient trading schedule can be ensured. Maximum use of rebates, particularly full-ship loading and single port destination, could eliminate freight differential entirely. If a port at Tanjong Kidurong is rejected then minimum facilities must be provided for efficient off-shore loading from barges, container-loaded, at a land-based terminal near Tanjong Kidurong. During the monsoon loading would be irregular and stock piling might be necessary. In this alternative bulk carrier rates could apply only for nine months.

3.3.3.11 Conclusions and Recommendations

Bintulu provides an unique opportunity to pioneer technical innovation for release of the full potential of Sarawak's Mixed Dipterocarp Forests. Such pioneering has no local basis for a regime of sustained yield management and requires large scale applied research and special attention to local training in skills which could provide experienced men for industrial expansion elsewhere in Sarawak. In the meantime a cutting cycle of 25 years is recommended on the basis of Peninsular Malaysian research data: felling of commercial species to a minimum diameter of 18 inches or more followed by a light treatment "to adjust the canopy through the removal of unwanted species" (FAO 1973 b). The present Forest Department cannot possibly cope with the additional load of planning, management, research and administration required for the harvesting of

some 20 000 acres annually provided by the three complexes. To fulfill these responsibilities necessary finance must be supplied and immediate action taken on re-organisation and expansion of the Department. New concepts of co-operation between Government and industry are expected if adequate staff and finance are to be provided for the Timber Development Corporation (FAO 1973 c).

3.3.4. Economic Considerations

The economic consequences of the future development of the forest resources in the Study Area can be divided into different categories according to the method and rate of exploitation.

These are:-

- The areas under present exploitation for which licences are still valid. Exploitation in these areas will take place according to already prepared logging plans.
- Areas logged according to sustained yield principles.
- Areas to be finally logged (salvage felling) where existing logged forest is to be converted into agricultural land.
- Areas allocated for industralised timber production - that is the areas included in the Forest Utilisation identified by the FAO team.

The areas under existing licences have not all been operated in recent years even though timber prices have been extraordinarily high in 1973. Some areas have been declared complete, but as the licences in question have not been surrendered re-entry into those areas is possible. Allowance for this has been made in the estimates of future log production. Of the existing concessions which are not being logged according to a sustained yield system the expected output is assumed to be:

	1974	1975	1976	1977	1978	1979	1980
in 1 000 tons hoppus	750	700	650	600	500	400	300
in mn dollars[1]	75.0	70.0	65.0	60.0	50.0	40.0	30.0

(1) With an average log price of $100 per ton hoppus.

The peat swamp forest (PSF), a substantial part of the forest estate, being operated according to sustained yield systems, means that the output from these areas is assumed to be constant in future. The annual output from these areas is estimated at 235 000 Ht which, at an average log price of $70 per ton, will amount to $16.5 mn per year.

The forest areas which were selected for agricultural development are planned to be logged of all marketable timber before land clearing begins. The output from the salvage logging is estimated at 4 tons hoppus per acre which is based on present experience of such logging in the Study Area. This salvage yield is assumed to be obtainable from all areas logged under existing licenses. For calculation purposes in the FAO Units, a similar volume has been added to the average yields (as estimated by the FAO Team) in those parts of the Units which have been identified for agricultural development. The output for the years 1974-80 from salvage logging including the 4 ton per acre contribution from parts of the FAO Units has been estimated at:-

	1974	1975	1976	1977	1978	1979	1980
in 1 000 tons hoppus	2	60	65	115	110	65	45
in mn dollars[1)]	0.2	5.7	6.2	10.9	10.5	6.2	4.3

1) average log price $95 per ton.

The combined output from the three FAO Units based on the short rotation cycle system is estimated at:-

	1976	1977	1978	1979	1980
in 1 000 tons hoppus	50	110	180	230	290
in mn dollars[1)]	5.3	11.6	18.9	24.2	30.5

1) average log price $105 per ton.

- provided that no logging in these areas will be allowed before the manufacturing units are operational.

The total estimated volume and value of logs that will be extracted in the Study Area is thus:-

	1974	1975	1976	1977	1978	1979	1980
in 1 000 tons hoppus	987	995	1000	1060	1025	930	870
in mn dollars	91.7	92.2	93.0	99.0	95.9	86.9	81.3

The logging operations might differ within the concession licence areas depending on whether the harvesting is, in already licenced areas, earlier logged areas or within the new industrial units. The cost will vary accordingly. The hill areas under present licence will be logged in the traditional way (San Tai Wong) while the industrial units, because of their size, will justify large scale industrial extraction. This involves higher investments in roads and the use of heavier extraction machinery.

While the traditional logging costs as described a ove are estimated at $45 per ton hoppus in non-logged MHD areas the operation in remnant MHD forest areas will be about $35 to $40 per ton hoppus. The extraction costs in PSF areas are estimated at $25 per ton hoppus.

The industrial units will however be logged on the same principles as the traditional logging:-

- logs are felled in long logs or tree lengths when possible;
- a crawler tractor makes skid trails and the logs are dragged/winched to the landing with crawler tractors. Skidders are not recommended initially because of the terrain, they might be introduced if proposed tests are satisfactory. Skidding should be long-log or tree length when possible.
- at the landing the logs are debarked, bucked and sprayed then loaded onto trucks by rubber wheeled fork loaders.
- the hauling of logs from the landing to the dumping point (sawmill logyard) will be done by log-trucks with approximately 30 ton load capacity.

The industrial logging costs have been calculated at $40 per ton hoppus. The composition of the logging costs is given below.

Logging				Roads	Overheads		Total
Fell, buck, debark	Skid	Load	Haul	Construction maintenance	Camp management	Other contingencies	$/Ht
2.00	7.85	1.00	6.00	5.00	14.50	3.65	40.00

When considering the total costs and revenues from the forestry industry, the expenses of a silvicultural treatment should be included. Research may show what treatment is necessary in areas where a 25 year rotation cycle is planned. The silvicultural treatment is estimated at $38 per acre according to investigations carried out in Peninsular Malaysia. The operations might be counted as a benefit for the subsequent crop, making it possible to log about 90 per cent of the original fully marketable volume 25 years after the first harvest. However, because silvicultural treatment is mostly undertaken around the time of the primary logging it is more reasonable to add the silvicultural expenses to the costs of the first extraction. Consequently the total cost of timber extracted in the industrial units would average $42 to $43 per ton hoppus. (under the assumption of constant prices and costs.)

The net revenue before taxes and royalties of the forest production in the Study Area would consequently be:-

	1974	1975	1976	1977	1978	1979	1980
in mn dollars	52.0	52.6	53.3	57.1	55.7	50.7	47.8

The royalties to be paid would depend on Government policy and the arrangements for participation of Government in the development of the wood based industries. If the present policy is continued the royalty would probably be around $10 mn in each year during the period 1975-1980. An estimate of the forestry sector's contribution to the Regional Economy can be expressed by the total "value-added" in the sector. The "value-added" figure is included in the calculation of the gross Regional Product in the Main Report. It is calculated by reducing the gross value of logging by such externally originating inputs as fuel, machinery, trade margins, external transport etc.

The "value-added" thus is:

	1974	1975	1976	1977	1978	1979	1980
in mn dollars	68.1	68.7	69.5	74.7	73.0	66.9	65.8

The entire economic evaluation of the forestry industry is based on present existing and planned development. Results from extended research into uses of non-merchantable timber, chipping and possible establishment of plantations of fast growing species might in the future increase the economic importance of the forest estate in the Study Area. There is, however, at present no basis for any assessment of the economic importance of these possibilities.

3.3.5. Control of Exploitation for Industry

FAO detail for log costings in the three complexes are based on the assumption that the industry itself can properly control the harvesting. The system of Forest Department control must therefore be modified from present practice as described by Walker (1968) if this assumption is accepted. The assumptions made are that in the three industry complexes the exploiting agency will prepare topographic maps, carry out an inventory, demarcate logging blocks throughout the whole of an operational planning sub-unit or "period" and complete road construction before starting exploitation. A re-adjustment of FAO sub-unit periods has been undertaken by the Consultants so as to facilitate phasing or exploitation with release of land for agricultural development. This was complicated by the boundaries of the development areas being really the boundaries of areas in which future semi-detailed soil surveys are to take place. The final agricultural development areas are expected to be 30 per cent less than the areas shown. For flexibility and in the hope that actual out-turn will be great enough to justify a longer felling cycle than 25 years, seven instead of six periods are provided in units 1 and 2 but five periods retained in unit 3, as shown in Figures 3.2, 3.3 and 3.4. Some of the new proposed boundaries of the sub-units may have to be altered again to suit natural extraction routes,

FIGURE 3.2

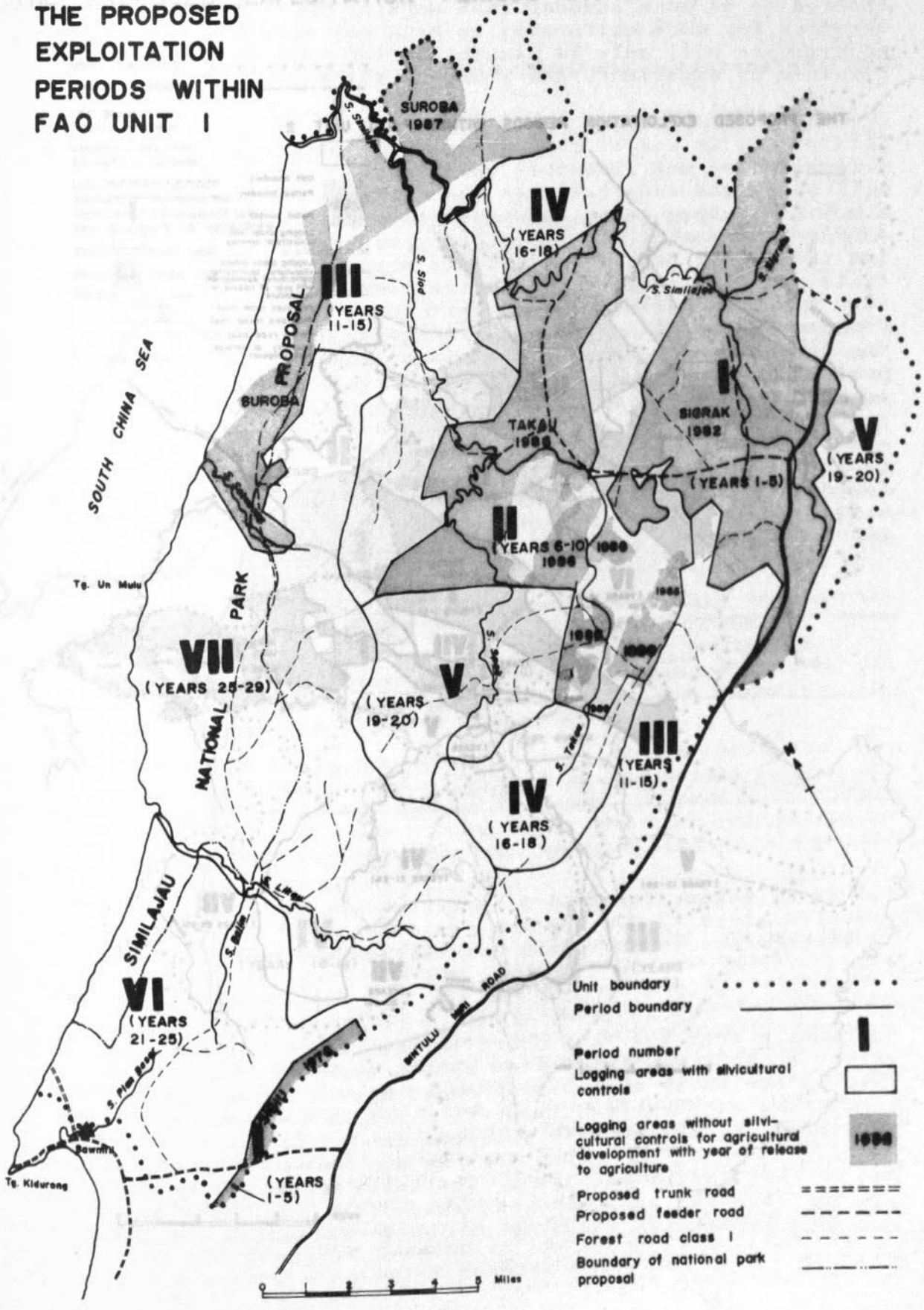

THE PROPOSED EXPLOITATION PERIODS WITHIN FAO UNIT 1
SUROBA 1987
IV (YEARS 16-18)
III (YEARS 11-15)
PROPOSAL
SUROBA
SOUTH CHINA SEA
TAKAU 1988
I SIGRAK 1982
(YEARS 1-5)
V (YEARS 19-20)
II (YEARS 6-10) 1986
Tg. Un Mulu
PARK
VII (YEARS 25-29)
NATIONAL
V (YEARS 19-20)
III (YEARS 11-15)
IV (YEARS 16-18)
SIMILAJAU
VI (YEARS 21-25)
Bawang
Tg. Kidurong
(YEARS 1-5)
BINTULU
Miles
Unit boundary
Period boundary
Period number
Logging areas with silvicultural controls
Logging areas without silvicultural controls for agricultural development with year of release to agriculture
Proposed trunk road
Proposed feeder road
Forest road class 1
Boundary of national park proposal

FIGURE 3.3

THE PROPOSED EXPLOITATION PERIODS WITHIN F A O UNIT 2

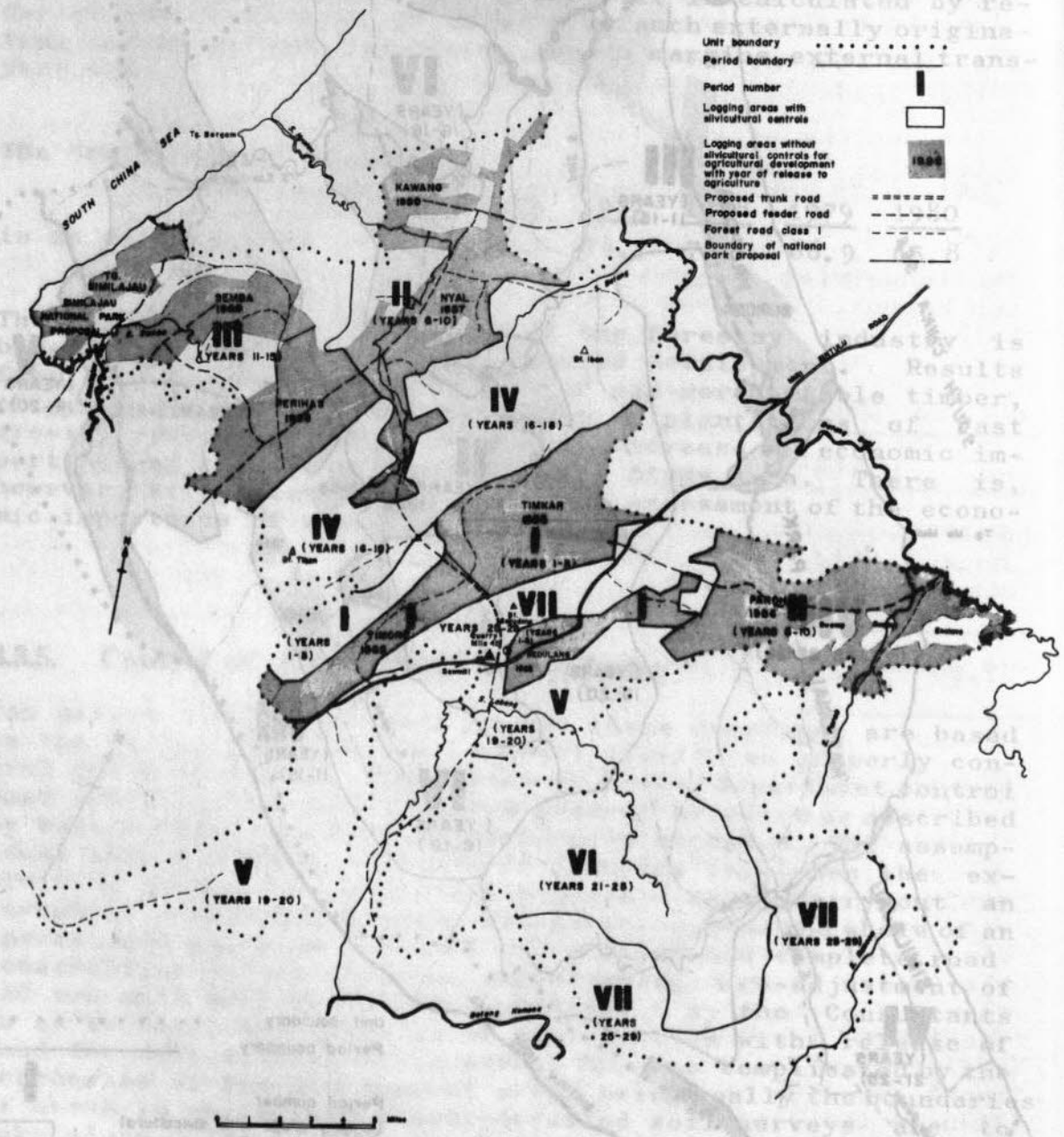
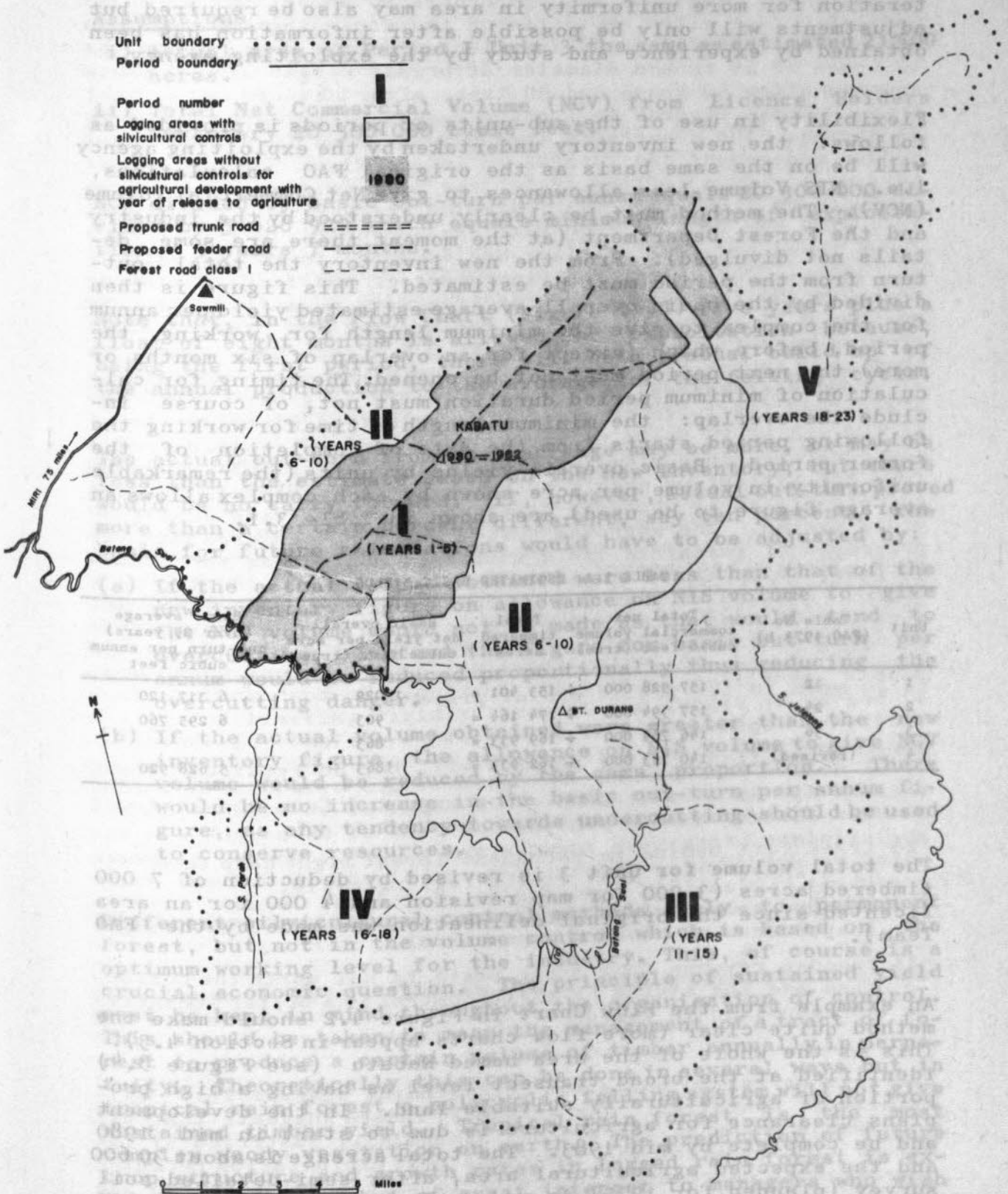


FIGURE 3.4

THE PROPOSED EXPLOITATION PERIODS WITHIN FAO UNIT 3



but the principle of working agricultural development areas separately from permanent forest areas where practical is considered to be much sounder than working the two together. Alteration for more uniformity in area may also be required but adjustments will only be possible after information has been obtained by experience and study by the exploiting agency.

Flexibility in use of the sub-units or periods is provided as follows: the new inventory undertaken by the exploiting agency will be on the same basis as the original FAO calculations, i.e., NIS Volume less allowances to give Net Commercial Volume (NCV). The method must be clearly understood by the industry and the Forest Department (at the moment there are some details not divulged). From the new inventory the total outturn from the period must be estimated. This figure is then divided by the basic overall average estimated yield per annum for the complex to give the minimum length for working the period, before which (except for an overlap of six months or more) the next period must not be opened. The timing for calculation of minimum period duration must not, of course include the overlap: the minimum length of time for working the following period starts from the date of completion of the former period. Basic overall yields by units (the remarkable uniformity in volume per acre shown by each complex allows an average figure to be used) are shown in Table 3.1.

TABLE 3.1 ESTIMATED BASIC YIELDS

Unit	Table No (FAO 1973 b)	Total net commercial volume cubic feet (true)		Total timbered acres		Basic overall net yield per acre cubic feet (true)	Basic average (over 25 years) out-turn per annum cubic feet
1	12	157 928 000	÷	153 401	=	1 029	6 317 120
2	24	157 394 000	÷	174 164	=	903	6 295 760
3	36	146 764 000	÷	169 933	=	863	
4	(revised)	140 723 000	÷	162 933	=	863	5 628 920

The total volume for unit 3 is revised by deduction of 7 000 timbered acres (3 000 for map revision and 4 000 for an area licenced since the original delineation was made by the FAO Team).

An example from the Flow Chart in Figure 4.2 should make the method quite clear (more flow charts appear in Section 4.3). This is the whole of the area named Kabatu (see Figure 3.4) identified at the broad transect level as having a high proportion of agriculturally suitable land. In the development plans clearance for agriculture is due to start in mid 1980 and be complete by mid 1983. The total acreage is about 30 600 and the expected agricultural area, after semi-detailed soil survey (planned for 1975) is presently estimated at 21 500

acres. This is Period I of Unit 3.

Assumptions

i) Actual area of Period I Unit 3 the same as estimated 21 500 acres.

ii) Total Net Commercial Volume (NCV) from Licence Holders inventory 20 300 000 cubic feet.

NCV divided by basic out-turn per annum equals 20 300 000 divided by 5 628 920 which equals minimum length of exploitation - 3 years 7 months.

Note that, in the Flow Chart (Figure 4.4.1), five years plus a float of eight months is allowed for exploitation because, being the first period, there will be a gradual build up of the annual production to the average for the felling cycle.

The actual out-turn from this acreage may be more, or may be less than the estimate based on the new inventory; but there would be no carry forward. If, however, actual out-turn proved more than a certain percent different, say ten percent, the basis for future calculations would have to be adjusted by:

(a) If the actual volume obtained were less than that of the new inventory figure on allowance on NIS volume to give the NCV volume would not be made as that would tend to overcutting. Instead the figure for basic out-turn per annum would be reduced proportionally thus reducing the overcutting danger.

(b) If the actual volume obtained were greater than the new inventory figure, the allowance on NIS volume to give NCV volume would be reduced by the same proportion. There would be no increase in the basic out-turn per annum figure, as any tendency towards undercutting should be used to conserve resources.

Different silvicultural control methods apply to permanent forest, but not in the volume control which is based on the optimum working level for the industry. This, of course is a crucial economic question. The principle of sustained yield must be kept in mind throughout the organisation of control. This should be taken to mean the management of a tract of forest to produce a certain volume of timber annually in perpetuity. Theoretically this can be done in several ways but in tropical rain forest a polycyclic felling system will not give sustained timber yield. Tropical rain forest is the most complex woody vegetation on earth. The prediction of future crop structure and growth rates in logged rain forest is extremely difficult but of great interest to managers who wish to calculate possible lengths of the first post-virgin felling cycle. A number of complex Sarawak experiments are going on

and the analytical work is being carried out at the Commonwealth Forestry Institute Oxford. Information from Sabah, where exploitation standards are comparable to those in Sarawak, indicates that after exploitation in fairly lightly exploited, well stocked, evenly distributed forest there could be 10 trees of 24 inches diameter at breast height of desirable species after 40 years and 20 trees after 60 years in the best areas. These figures in lightly logged forest are likely to be maxima. The conversion from natural high forest to monocyclic management can involve an intermediate felling. After this post virgin felling cycle, the next felling cycle will perforce be close to a full rotation the length of which must vary with the type of crop that can acceptably be grown. Fast grown trees and smaller sizes are expected to be acceptable in future. The mean annual increment of the fastest growing trees in the list of desirables (the red merantis) rarely reaches 0.75 inches diameter. The average for the fastest growing meranti is of the order of 0.5 inches per annum so that an 18 inches diameter tree (the minimum size marketable at present standards) will take 36 years to grow. The complexes are likely to be short of supplies at District level at the end of 25 years unless a wider range of species and a lower merchantable diameter limit become acceptable. Supplies from the hinterland should be coming through Bintulu then and conceivably these would be based on a country wide sustained yield system. The approved policy, however, declares that the principle of sustained yield should be applied as far as may be possible to each District and not only to the country as a whole. Instead of planning exploitation entirely at the maximum level some attention might be given to the possibility of using something nearer the minimum level. This would be more in keeping with ideals of conservation of resources which is so much in the public eye at present.

Block inspection closing reports will not be required because

(a) the standards of exploitation expected from the licences for this work is expected to be high,

(b) trees left behind in permanent forest might help to justify a short first post-virgin felling cycle,

(c) because releasing in five year periods at once makes block inspections on closure impractical,

(d) because revenue from minor waste is not worth the collection and the system of yield control is a better incentive to reduction in waste.

There is as yet no basis for recommending any specific silvicultural operation. The evidence, indeed suggests that all treatments tried so far are not financially justified by results. In any event the immediate post exploitation refining operation is discredited. Better to wait until the crop has settled down after the shock of harvesting. Hence, unless there is a fear that enrichment planting will be necessary, diagnostic samplings are recommended in the year F + 10 together

with establishment of yield plots (one for 1 000 acres) and experimental replicated plots to study the effects of various silvicultural treatments. The yield plots should include (as at present) sub sampling down to four inches diameter to assess all species for increment with a view to obtaining figures for a source of chips for pulping.

Suggestions have been made that a higher minimum diameter should be imposed so as to increase the yield in the first post virgin felling cycle. This is rejected except for research because it would then in this second felling, increase felling damage on young growth, reduce the current yield and tend to hold back young growth of the faster growing species which are intolerant of shade. A tendency, indeed, towards polycyclic felling which is regarded as quite unsuitable for Tropical Rain Forest.

The idea, novel to this country, of the industry itself controlling the harvesting, is bound to arouse scepticism especially without knowing anything about the prospective licence holders. There should, therefore, be some provision in the licence to bring back the normal present system of control, or something very near to it, over any licence holder who does not measure up to the high standards demanded. Some of the premises for the five-year period are questionable. For instance there is no evidence so far, indeed the contrary, that species distribution is so localised that detailed mapping of growing stock will reveal concentrations of particular timber types. Nor is there evidence that markets are so sensitive that there need be appreciable concentration on demand to justify long runs of supply of any particular timber. Indeed the aim of limiting rigidly the area and length of period is to encourage complete exploitation and discourage selective exploitation. A period as long as five years provides a long time for selective exploitation, if the licence holder is so minded, before he is found out. There should be safeguards and one suggested is that the licence holder should submit annually to the S.F.O. a map showing progress of exploitation which the S.F.O. should use for inspection and check by helicopter. Annual comparison of out-turn figures with inventory figures will also assist in tracing selective exploitation.

With these considerations in mind, working plans could include the following:-

SEQUENCE OF OPERATIONS RELATING TO EACH PERIODIC COUPE OR LESSER COUPE

Item	Operation		Approximate time(months)
i	S.F.O. and licence holder agree on location of coupe and location and specification of the Feeder Road (unless in PWD hands).	D	24
ii	S.F.O. authorises work on feeder road to begin (12) and survey boundaries unless done by the Land and Survey Department and demarcate (under supervision of a Forest boundaries (13) and carry out an inventory (14).	D	23
iii	Licence holder carries out work under ii.	D	(25 to 2)
iv	Licence holder submits to S.F.O. survey data, inventory and map (on a scale of not less than 1:25 000) showing boundaries, extraction routes, block boundaries and stand locations.	D	2
	S.F.O. calculates the period allowed for exploitation, informs the licence holder and signs the permit to begin exploitation w.e.f. D day, or, as amended.	D	3

Notes: 1. Sequence and timing is flexible.

2. D is projected data of starting exploitation.

3. The number in brackets in column 3 refers to authorisation in the standard permit to enter coupe.

CHAPTER 4

PHASING OF FOREST EXPLOITATION AND AGRICULTURAL DEVELOPMENT

4.1. INTRODUCTION

Unless there is close co-operation between different interests, the phasing of land clearance for agricultural development becomes chaotic. By the terms of his licence in standard form a licence holder can expect to be allowed reasonable time to remove all the timber he is legally entitled to before the land is taken for other use. There is concern on the part of the Forest Department to ensure that all commercial timber is removed from an area before release and the instructions to staff have strong provision concerning this (Forest Department, 1965) and there will be concern that abolishing block inspection does not in fact lead to undue waste. No provision is made in Sarawak for an agricultural development agency (either the Sarawak Land Development Board or private agencies) to carry out the primary or salvage exploitation prior to release of land. Generally this should be the rule because the forward planning needed for such commercial exploitation is unlikely to be achieved by an agricultural development body and the intermittent use of the specialised machinery would be uneconomic. Moreover all forested development areas are either under licence or allocated to an industrial complex.

Fluctuating values of timber can make residual forest commercially valuable from time to time and salvage exploitation can sometimes be combined with clearance for burning. Licence holders themselves are frequently allowed to re-enter their working areas for salvage fellings, and this can complicate phasing of release. The solution is to give enough warning to the Forest Department and to be sure all parties have correct knowledge of the boundaries concerned: too often trouble can occur because maps differ.

4.1.1. Summary

The scope of the planned phasing of forest and agricultural development is described in detail with a programme of action. The operational sequence envisaged from the planning of road access and semi-detailed soil survey to final release for agricultural development is explained step by step, supported, where relevant, by flow charts.

4.2 SCOPE

The area which will have to be cleared of forest for agricultural development (including land which has been exploited under licence but which may or may not be subject to salvage

fellings) is estimated at 233 100 acres. Some of this land has been soil surveyed at the semi-detailed level and the areas are final but most of it has not. The extent of the area still needing semi-detailed soil survey to give the above total estimated area (on the basis of a probable reduction by 30 per cent) is 224 963 acres.

The various areas have been given names based on some nearby physical feature in the published maps, usually a river. Convenience rather than authority is the justification. These areas are subject to subdivision by other names for agricultural development purposes but the names given in Table 4.1 are those shown on Figure 4.1. The acreage of land under shifting agriculture is excluded from the acreages shown. The northern portion of the Igang SLDB Scheme Area of 4 600 gross acres in Niah Forest Reserve is ideally situated, from the development point of view, to be the location of a new sub-regional service centre. However the area also contains recently started forest research plots of special value to the Forest Department. For this reason Government is undecided whether to allow the allocation of the area to agriculture and therefore retard the Forest Department research plans, or whether to retain the area as Forest Reserve and thereby force the building of the town in another, less favourable location. These alternatives are analysed and discussed in the Main Report and in Supporting Reports 2 and 5 while the importance of the research plots to forestry in Sarawak is described in Appendix II.

4.3. OPERATIONAL SEQUENCE

4.3.1. Procedural Stages

The studies, investigations and surveys carried out by the Consultants are fully described in Supporting Report 1 Part II. They are summarised below.

BROAD ZONATION OF LAND (Schematic reconnaissance)

1. Air-photo interpretation of land on terrain and vegetation criteria supported by reconnaissance soil survey and post-air photo field checks to identify areas possibly suitable for agriculture and areas unsuitable. This was completed for the whole Study Area.

DETAILED RECONNAISSANCE SOIL SURVEY

2. Broad transect soil survey carried out in areas identified as possibly suitable for agriculture at the Broad Zoning stage. From this survey, based on strategically located transects and photo interpretation, the boundaries

between areas with a high proportion of land suitable for agriculture and areas unsuitable for agriculture were ascertained and mapped on a scale of 1:100 000. Within the areas surveyed the result was a land capability map where Class VII (all sub-classes) and sub-classes VIsw and Vs are judged unsuitable and are allocated to Forestry, (Maps 14 and 15). Areas for more detailed examination were then chosen using generalised boundaries. This covered a total area of 1 530 000 acres.

RE-MAPPING

3. Mapping from latest aerial photos of boundaries between unoccupied and occupied land. This covered the whole Study Area.

SEMI-DETAILED SOIL SURVEY

4. Semi-detailed soil survey; carried out within chosen areas (totalling approximately 100 000 acres) mapped on a scale of 1:50 000, and identifying precisely the boundaries between land suitable and land unsuitable for agriculture. Generalised boundaries between these two categories are marked on the 1:50 000 scale Detailed Plan Area map to facilitate eventual survey and demarcation on the ground. Encalves of forest to be preserved are also similarly marked on the 1:50 000 scale Detailed Plan Area (Map 20).

SURVEY WORK STILL TO BE UNDERTAKEN BY LAND AND SURVEY DEPARTMENT

5. Survey and demarcation of these boundaries on the ground by staff of the Land and Survey Department using prismatic compass. Also survey and demarcation of the boundaries of occupied (cleared) land before the local planting month. (A survey team could consists of a demarcator, one chainman and three labourers and should complete 400 to 500 chains per month costing about $5.00 per chain). The rate of survey can be increased up to 1 000 chains per month by augmenting the number of labourers to eight. Whether survey would be carried out by prismatic compass or theodolite will depend on staff available. A theodolite survey team would consist of:

1 surveyor
2 chainmen
5 labourers

With this team 400 to 500 chains a month could be surveyed at a cost of $10 per chain. The supply of a chainsaw would speed up the work of either team.

DEMARCATION BY FOREST DEPARTMENT

6. Further demarcation by the Forest Department, with labour and assistance from the timber licence holder, by application of red paint rings to trees below 18 inches diameter

at approximately half chain intervals along all cut line boundaries, including those of the proposed forest enclaves in agricultural areas. The outside boundaries of the agricultural development blocks (i.e. between land to be developed to agriculture and Forest Reserve) should in addition be demarcated in the usual way for Forest Reserves by aluminium tags at every chain and with notice plates at corners and road, path and river crossings, and other salient points.

FOREST ENGINEERS SURVEY

7. The Forest Engineer of the licencee should carry out a topographical survey of the whole exploitation area. This together with an inventory of the timber would enable preparation of forest road maps to be made in consultation with agricultural interests and Forest Department control. It would then be possible to demarcate logging blocks using yellow rings on the trees.

ROAD CONSTRUCTION AND EXPLOITATION

8. Road construction followed by exploitation.

Exploitation of a block destined for agricultural development should be completed by June in any year during which release is required so as to allow for clearing and burning by April the following year. External and enclave boundaries should be cleared of debris and minor logging roads cross drained to reduce erosion.

FOREST DEPARTMENT CLOSURE PROCEDURE AND RELEASE TO AGRICULTURE

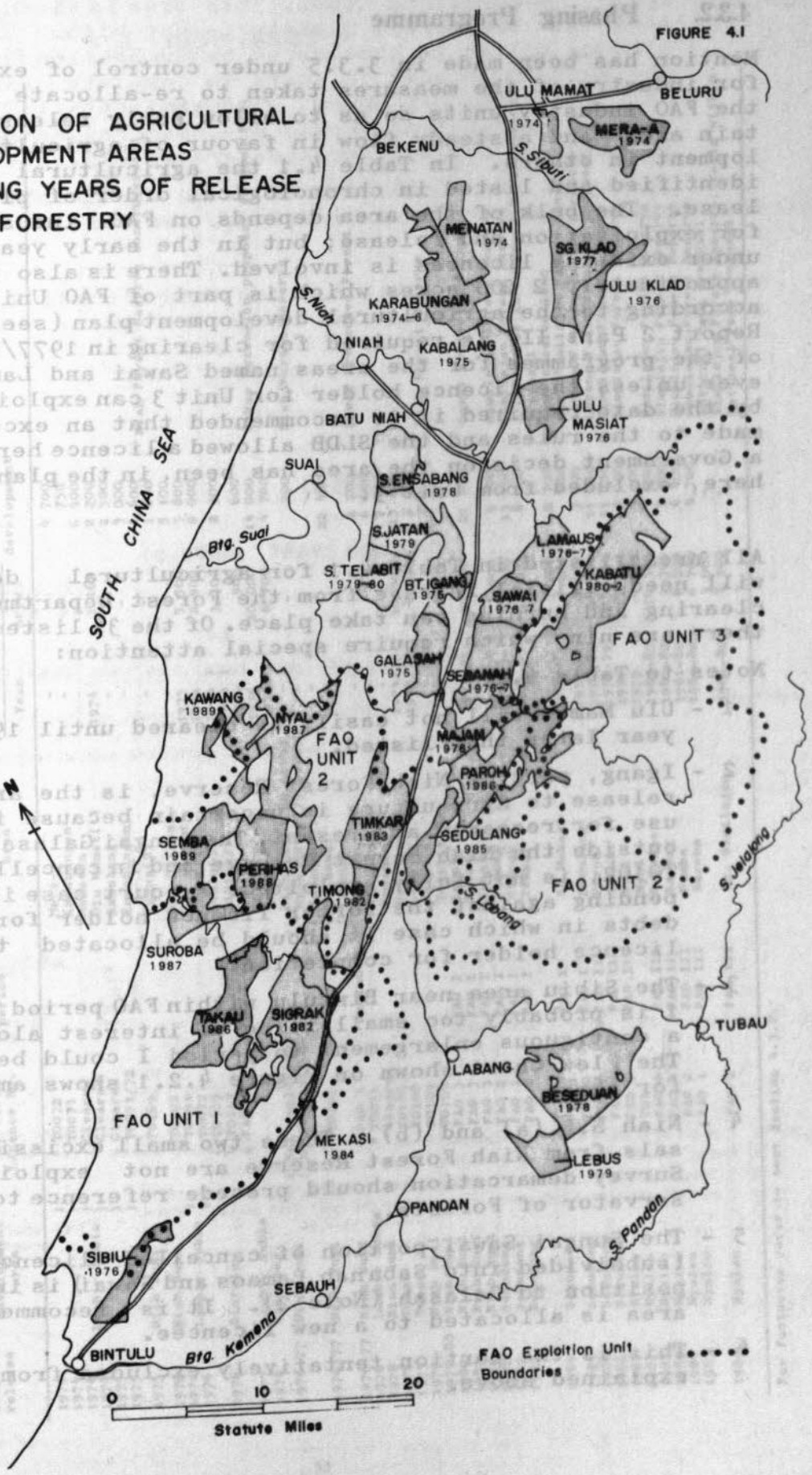
9. Forest Department closure procedure should be completed before the end of July for gazetting and release of the land in August for agricultural development. About 100 acres for a nursery should, in those areas developed to agriculture by SLDB (see Supporting Report 2 Part II), be released early in the year.

The above procedure does not mention the integration (between forestry and agriculture) of road construction plans at least two years earlier. The procedure can be relaxed when pressure to release land is reduced. In such circumstances, more time can be allowed for road consolidation and the logging of future agriculture areas can be combined with permanent Forest logging provided the boundary marking procedure has been fully completed.

Determination of the legality of occupation of land found cleared (3 in the sequence) must have high priority after the survey by Land and Survey Department. Principles for undertaking this task and described in Supporting Report 2 Part I.

FIGURE 4.1

LOCATION OF AGRICULTURAL DEVELOPMENT AREAS SHOWING YEARS OF RELEASE FROM FORESTRY



4.3.2. Phasing Programme

Mention has been made in 3.3.5 under control of exploitation for industry of the measures taken to re-allocate periods in the FAO industry units so as to allow early release of certain areas and a steady flow in favour of agricultural development in others. In Table 4.1 the agricultural areas are identified and listed in chronological order of planned release. The bulk of the area depends on FAO industry units for exploitation and release; but in the early years forest under existing licences is involved. There is also an area of approximately 2 200 acres which is part of FAO Unit 3 which according to the agricultural development plan (see Supporting Report 2 Part II) is required for clearing in 1977/78 as part of the programmes for the areas named Sawai and Lamaus. However unless the licence holder for Unit 3 can exploit the area by the date required it is recommended that an exception be made to the rules and the SLDB allowed a licence here. Pending a Government decision the area has been, in the plan presented here, excluded from Unit 3.

All areas listed in Table 4.1 for agricultural development will need official release from the Forest Department before clearing and burning can take place. Of the 34 listed there are nine which require special attention:

Notes to Table 4.1

1 - Ulu Mamat will not easily be cleared until 1975: one year later than listed.

2 - Igang, part of Niah Forest Reserve, is the area whose release to agriculture is uncertain because it is in use for research at present. The Sungai Galasah portion, outside the Niah Forest Reserve and in cancelled licence TO102, is not fully exploited. A court case is probably pending against the former licence holder for royalty debts in which case it should be allocated to a new licence holder for completion.

3 - The Sibiu area near Bintulu within FAO period I of Unit 1 is probably too small to be of interest alone. If so a contiguous enlargement to period I could be afford. The Flow Chart shown on Figure 4.2.1 shows ample float for this.

4 - Niah S.E.(a) and (b). These two small excission proposals from Niah Forest Reserve are not exploited yet. Survey demarcation should precede reference to the Conservator of Forests.

5 - The Sungai Sawai portion of cancelled licence TO102 (subdivided into Sabanah, Lamaos and Sawai) is in a similar position to Galasah (Note 2). It is recommended the area is allocated to a new licencee.

6 - This is the portion tentatively excluded from FAO 3 as explained above.

TABLE 4.1 AGRICULTURAL DEVELOPMENT AND EXPLOITATION PHASING

Year of release	Rural development area	FAO Unit or F.D. Licence No.	FAO period	Name of agricultural area	Area (acres) For semi-detailed soil survey Year	Area	Estimated for development	Current status
1974	)	T0072		Mera-a	-	-	4 700	
1974	)	T0071		Karabungan	-	-	750	
1974	)	Cleared		Menatan	-	-	6 400	
1974	Lambir Subis)	Cleared		Ulu Mamat(1)	1974	3 163	2 200	
1975	)	Cleared		Kabalang	-	-	2 500	
1975	)	T0071/72		Karabungan	-	-	3 000	
1975	Niah Suai	T0169		Igang(2)	-	-	4 600	Niah Forest Reserve controversial
1976	Niah Suai	T0102		Sg. Galasah	-	-	1 800	
1976	Lambir Subis)	T0091		Ulu Masiat	1975	5 500	5 100	
1976	)	T0072		Ulu Klad	1974	2 900	3 800	
1976	Bintulu (	T0309		Sibiu(3)	1974)	3 300	2 000	
	(	T0117		Sibiu(3)	1974)		2 300	
	(	FAO 1	FAO I	Sibiu	1974	900	600	
1977	Lambir Subis			Sg. Klad	1976	20 000	14 000	Bakas Extension proposal to Niah F.R.
1976	Sekudong			Majam	1976	6 700	4 700	
1976-77	Niah Suai	(Not exploited		(4) Niah SE(a) 80 acres	-	-	300	Niah Forest Reserve
		(Not exploited		Niah SE(b)179 acres	-			
				(Sabanah(5)	-			
1976-77	Niah Suai	T0102		(Sg.Sawai	-	-	22 400	
				(Lamaus				
1976-77	Niah Suai	FAO 3	Excluded	Sg.Sawai(6)	-	-	2 200	Sawai Protected Forest
1976	Lambir Subis	T0071		Karabungan	-	-	6 800	
1978	Niah Suai	Cleared		Ensabang	-	-	7 750	
1978	Tubau	T0108		Beseduan(7)	1974/75	18 800	13 100	
1979	Tubau	T0108		Lebus(7)	1974/75	4 100	2 600	
1979	Niah Suai	T0109		Jatan(8)	-	-	7 900	Niah Forest Reserve
1979-80	Niah Suai	T0109		Telabit(8)	-	-	5 200	
1980	Niah Suai	FAO 3	FAO I	Kabatu)				
1981	Niah Suai	FAO 3	FAO I	Kabatu)	1974-75	30 700	21 700	Sawai Protected Forest
1982	Niah Suai	FAO 3	FAO I	Kabatu)				
1982	Sekudong	FAO 2	FAO I	Timong	1974-75	5 900	4 100	Similajau Forest Reserve
1982	Sekudong	FAO 1	FAO I	Sigrak	1974-75	18 900	13 200	Similajau Forest Reserve
1983	Sekudong	FAO 2	FAO I	Timkar	1974-75	12 200	8 500	3 000 acres in Labang F.R. Extension proposal
		T0309	FAO I	Sg.Mekasi	1974-75	(3 900	2 700	Some cleared land
1984	Sekudong	FAO 1				(900	600	Part Similajau Forest Reserve
1985	Sekudong	FAO 2	FAO I	Sedulang	1977-81	4 400	3 100	Labang F.R. Extension proposal
1986	Sekudong	FAO 2	FAO II	Paroh	1977-81	16 700	11 700	Labang F.R. Extension proposal
1986	Sekudong	FAO 1	FAO II	Takau	1978-79	15 900	11 100	Similajau Forest Reserve
1987	Nyalau	FAO 2	FAO II	Nyal	1979	12 000	8 000	Similajau Forest Reserve
1987	Nyalau	T01		Nyal	1979	4 500	3 100	
1988	Nyalau	FAO 2	FAO III	Perihas	1981-82	10 300	7 200	Similajau Forest Reserve
1989	Nyalau	FAO 2	FAO II	Kawang	1981-82	3 300	2 300	Similajau Forest Reserve
1989	Nyalau	FAO 2	FAO III	Semba	1981-82	6 200	4 400	Similajau Forest Reserve
1987	Nyalau	FAO 1	FAO III	Suroba	1981-82	6 700	4 700	Similajau Forest Reserve
						3 000	-	National Park proposal
1989	Nyalau	FAO 2	FAO III	Tg. Similajau	1981-82	4 100	-	Similajau Forest Reserve, falls within National Park proposal

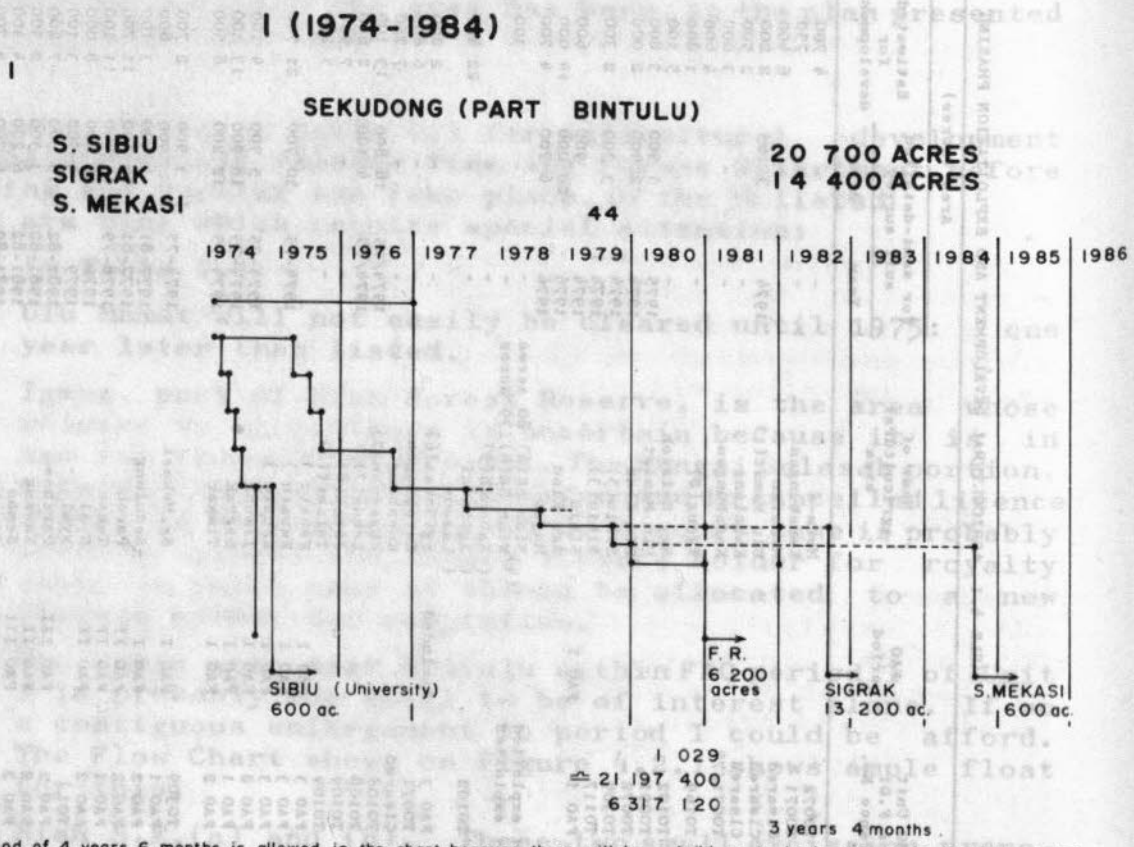
For footnotes refer to text Section 4.3.2.

7 - Tubau, Beseduan and Lebus. This area is virtually unexploited. The forest quality is not high. The present licence holder is considered by the Section Forest Officer Bintulu to need 10 years to complete exploitation at 1 500 acres per annum. The semi-detailed soil survey and demarcation should precede a request to the Conservator of Forests for accelerated exploitation here.

8 - Survey of the boundaries of Jatan and Telabit are required before clearance salvage can take place.

The entries listed in Table 4.1 for the FAO exploitation units are accompanied by flow charts shown in Figures 4.2 to 4.4.

FIGURE 4.2.1



NOTE: (1) A period of 4 years 6 months is allowed in the chart because there will be a build up to basic outturn in the first period.
(2) Except for the Semi Detailed Soil Survey all acreages are hypothetical.
(3) S. SIBIU estimate 2300 acres to be released not later than AUGUST 1975.
(4) S. MEKASI estimate 2700 acres to be released not later than AUGUST 1984.

FIGURE 4.2.2

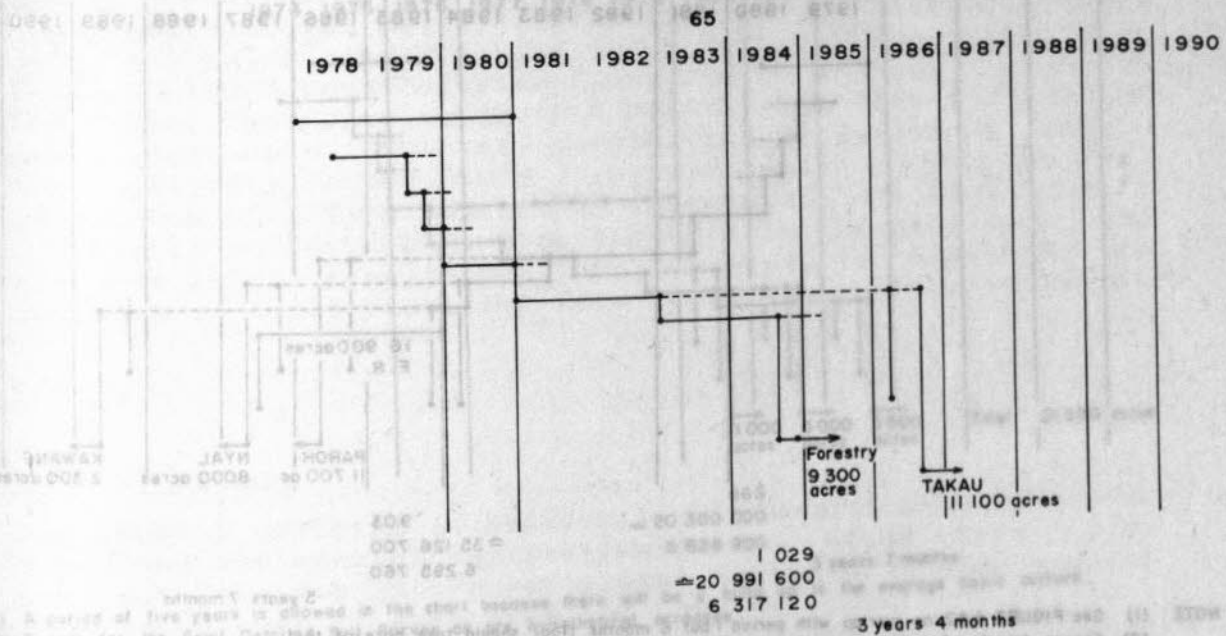
I (1981-1986)

II

SEKUDONG

TAKAU

15 900 ACRES
11 100 ACRES



1 029
≙20 991 600
6 317 120

3 years 4 months

NOTE: (1) A lengthy float will allow for tremendous boundary difficulties if the fragmentation of the agricultural area proves practical.

(2) Except for the Semi Detailed Soil Survey all acreages are hypothetical.

FIGURE 4.2.3

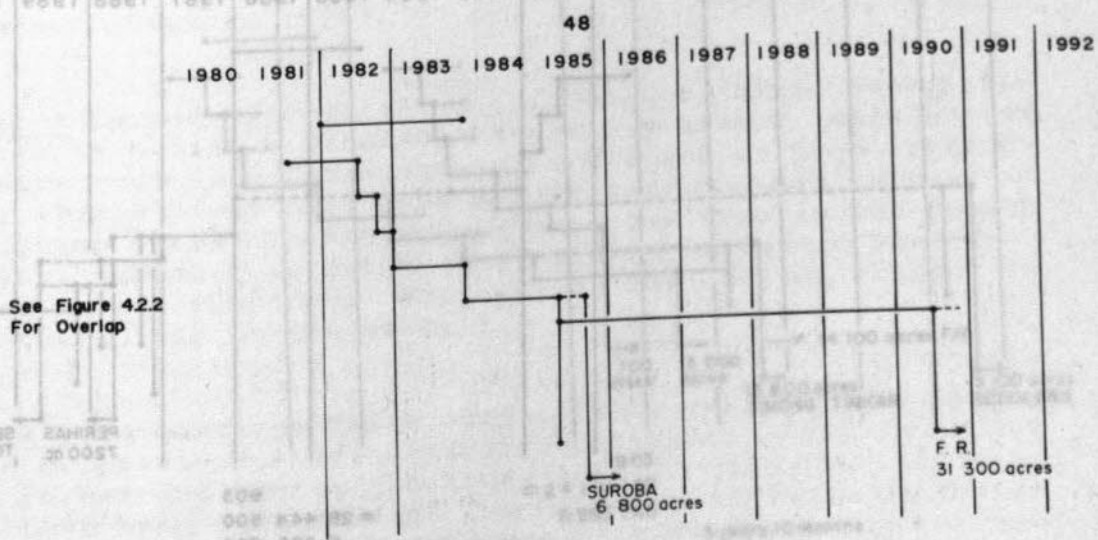
I (1982-1990)

III

NYALAU

SUROBA

9 700 ACRES
6 800 ACRES



1 029
≙ 39 204 900
6 317 120

6 years 3 months

NOTE: (1) Except for the Semi Detailed Soil Survey all acreages are hypothetical.

(2) 3000 acres SUROBA falls within National Park proposal.

FIGURE 4.3.1

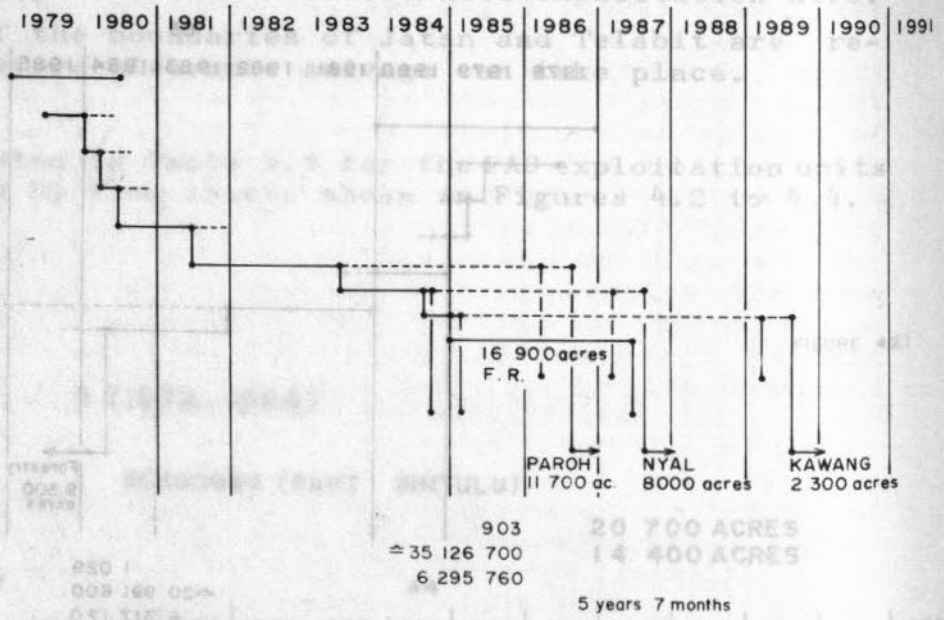
2 (1981-1989)

II

SEKUDONG AND NYALAU

PAROH - SEKUDONG R.D.A. 32 000 ACRES
NYAL, KAWANG } NYALAU R.D.A. 22 000 ACRES

III



903
≙ 35 126 700
6 295 760

5 years 7 months

NOTE: (1) See FIGURE 4.4.2, no overlap with period I but 6 months float should take care of that.
(2) Except for the Semi Detailed Soil Survey all acreages are hypothetical.

FIGURE 4.3.2

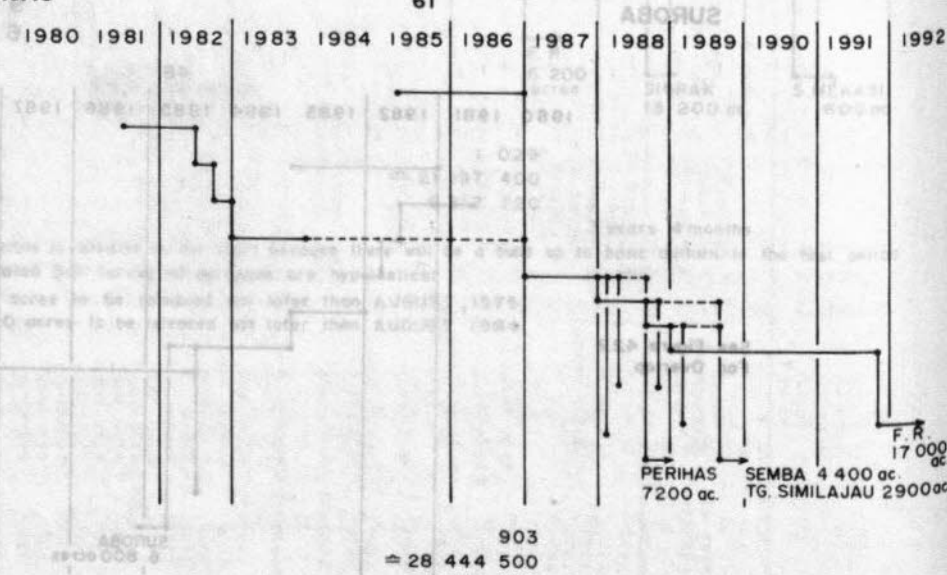
2 (1983-1989)

III

NYALAU

PERIHAS 20 600 ACRES
SEMBA 14 500 ACRES
TG. SIMILAJAU

61



903
≙ 28 444 500
6 295 760

4 years 6 months

NOTE: (1) See FIGURE 4.3.1, 6 months overlap allowed.
(2) Except for the Semi Detailed Soil Survey all acreages are hypothetical.
(3) Tg. Similajau falls within National Park proposal.

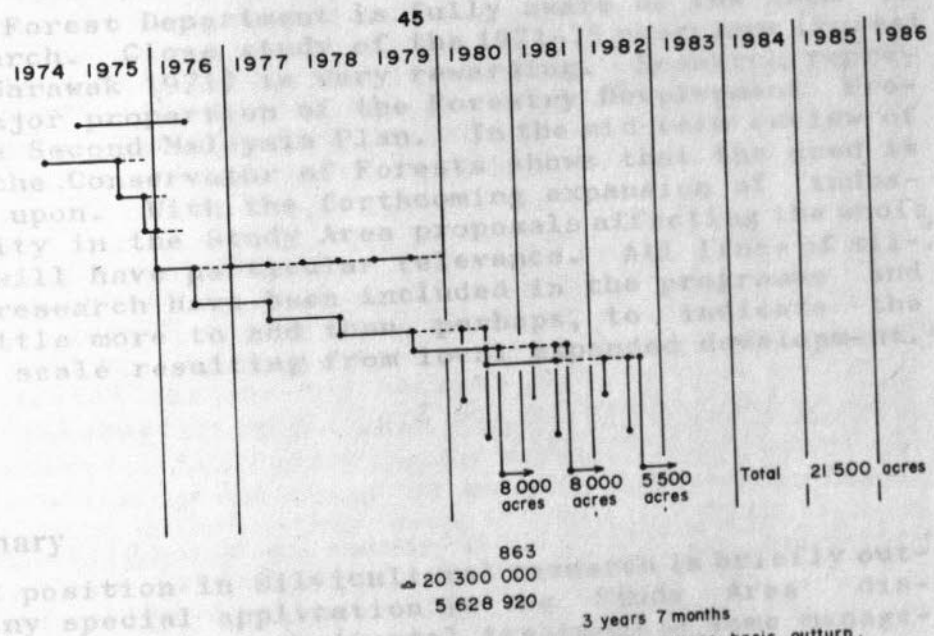
3 (1976-1982)

I

SEKUDONG

KABATU

30 691 ACRES
21 500 ACRES



863
≙ 20 300 000
5 628 920

3 years 7 months

NOTE: (1) A period of five years is allowed in the chart because there will be a build up to the average basic outturn.
(2) Except for the Semi Detailed Soil Survey all are hypothetical acreages.

FIGURE 4.4.2

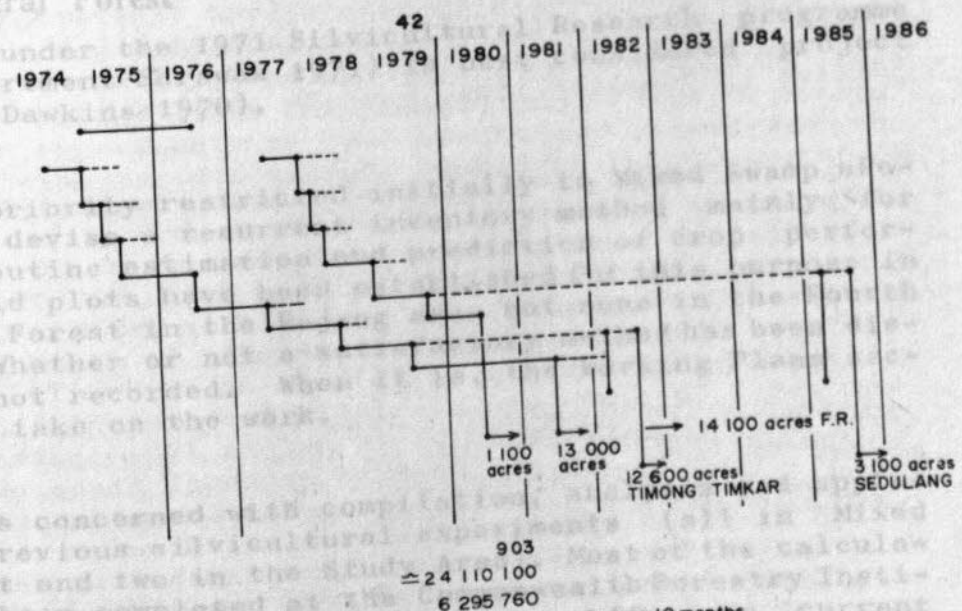
2 (1976-1985)

I

SEKUDONG

TIMONG
TIMKAR
SEDULANG

22 500 ACRES
15 700 ACRES



903
≙ 24 110 100
6 295 760

3 years 10 months

NOTE: (1) A period of 5 years is allowed in the chart because there will be a build up to basic outturn in the first period.
(2) Except for the Semi Detailed Soil Survey all acreages are hypothetical.

CHAPTER 5

RESEARCH

5.1. INTRODUCTION

The Sarawak Forest Department is fully aware of the need to expand research. Close study of the 1971-75 programme (Forest Department Sarawak 1971) is very rewarding. Research represents the major proportion of the Forestry Development Projects in the Second Malaysia Plan. In the mid term review of this Plan, the Conservator of Forests shows that the need is being acted upon. With the forthcoming expansion of industrial activity in the Study Area proposals affecting the whole of Sarawak will have particular relevance. All lines of silvicultural research have been included in the programme and there is little more to add than, perhaps, to indicate the increase in scale resulting from local expanded development.

5.1.1. Summary

The present position in silvicultural research is briefly outlined and any special application to the Study Area discussed. Research into experimental treatment of some management techniques is suggested and certain aspects of utilisation and marketing which appear important are mentioned. Erosion studies are recommended in localities where logging roads can be a grave erosion danger.

5.2. SILVICULTURAL AND MANAGEMENT RESEARCH

5.2.1. Natural Forest

Achievement under the 1971 Silvicultural Research programme (Forest Department Sarawak 1971) is best considered project by project (Dawkins 1970).

Project 1 (priority restricted initially to Mixed Swamp Forest) is to devise a recurrent inventory method mainly for extensive routine estimation and prediction of crop performance. Yield plots have been established for this purpose in Mixed Swamp Forest in the Rejang area but none in the Fourth Division. Whether or not a satisfactory method has been discovered is not recorded. When it is, the Working Plans section should take on the work.

Project 2 is concerned with compilation, analysis and application of previous silvicultural experiments (all in Mixed Swamp Forest and two in the Study Area). Most of the calculations have been completed at the Commonwealth Forestry Institute Oxford. There is no evidence of any effect on current

silvicultural procedure. One of the earliest plots involving release-poisoning was unfortunately felled illegally. Data transcriptions from a five-poisoning treatment have been sent to Oxford. Published results are urgently required.

Project 3 is designed to test a second silvicultural treatment in Mixed Swamp Forest and the investigation (No.52) was started in 1972 in the Rejang area. The value of poison treatments in this forest type is in question.

Project 4 entitled "Diagnosis of condition after felling" was initially concerned with the proper identification and recognition of species in Mixed Dipterocarp Forest but has now progressed beyond a research project to routine Diagnostic Sampling such as that carried out in Niah Forest Reserve in 1972 and elsewhere in the Study Area, outside Forest Reserves in 1973 (Lee H.S. 1973).

Project 5 "Study of growth-rates in Mixed Dipterocarp Forests". Dawkins (1970) recommended a concentrated study of trees in a compact area pending establishment of routine yield plots under Project 1 held up at the time by the need for teaching Field Staff how to recognise desirable species (Project 4). Twelve yield plots were established in Niah Forest Reserve and one in Batu Belah Protected Forest in 1970.

Project 6 "Silvicultural Treatment of Mixed Dipterocarp Forests" Research plot 68 was started in 1971 in Niah Forest Reserve using four treatments varying from nil treatment to intense treatment in which unwanted stems down to four inches diameter were poisoned. The site is partly on land classified as suitable for agriculture. Another experiment would seem appropriate on a site wholly on land unsuitable for agriculture and preferably a different soil. These plots, very expensive in computer time, must be limited in number.

Dawkins stresses (1971) that devising a method for recurrent inventory is priority 1. When the method is proven the work should become part of the normal routine of the Department's inventory teams in the Working Plan Section. Many more recurrent inventory plots are required in the Mixed Dipterocarp Forests. The number required can only be found after trial, as suggested by Dawkins (1970), at an intensity of 0.25 percent until 30 plots are available for analysis. Only 4 200 acres will require yield plots before 1981 in the Similajau Forest Reserve. In the reserve proposal areas centred round Diagnostic Sampling areas, recurrent inventory plots are required over 108 400 acres as soon as the areas can be gazetted as proposed Forest Reserves. Land capability boundaries have been finally determined in all the proposal areas except Bakas where, for security of tenure, care must be taken to locate the yield plots on land whose non-agricultural capability is without doubt.

Diagnostic sampling in forest regenerating after the selective fellings currently undertaken to supply the log export market (such forest is termed by the FAO Term as "remnant forest") has shown a range of stocking which does not vary significantly between forests logged for release to agriculture and forest logged on a sustained yield system. There is an indication (though not statistically proven) of differences between different operators far greater than the differences between logging outside or inside Forest Reserve. In future, however, Diagnostic Sampling had far better be postponed until ten years after the final felling unless there is reason to suspect the necessity for enrichment planting when diagnostic sampling immediately after the felling is advisable. Recurrent Inventory plots (yield plots) can profitably be started immediately after the felling.

Project 7 "Planting of high value timbers in logged Mixed Dipterocarp Forests". Line planting to enrich (supplement) natural regeneration is not regarded as plantation work. Experimental enrichment planting has been started in Niah Forest Reserve. Line planting has failed very often in countries where it has been tried but Dawkins has no doubt it is the proper way to provide a second crop where natural regeneration is inadequate. The limitations are stated by Lamb(1969); the most important being that the species must be very fast growing and capable of standing full light when given full exposure from the start which it must be.

5.2.2. Silvicultural Management Research

Trial exploitation to various minimum diameters has been suggested (FAO 1973). Unless the operator agrees readily to the raising of the minimum diameter above the minimum commercial diameter there seems small warrant for carrying out such experiments. In any event they should only be done on statistically sound experiments so that results can be analysed properly. Also diameter differences should be large enough to produce significantly different results.

5.3. PLANTATIONS

Until very recently official policy did not provide for plantation work. Pending a change in policy a certain amount of work has been done in the Oya road experimental area, Sibu, and species trials in other Divisions, under a separate project:

Project 8 "To discover species suitable for large scale production of industrial cellulose from de-forested land". Two small scale investigations are in progress: boron and aldrex (termite control) on Agathis macrophilla and trials on Pinus caribaea of seven different provenances.

Plantation research can begin in earnest now that official policy has been altered to include an interest in plantations. Tentative demand projections for wood and wood products do not justify establishment of plantations until natural regeneration techniques are proven failures. Trials are justified on other grounds such as utilisation of previously cultivated land assessed as unsuitable (most often because of steep slopes) for agriculture; or for the need of socio-economic improvement of depressed areas (Palmer J.R. 1970 b). There is, too, the possibility of export to Japan of chips from bulk cellulose species. Palmer (1970 b) quotes H.D. Waring, consultant in tree nutrition to the UNDP Pilot Plantations Project for Quick Growing Species, in Peninsular Malaysia as saying "sufficient work should be done to demonstrate the potential of an afforestation crop as a possible national investment". The first stage in this work will be under Project 8. The second stage, which will involve purchase of land, could properly be a socio-economic Taungya project in First or Second Division. All are agreed that the sub-professional staff for such work must be of high calibre. At the moment efforts to recruit a plantations officer have been unsuccessful.

The proposal in the Mid Term Review of Second Malaysia Plan for reforestation of remnant Mixed Dipterocarp Forests was made before the diagnostic samplings mentioned in 2.3.2 were carried out. With the results in hand there is every indication that natural regeneration in these forests will be successful, given sufficient time and possibly treatment. Thus the artifical regeneration proposed could be unnecessary.

5.4. UTILISATION AND MARKETING RESEARCH

Utilisation, which should include marketing studies should come under the heading Forest Industrial Development Research in the proposed new structure for the Forest Department in the period 1974 to 1980. Increased knowledge about the timbers of Sarawak obtained from the timber research laboratory and wood technology studies requires forceful presentation abroad. Liaison with individuals and authoritative bodies in the main sawn timber import countries, such as United Kingdom and West Germany ought to help the introduction of new timbers to existing important markets. Any official body with these functions should be financially independent of the trade.

5.5. EROSION STUDIES

Forest roads, when neglected, are the source of heavy erosion which can continue for many years. The danger increases with steepness of the land. The study of measures to reduce that danger could well be a part of water-shed management which is

a branch of research appearing in the proposed new structure for the Sarawak Forestry Department 1974-80. For instance recommendations that logging roads should run along the centre of ridges and spurs have been made by some authorities whereas observation suggests that roads are more easy to drain properly when constructed off-head centre. Cross ditching of roads as they are abandoned has also been suggested to prevent water changing the road into an eroding ditch after ditch abandoned. These studies should be devised in consultation with the forest engineer and soils research officer, and designed to be the basis of rules to be enforced by the licence conditions. The study could also investigate the relative erosion hazard to be attributed to different forms of logging and logging vehicles and be the instrument to determine the designation of areas for special conditions of working (Burgess, P.F. 1971). The value of frequent distribution of road drainage water into untouched vegetation rather than into river channels to over-load them should be studied.

5.6 ADMINISTRATION

The proposed Forest Department organisation structure to meet both present requirements and the forthcoming challenge of the projected industrial expansion is bold and comprehensive. The functions of the groups, sections and individuals has been carefully thought out to avoid overlapping, yet at the same time flexibility has been provided for by "Special" sections for functions that do not yet fit in very well, yet at present are not active enough to have separate sections of their own. National Parks and Wild Life and the training of Junior staff, now bed fellows, will probably function more happily in separation. When expansions on this scale are contemplated a full comprehension of the likely results is impossible, but the impression is inescapable that the proposals are eminently sound.

There seems doubt that locally trained personell will be available for some senior posts. In particular a plantation's officer will have to be recruited from overseas, the assistance of the Overseas Development Adviser or the Queensland Forest Department should be sought. Alternatively a graduate specialising in plantation work and wanting experience before writing a thesis might be obtained from one of the schools paying particular attention to plantation work such as Aberdeen. In this connection delays in removal of anomalies in the present salary and allowance structure can be galling. For instance, an expatriate Assistant Conservator of Forests on the same salary as a local officer on the Suffian scale at present draws smaller allowances when away on duty then his counterpart. Another factor contributing to the difficulty in securing expatriate staff is the reduction in number of students in the forest schools in England because of the fewer

opportunities available. Needs will have to be foreseen many months ahead to obtain expatriate staff and conditions made obviously attractive.

With centralised revenue accounting under the new structure, staff in the Study Area for this purpose should be sufficient. The Silviculturist has estimated (Palmer, J.R. 1970 b) for massive increases in Mixed Dipterocarp Forest work as asked for by F.A.O. and this Study. The estimates should be officially supported. Recurrent Inventory will require more staff under Working Plans; but this will be gradual because the section operates by massive concentration of work in one place at a time which can average out over the whole country. With reduced activity under old licences and more control by industry itself present field staff should be sufficient for control of working.

PART 2
CONSERVATION

SUMMARY

1. A broad outline is given of the vegetation types of the Study Area, their relative abundance and the extent to which they have been scientifically investigated.

2. The possible impact of forest exploitation and agricultural development on the vegetation is assessed. Some indication is given of the points at which special conservation effort is required.

3. An overall assessment is made of the ecological impact of the proposed development on the soils and vegetation of the Study Area. Some general principles to be followed in carrying out the development are listed.

4. General observations are made on the severity and extent of present soil erosion throughout the Study Area. Recommendations are given for soil conservation measures that could be applied at the present stage and in future development. Establishment of a small Soil Conservation Unit is suggested.

5. Existing legislation relevant to wild life protection and the present state of the National Parks programme is outlined.

6. Some inadequacies of the existing programme are discussed and support is given to a recent Government proposal to set up a special section under the Conservator of Forests to take over the work of the present National Park Trust. However, the need may soon arise for the establishment of a new Government Department to assume responsibility for biological resource inventory, wild life protection, habitat conservation and National Parks.

7. Existing National Park proposals within the Study Area are discussed in detail.

   Niah, Similajau and Loagan Bunut are accepted as suitable for designation as National Parks. However, the last two require some boundary modifications and different designations are suggested for them. Additional conservation areas are proposed at:-

   Tanjong Lobang
   Bukit Dulit
   Lobang-Salai

   An ecological survey of limestone outcrops, other than Gunong Subis, is recommended prior to the choice of locations for quarrying. The outcrops at Lobang-Salai and Batu Gading are regarded as having potential ecological importance.

CHAPTER 7

PLANT ECOLOGY OF THE STUDY AREA

7.1 INTRODUCTION

In Sarawak vegetation and forest cover are virtually synonymous. A broad outline of the forest vegetation of the Study Area is given in Part I, Chapter 2 of this Report.

The ecology of the peat swamp forests is particularly well known as a result of the studies carried out by Dr. J.A.R. Anderson. Anderson's community type, the padang keruntum or Combretocarpus - Dactylocladus association, is of little interest to the forester as it is essentially an open bogland with only stunted trees.

The heath forests (or kerangas) of the State have been studied in comparative detail by Dr. E.F. Brunig, but this work has not yet been published. He identifies six kerangas types within the Bako National Park.

Richards (1936) has published some observations on the rain forest of Bukit Dulit.

The oak-laurel forests of the mountains, the Mixed Dipterocarp Forests of hills and lowlands, the beach forests, riparian forest and coastal swamps of mangrove and Nipa fruticans palm have not yet been subdivided ecologically into community types or associations. Lowland Dipterocarp Forest is known to be the richest vegetation type floristically.

Non-forest communities of open water, swamp and rocky places cover a very small area indeed.

7.2 COMMUNITIES OF SPECIAL SCIENTIFIC IMPORTANCE

All the communities outlined above and in Part I, Forestry, are well represented in the Study Area except the coastal swamp types and oak-laurel forest. Kerangas is not particularly well represented but most types appear to be present. Little if any unmodified beach forest remains, and riparian forest has virtually ceased to exist within the Study Area as elsewhere in the State.

Peat swamp forests are abundant in the Study Area and two of Anderson's phasic communities, the Combretocarpus - Dactylocladus association and the Tristania - Parastemon - Palaquium

association, are found only in the deep swamps of the middle Baram. The remaining peat swamp forest types have been exploited or are now fully committed and it is doubtful if any extensive unmodified areas remain.

Special effort will therefore be required to save examples of the following types of vegetation. The list is made out in approximate order of urgency.

(a) Beach and riparian forest (it is probably too late to save worthwhile samples);

(b) Open water vegetation (lagoons, ox-bow lakes and Loagan Bunut);

(c) The commercially exploitable peat swamp forest types (it is probably too late to save them as an unmodified complex in one place);

(d) Non-commercial peat swamp forest types (can be conserved but not in association with unmodified examples of (iii));

(e) Kerangas (the position will be clearer on publication of Dr. Brunig's work);

(f) Non-peaty swamp forest (small areas associated with riparian forest and limestone outcrops in peat swamp forest).

Areas of special importance, as distinct from vegetation types are considered in Chapter 9.

CHAPTER 8

ECOLOGICAL IMPACT OF THE ACTION PROGRAMME AND LONG TERM PLANS

8.1 INTRODUCTION

If the risks attendant upon large-scale clearance of rain forest on largely immature terrain must be taken then the development programme proposed offers the best chance of minimising undesirable effects. The programme's general outline, and such details as can be planned in advance, are ecologically sound. The mode of implementation will, however, be of considerable importance. Following large-scale forest clearance there will be a permanent change in the hydrological regime and a phase of accelerated soil erosion coupled with a substantial increase in river sediment loads. For example, in cleared catchments of 10 square miles in the Johore Project in Peninsular Malaysia an increase of peak river discharges of 100 per cent and a decrease in nadir flows of 50 to 75 per cent was obtained. The new equilibrium level attained on the completion of the programme in the Study Area will be higher than at present, but should be acceptable in terms of agricultural soil loss and river water purity. However, great care will have to be taken during the period between forest clearance and crop establishment if exceptional rain storms are not to result in locally catastrophic soil loss. Even if all goes smoothly there is great danger of severe damage to the aquatic environment of the area as indicated in the Fisheries Report (Part V of Supporting Report 2). The Study has clearly recognised many of the other potential hazards to the environment (such as pollution from oil palm factories and sawmills along the rivers) and measures for their removal or amelioration are suggested.

From the ecological point of view the following general recommendations are particularly important:-

(a) retention of peat swamp forest in production forestry rather than attempting agricultural development on such terrain;

(b) introduction of effective measures to end unauthorised encroachment by shifting cultivators in Forest Reserves and on other land;

(c) attempts to stop shifting cultivation for hill rice on Native Customary Land;

(d) the eventual utilisation for forestry of Native Customary Land assessed as too steep for agricultural development;

(e) all unencumbered State Land exceeding about 1 000 acres in area and not suitable for agriculture to be taken into the Forest Estate, plainly demarcated and regularly patrolled;

(f) considerable expansion of the Forest Department's silvicultural programme, particularly in peat swamp forests. The present phase of mainly exploitative forestry is

approaching a natural end and research should be expanded to meet a change in emphasis, particularly in regeneration and enrichment of remnant forest and planting up of abandoned cultivation on land not suitable for agricultural development.

There are some doubts on the ecological soundness of establishing short rotation plantations for special purposes, such as pulp, in the humid tropical environment, especially where Pinus species are involved. Besides the problem of weeding there can be, even within the first rotation, other problems of major and minor element nutrition, loss of soil structure, development of a thick litter layer felted with fungal hyphae (in the case of pine) and acute fire and soil erosion hazard during felling. Erosion hazard is greatly increased by deliberate burning of lop and top and leaf litter or accidental fires which are both difficult to control and may lead to loss of standing timber. The drought of mid-December to mid-March, 1973, indicates that wild fires can be a problem even in Sarawak. Pines and eucalypts are very much more inflammable than native species. Eucalypts have the advantage over pines in that they are less demanding of nutrients and many species will coppice readily.

A Task Force in Agriculture and Forestry, which set out to determine the criteria for delineating State Catchment Reserves on vulnerable areas of the Study Area watershed, decided at its meeting on 18th July, 1973, that such a designation would be unnecessary because a reasonable proportion of the headwaters of each river within the Study Area is, and will continue to be, covered by permanent State Forests subject to Forest Department logging rules. These rules, which the Task Force recommended should be rigidly enforced, are as follows:-

(a) Prohibition of logging or removal of timber along river banks, at least over a strip one chain wide on both banks. This refers to navigable rivers, but the minimum river width adopted is not clear.

(b) Prohibition of logging or removal of timber in forest land above 2 000 feet.

(c) Logging roads to conform to certain patterns so that there will be no impedance of water flow.

(d) Restrictions on the cutting of certain species of trees regarded as useful protection against soil erosion.

(e) A minimum limit set to the girth of trees to be felled.

These recommendations of the Task Force can be accepted in view of the fact that there are few especially vulnerable high catchments within the Study Area. However, much stricter standards for logging roads will be necessary in general, and in the higher catchments particularly. The FAO tractor logging limit of 35 degrees slope (which is essentially an economic limit) should also be applied and might have to be reduced.

The cattle development programme that has been suggested could generate soil erosion problems of its own, quite distinct from those encountered in crop cultivation. Care should be taken to avoid the following situations:-

(a) overgrazing of slopes and delay in establishing grasses or other plants to replace the natural water-spreading vegetation along the drainage lines;

(b) puddling of soil around gates, watering points and other foci or cattle tracks. Particularly damaging would be the overgrazing and trampling of vegetation around springs and ponds;

(c) concentration of cattle tracks across slopes on certain soils and rock attitudes susceptible to soil slips following heavy rain;

(d) concentration of cattle tracks up and down steep slopes.

Some general ecological principles are recommended for any scheme involving large scale clearance of tropical forest for agricultural development in the Study Area. They are:-

(a) Land should be cleared at those times of year when past climatological records show there is least probability of heavy and prolonged rain storms. At present records of rainfall intensity are scanty, but suggest that the maximum daily rainfall (3 to 12 inches on record at Miri) is liable to occur in any months of the year, with a concentration of brief, intense storms of 2 inches per hour for one hour or longer in the months of April to June.

(b) At present virtually clean burning of all debris from forest clearance is the rule. This leaves a short period of high soil vulnerability before establishment of the cover legumes. Creepers such as Centrosema pubescens, Pueraria phaseoloides, Pueraria javanica and Calopogonium mucunoides are used at present and seem to be reasonably effective although volunteer stands of Siamese weed Eupetorium spp. are doing a better job in many areas. Problems may arise later as the light-demanding creepers are shaded out and soil is laid bare for a second time.

(c) A forested corridor through which animals can escape to the main forest should be left in the course of jungle clearance. This would avoid the general slaughter that takes place at present in an isolated island of forest from which animals are unable to escape. Some species would be able to move right out of the area, others may increase temporarily with consequent pressure on local food supplies, perhaps leading to crop raiding. Fortunately, in this connection, the development plan allows for an intimate mixture of areas of cultivation and permanent forest as a natural result of the distribution of terrain and soil classes. Only in the region to the west of the present Lambir-Subis Development Area does there seem to be a danger of displaced wild life being cut off from the main forest areas.

8.2 EROSION HAZARD

Observations throughout the Study Area indicate considerable erosion hazard on the majority of soil types, except on the most gentle slopes. However, under natural conditions the soils have been shown to vary widely in inherent erodibility and have good infiltration rates in undisturbed surface horizons (see Supporting Report 1 Part II). At low flow the streams draining virgin jungle are clear (or peat stained in swamp forest) but many of the beds are sand-choked. Flood peaks do carry a certain amount of sediment in the form of silt, clay, and even particulate plant debris and peat. This may represent the natural erosion level for forest covered land and result from natural slippage and surface water movement when soils are fully charged after prolonged rain. Larger landslips, which show up from the air and can be picked out in aerial photographs, are fairly frequent even under an undisturbed forest cover. They generally occur in groups such as those on the eastern slopes of Bukit Merong and the eastward-running spurs of the Dulit Range. At low flow the larger rivers are kept turbid due mainly to the wash of power craft. This is causing constant instability of undercut banks and newly deposited mud. At flood levels most of the greatly increased sediment load appears to originate from hill logging areas (roads and skid trails), shifting cultivation, all forms of agriculture where there is clean cultivation, construction sites, various public works and the river banks themselves.

Along the Batang Baram, bank cutting and slumping appears to be on the increase everywhere and threatens riverside buildings and cultivation, including the Long Lama bazaar. Flood levels in the Baram are of the order of 15 feet above normal flow and although the bazaar area of Marudi is not at present in danger it is regularly inundated each year. It is difficult to imagine the bazaar being originally sited where it is if this had been the flood position in those days.

Sheet wash and slumping, rather than gully erosion, are the universal forms of soil loss in the Study Area. These are not so immediately apparent as the more spectacular forms except as reflected in the sediment load of the rivers and the discolouration of the sea along the coast. The rarity of gullying is due to the general absence of long, bare slopes, the rapidity of vegetation growth and the abundance of natural settling ponds and water spreading systems in the form of grass swamps, fern brakes and secondary weedy growth of all kinds. These trap much of the larger soil particles but little of the silt and clay which pass into the rivers. Wherever soil is laid bare for any length of time the development of pedestals under any harder object indicates the rapidity with which the general surface level is being lowered and also the quantity of material being removed. In Supporting Report 1, (Part II), the occurrence of subsoil horizons on the surface of steeply sloping shifting cultivation has been shown to indicate a soil loss of up to 450 tons per acre per year. Roads everywhere

(including the Miri-Bintulu Trunk Road) depend on the adjacent natural topography and vegetation for the safe disposal of storm run-off and the only counter-erosion measure taken has been the terracing of road cuttings. This is fairly satisfactory provided that the natural ponds are not watertight. A spectacular example of erosion is close to Miri town where vegetation clearance for public works on top of the Miri ridge has resulted in road blocks and flooding in several places at the base of the ridge.

Little contour working is being practised on areas of permanent cultivation, and wherever the soil surface has been left bare on a slope there is evidence of sheet wash, rilling and incipient gullies (see Supporting Report 1, Part II). Pepper gardens on steep slopes are particularly culpable in this respect. Fortunately run-off from cultivated land has generally only a short distance to go before meeting dense natural vegetation in hollows and along natural drainage lines so that gullying is generally absent. The situation could be quite different in large scale agricultural development, and there is some danger that the need for the planned safe disposal of surface run-off will not be sufficiently appreciated. Soil loss measurements, described in Supporting Report 1, (Part II), on eight plots of 21 to 35 degrees slope, provide a convincing demonstration that large quantities of soil are lost from bare cultivation.

8.3 SOIL CONSERVATION

8.3.1 General

Prevention of soil loss from river banks, logging roads and construction sites will cost money but, if maintenance of at least the existing standards of river water purity is to be part of development policy, then some effort will have to be expended on this as well as on agricultural land. The road building programme envisaged both under Public Works and Forestry will lead to an enormous increase in river sediment loads. This can be held in check only by some mechanical means of stabilishing the soil surface while vegetation cover is established or until construction work moves on to the next phase. Where freely available, sawdust could be applied as a thin mulch before spraying, and these areas can be graded, terraced and pitted in a way which will discourage run-off and subsequent scouring. At present soil is being lost from construction sites even during quite modest showers. An attempt to place a cash value on river water purity will have to be made as an indication of justifiable expenditure in such a scheme.

The legumes at present being used as soil cover in tree crop establishment may not grow sufficiently well on roadside soils but there must be a wide range of fast growing native species

that could provide the necessary protection on banks and cuttings. At present a poor growth of Siamese weed provides the only cover on many infertile subsoils. A procedure that has been found useful elsewhere consists in harvesting a "hay" crop from seeding native plants from roadsides and waste ground, chopping this for ease of handling and applying it as a thin mulch to the bare soil, holding it in place by bitumen spray. Seedlings quickly penetrate the bitumen crust which is permeable to water. Where the appearance of the work is a consideration then a synthetic rubber latex spray is less obtrusive but more expensive. The same treatment could well be applied around the new agricultural settlements where soil remains exposed and eroding for much longer than in many crops and plantations. It would also contribute to the comfort of the inhabitants.

The cost of river bank stabilisation would be prohibitive over the vast distances involved. Only where settlements are threatened might some attempt at sloping and revettment be justified. In anticipation of increased rates of bank cutting it would be advisable to keep all future buildings well back from the banks of the larger rivers. As the road network expands, a reduction in the number of high-powered river craft may help to compensate for the anticipated increase in the fluctuation of river flow.

8.3.2 Agricultural

The agronomic and engineering aspects of erosion control on agricultural land are dealt with in Supporting Report 1 (Part II) and 2 (Part IV). It is recommended that a number of small, paired catchments on minor streams be studied to determine the effects of forest clearance and crop establishment on the hydrological regime and sediment loads. Anticipated soil loss should also be measured in some way. A number of simple methods appropriate to different situations are available. These range from the simple projecting peg or surface disc to elaborate levelling between fixed points. Where disturbance by cultivation is minimal, as on permanent or semi-permanent grassland, a convenient method is to measure periodically the distance to the soil surface from a rigid bar placed across two rods firmly set into bedrock at right angle to surface slope.

It can be anticipated that under large-scale agricultural development the natural water spreading vegetation which occurs around small-holdings and areas of shifting cultivation will be absent. Some alternative means will be needed of safely disposing of surface run-off from roads, buildings, terraces and other areas of drainage concentration. To ensure that this is properly carried out, and to act as a general good example for soil conservation in the overall development, it is recommended that Government should set up a small Soil Conservation

Unit, possibly as a joint venture between the Ministry of Agriculture and the Ministry of Lands and Mineral Resources. A suitable structure for such a unit in the first instance might be:-

- Soil Conservation Engineer (Officer-in-Charge)
- Agronomist (with special interest in vegetative control of erosion)
- Forest Officer from the Watershed Management Research Branch (assuming Forest Department proposals in this respect are accepted)
- A small labour force equiped with special items such as bitumen sprayers.

CHAPTER 9

THE NATIONAL PARKS PROGRAMME

9.1 LEGISLATIVE BACK GROUND

Legislation relevant to a programme of resource conservation, National Park establishment and administration in Sarawak has been confined to the following:-

- Natural Resources Ordinance 1949
- Enlargement of Natural Resources Ordinance 1952
- National Parks Ordinance 1954
- Land Code 1957
- Bako National Park gazetted 1957
- Wildlife Protection Ordinance 1957

The Natural Resources Ordinance was intended to consolidate and amend the law relating to the conservation of natural resources by the establishment of a Natural Resources Board. The scope of the Ordinance was then enlarged in 1952 and this, together with the Land Code provisions of 1957, extended it to the regulation and control of land use and such action as the burning, clearing and other destruction of vegetation. There is little evidence that the powers assumed have been seriously applied.

The National Parks Ordinance allowed for the establishment of a number of National Park areas throughout the State under the joint control of a Board of Trustees on which Forest Department, Department of Land and Survey, Sarawak Museum and the general public were all represented. The Bako National Park, gazetted in 1957, was the first, and remains the only one of the eleven areas that have been proposed at various times, to achieve full official status.

The Wildlife Protection Ordinance of 1957 gave full protection to three mammals, one turtle and a number of birds as well as listing other animals whose export was forbidden except under licence. The amendment to the first schedule, produced in 1973 brought the list of totally protected species to 32. Other than birds these are:-

Long nosed monkey	Earless monitor lizard	Three gibbons
Orang utan	Tarsier	Three turtles
Rhinoceros	Clouded leopard	
Dugong	Slow loris	

Several of the hornbill species on the protected bird list appear to be reasonably common but, on the other hand, some inexplicable absences from the list of land animals include

the Malaysian sun bear and the estuarine crocodile. Tom Harrison, in his Foreword to Lord Medway's "Mammals of Borneo" (Medway, 1965) warns against the rapid decrease in numbers of many presumed abundant species (even small forms such as tree shrews and squirrels) as a result of human population pressure and the increased use of shotguns. It is clear that the only solution lies in the complete protection of all forms of life within substantial areas covering a wide selection of habitats, and not the gradual lengthening of a protected list as it becomes evident that more and more species are following the rhinoceros and orang utan along the road to extinction in the wild.

The Consultants agree with proposals previously submitted to Government by the Divisional Development Committee of the Fourth Division for the creation of five National Parks in the Study Area. The locations of these Parks, listed below, are shown on Figure 9.1 together with three proposed additional areas.

- Niah
- Similajau
- Loagan Bunut
- Lambir
- Sungai Dalam

However, little State-level action has so far been undertaken. And, because of the logging of peat swamp forest near Loagan Bunut, the withdrawal of Forest Reserve protection from Sungai Dalam and the part damage by fire of the forest in that area, there is danger that there will soon be little left to protect, unless more rapid action is taken on the National Parks programme.

Recently in the Forest Department's submission to the Mid-Term Review of the Second Malaysia Plan it is stated that the National Parks Ordinance is being amended to vest responsibility for administration and control of the National Parks in the Conservation of Forests. A new organisational structure and terms of service for staff are being submitted to the Government for approval. These will include estimates for staff and recurrent expenditure. Extension of the Natural Resources Ordinance and full political support for the Conservator of Forests will be required to provide a sound State policy on biological resource conservation.

9.2 CONCEPTS AND NOMENCLATURE

A National Park (in the generally accepted sense of a fairly large tract of country, scenically attractive and with its

original vegetation and wildlife complexes virtually intact) is only one of a wide range of possible types of conservation area. International nomenclature of such areas is now confused and recommendations for standardisation by the International Union for the Conservation of Nature are awaited. There is danger in a narrow outlook focused on National Parks and Wildlife Sanctuaries alone. Valuable areas could easily be rejected out of hand if they fail to meet one or more of the above criteria or lack the potential for some form of public recreation. An area valuable for habitat and wildlife conservation can easily be rejected as a National Park due to traces of some past human activity which really makes little difference to the situation, except perhaps aesthetically, and which may become less obtrusive with time. If there is no alternative designation provided for in legislation such an area can be irretrievably lost. A flexible approach and system is required which can cater for areas of all sizes and varieties of purpose such as; coast or watershed protection, the preservation of rare plant and animal species or their communities, geological and archaeological monuments and examples of fine natural scenery. In Iran, for example, all such areas of value are immediately designated "Protected Regions" and receive blanket protection of their rocks, soils, waters, plants and animals until the most appropriate category for them, and the special use restrictions to be applied, have been decided. They are then renamed Wildlife Reserves, National Parks, etc. as they case may be.

Larger areas can sometimes be usefully zoned to serve a variety of purposes. Thus, a National Park might contain a central "Wilderness Area" for watershed protection and wildlife sanctuary which would have limited visitor access and no facilities. There could be a peripheral region (or zone) with tourist recreation and wildlife viewing provisions. Then, between this and the wilderness area, there might be a buffer zone of controlled forest exploitation and an intermediate level of access. The proposed National Monument within the Niah National Park would be a simple example of such zoning.

Within Sarawak as a whole, and even within the relatively small Study Area, there is scope for a range of conservation areas apart from National Parks. The present National Park Trust would not be an appropriate body for the administration of the primary survey, the continuing research effort and the complexities of the day-to-day management of these areas. The Consultants therefore support the Government's proposal to set up a special section under the Conservator of Forests to assume this function. The responsibilities can be expected to grow rapidly and the creation of a separate Government Department may soon become necessary. At this stage it is not possible to say whether the existing National Park proposals would safeguard a sufficiently wide range of habitat and wildlife throughout the State. Inventory of Sarawak's ecosystems would thus be one of the first tasks to be undertaken, but gazetting of existing proposals should not be allowed to wait

upon completion of this work. Manpower is going to be a problem and it is suggested that one or more of the many inter-departmental centres at United Kingdom Universities, specialising in the geographical and biological problems of Southeast Asia, might be able to help.

9.3 EXISTING NATIONAL PARK PROPOSALS

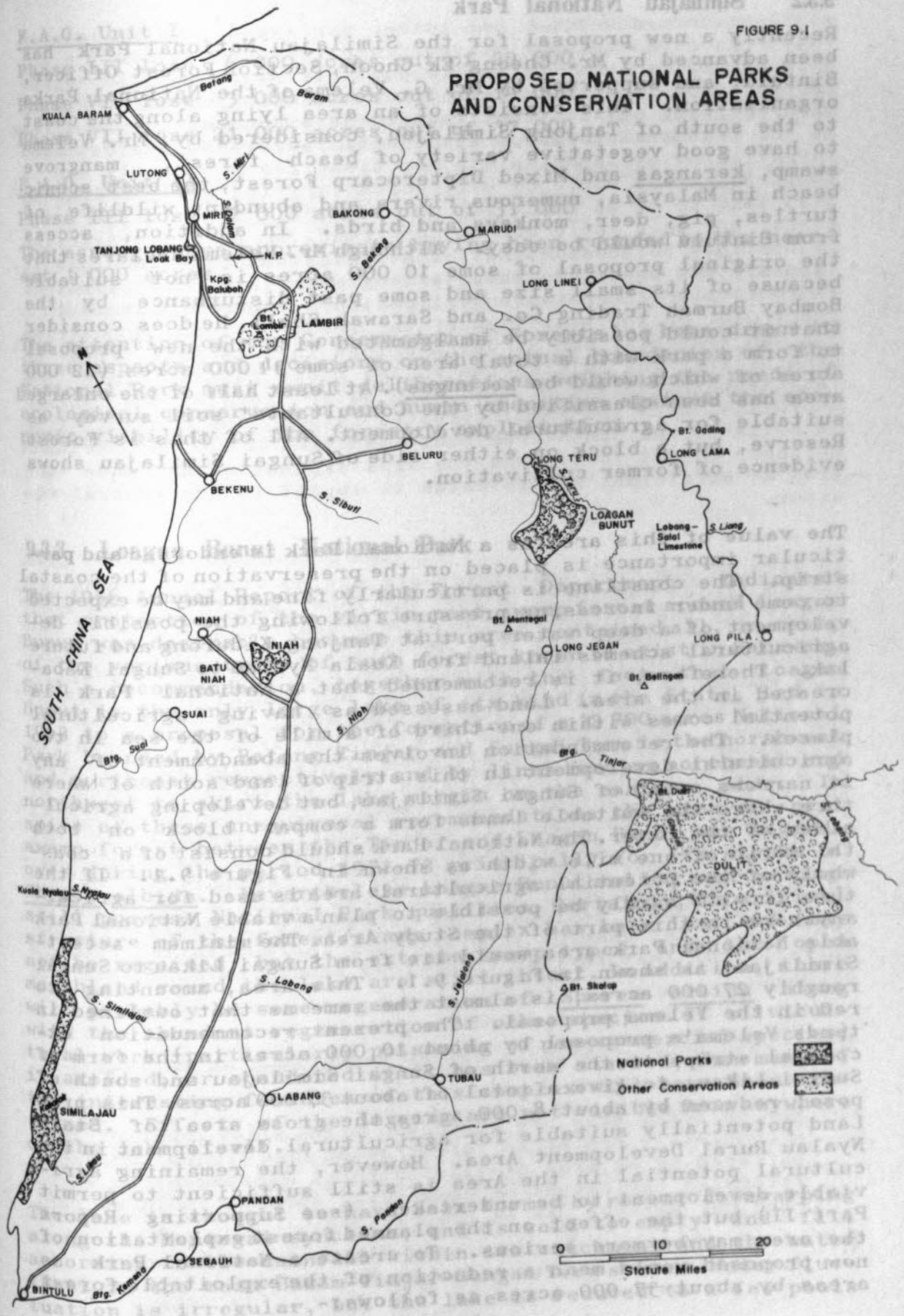
9.3.1 Niah National Park

It is now twelve years since this fine limestone massif, with its forested karst towers and important archaelogical cave sites, was proposed as a National Park. Official gazetting is still awaited. In the meantime agricultural development is increasingly isolating the forested block of Gunong Subis from the main forest areas to east and west. Fortunately, the abrupt increase in elevation removes some of the need for a forested buffer zone outside the proposed boundary, but doubt remains about the effect this isolation will have on the population dynamics of the cave swiftlets and bats whose feeding range and requirements appear to be unknown. Employment of persistent pesticides on adjacent crops would also constitute a danger to both these insect feeders. The Consultants' soil surveys have classified a large area of the forest to north, east and west (about half the total area of the proposed Park) as potentially suitable for agricultural development. It would be a great mistake if this forest in the proposed Park were to be allocated to agriculture. It is recommended that National Park needs should have priority in this particular clash of land use interests. This would protect the fine example of the rare non-peaty swamp forest extending along the Sungai Niah where drainage water from the limestone prevents peat formation.

An unfortunate result of delayed gazetting and divided responsibility inherent in the previous Forest Department - Sarawak Museum condominium is seen in the accumulation of rubbish in the Great Cave itself and around the unsightly scaffolding of the nest collectors' huts in the rock shelter approaches to the cave. A "National Monument" deserves better care than this.

Since zonation of the proposed Park has already been suggested there is a particularly strong case for further zonation here. Except for the area suggested as a National Monument the whole of this park is suitable for designation as a "Wilderness Area". Any application to quarry limestone within the park should be rejected and stone requirements should be supplied from the existing quarries just outside the Park and from the rock-outcrop area where the road to Batu Niah crosses Sungai Semelan and elsewhere.

FIGURE 9.1


PROPOSED NATIONAL PARKS AND CONSERVATION AREAS
KUALA BARAM
Batang Baram
LUTONG
S. Miri
MIRI
S. Sibuti
BAKONG
MARUDI
TANJONG LOBANG Look Bay
N.P.
S. Batang
Kpg. Baluboh
Bt. Lambir
LAMBIR
LONG LINEI
N
BELURU
Bt. Gading
LONG LAMA
LONG TERU
S. Teru
BEKENU
S. Sibuti
LOAGAN BUNUT
Lebong-Salol Limestone
S. Liang
SOUTH CHINA SEA
NIAH
NIAH
Bt. Mentegal
LONG PILA
LONG JEGAN
BATU NIAH
Bt. Belingan
SUAI
S. Niah
Btg. Suai
Btg. Tinjar
Bt. Dulit
S. Lebang
DULIT
Kuala Nyalau
S. Nyalau
S. Lebang
S. Jelalong
Bt. Skalap
S. Similajau
National Parks
Other Conservation Areas
TUBAU
LABANG
SIMILAJAU
S. Liang
PANDAN
S. Pandan
0 10 20
Statute Miles
SEBAUH
BINTULU
Btg. Kemena

9.3.2 Similajau National Park

Recently a new proposal for the Similajau National Park has been advanced by Mr. Cheong Ek Choon, Section Forest Officer, Bintulu, and supported by Mr. G. Velema of the National Parks organisation. This consists of an area lying along the coast to the south of Tanjong Similajau, considered by Mr. Velema to have good vegetative variety of beach forest, mangrove swamp, kerangas and Mixed Dipterocarp Forest, the best scenic beach in Malaysia, numerous rivers and abundant wildlife of turtles, pig, deer, monkeys and birds. In addition, access from Bintulu would be easy. Although Mr. Velema declares that the original proposal of some 10 000 acres is not suitable because of its small size and some past disturbance by the Bombay Burmah Trading Co. and Sarawak Shell, he does consider that it could possibly be amalgamated with the new proposal to form a park with a total area of some 34 000 acres (12 000 acres of which would be kerangas). At least half of the enlarged area has been classified by the Consultants' soil survey as suitable for agricultural development. All of this is Forest Reserve, but a block on either side of Sungai Similajau shows evidence of former cultivation.

The value of this area as a National Park is endorsed and particular importance is placed on the preservation of the coastal strip. The coastline is particularly fine and may be expected to come under increasing pressure following the possible development of a deep water port at Tanjong Kidurong and future agricultural schemes inland from Kuala Nyalau to Sungai Kabalak. Therefore, it is recommended that a National Park is created in the area. Land assessed as having agricultural potential comes within one-third of a mile of the sea in two places. The recommendation involves the abandonment of any agricultural development in this strip of land south of where it narrows south of Sungai Similajau, but developing agriculture where the suitable lands form a compact block on both sides of the river. The National Park should consist of a coastal strip of one mile width as shown in Figure 9.1. If the whole of the potential agricultural area is used for agriculture it will hardly be possible to plan a viable National Park anywhere in this part of the Study Area. The minimum acceptable National Park area would lie from Sungai Likau to Sungai Similajau, as shown in Figure 9.1. This area, amounting to roughly 27 000 acres, is almost the same as that outlined in red in the Velema proposal. The present recommendation extends Velema's proposal by about 10 000 acres in the form of coastal strips to the north of Sungai Similajau and south of Sungai Likau, to give a total of about 37 000 acres. This proposal reduces by about 8 000 acres the gross area of State Land potentially suitable for agricultural development in the Nyalau Rural Development Area. However, the remaining agricultural potential in the Area is still sufficient to permit viable development to be undertaken, (see Supporting Report Part II) but the effect on the planned forest exploitation of the area may be more serious. To create a National Park as now proposed would mean a reduction of the exploitable forest areas by about 37 000 acres as follows:-

F.A.O. Unit I

Phase III lose 6 000 acres out of 29 000

Phase VI lose 3 000 acres out of 19 000

Phase VII lose 21 000 acres out of 37 000

F.A.O. Unit II

Phase III lose 7 000 acres out of 31 000

The acreages are approximate having been rounded to the nearest 1 000 acres.

The attention of the Conservator of Forests has been drawn to these aspects and decisions on the actual boundaries of the National Park must await deliberations weighing the needs of ecological conservation and human amenities against the economic viability of the forestry exploitation.

9.3.3 Loagan Bunut National Park

The 1956 Annual Report of the Forest Department indicated that protection of the virgin peat swamp forest around Loagan Bunut was desirable becuase this area contained all, or most, of the various types of such forest known to exist in Sarawak. Such a recommendation, together with the fact that Loagan Bunut is the only large lake of its kind in the State, led in 1963 to a proposal for the formation of a 12 700 acres National Park bounded by Batang Tinjar and Sungai Teru to the northwest and northeast respectively and by lines running northeast and northwest to skirt the lake margin on the eastern side. In spite of these unequivocal recommendations the area of peat swamp forest between the Tinjar and Loagan Bunut was logged-over during the period 1971-73 principally for its stands of Shorea albida. Nevertheless Loagan Bunut and its surroundings still possess National Park qualities. Certainly, the original structure of the forest/swamp complex has been lost and may not be regained, but the extreme swamp types and the open marshland round the lake are still intact. In addition, there will probably be some regeneration of Shorea albida along with the abundant regeneration of other species. If silvicultural work (particularly poisoning of non-commercial species) is avoided, or abandoned if it has been started, then many of the interesting features of this complex will have been retained. Effects of the logging are not visible from anywhere on the lake itself.

The lake is thought to have been formed by recent downwarping along the Mentegai syncline, and is said to empty and fill according to the rainfall within its catchment and the water level in the main Baram-Tinjar-Sungai Teru system. Water fluctuation is irregular, but the lake is reduced to a few pools

at least once, and sometimes twice, per year. Probably for this reason the lake is extraordinarily productive of fish, although lying in a dystrophic peat basin. More silt enters it by refill from the Sungai Teru, whose catchment contains much shifting cultivation, than through the small feeder stream at the southwest corner. The aquatic ecosystem has not been investigated by limnologists nor fisheries biologists and a complete survey would be well worth carrying out. The lake is also said to be an important point of call for migrant water birds, but this could not be confirmed. May be its attraction is confined to those migration seasons that find the lake at suitably low levels so that feeding mud flats are exposed. There is also a Berawan burial platform, reputedly about sixty years old, on the west bank of the feeder stream. This stream has two branches, one of which brings in some soil from an area of shifting cultivation on the ridge running into the lake from the southwest. At high water levels the varied shoreline, with the small forested island, the distant line of hills to the south from Bukit Mentegai (2 170 feet) to Bukit Belingan (2 474 feet), and the wide expense of sky made the area of sufficient scenic value to appeal to the general visitor.

In view of the fact that there are now no virgin stands of Shorea albida remaining around the lake, and to protect more completely the catchment area from undesirable events in future, it is recommended that an extension to the presently proposed National Park boundary should be considered. Ideally, this should be on the Batang Tinjar and Sungai Teru, behind the riparian band of cultivation and along the watershed to the south. This would take in a further area of exploited peat swamp forest and a small area of Mixed Dipterocarp Forest with some shifting cultivation on land which is classed as suitable for agricultural improvement. The agricultural area within the lake catchment is small and it is recommended that it should be left as at present. The Berawan shifting cultivators consider that the lake and its fishing rights belong to them, and this proprietary interest might be employed to good effect under National Park management. It would not, however, be in the general interest that the population should increase nor that further incursions should be made into the forest.

The Loagan Bunut proposals can be summarised as follows:-

(a) the National Park designation should remain;

(b) the enlarged area now suggested might allow zonation into a completely protected forest/swamp zone around the lake, buffered by an area of silvicultural management in which attempted enrichment of commercial species could be carried out without use of arboricides;

(c) after gazetting the area as a National Park (or sooner if possible), a complete ecological/limnological investigation of the lake should be undertaken. It should follow

the lines of the study undertaken on the Tasek Bera lake in Peninsular Malaysia by International Biological Programme participants, some of whom might be still available and willing to undertake this work. Such a study could lead to a temporary laboratory being set up along with a more permanent visitors' centre on the lake shore;

(d) the Berawan cultivators and their fishing activities should form part of the National Park ecosystem, but a close watch should be kept on their population level;

(e) implementation of any proposal to construct a sluice in the inflow/outflow channel from the lake to the Sungai Teru should await the result of the above mentioned study;

(f) some restriction on size and power of boats in use on the lake and in the channel might eventually be required, especially if there were to be a rapid build up in the number of visitors following completion of the Beluru-Long Teru-Long Lama road.

9.3.4 Lambir National Park

The original proposal by the Divisional Development Committee that the Lambir Hills area should be gazetted as a National Park is endorsed in its conservational intention. It is, however, suggested that National Park is not the most suitable designation for Lambir and that Forest Nature Reserve (or something similar) would be more appropriate.

The area has rugged terrain of Miocene/Pliocene sandstone reaching an elevation of 1 524 feet on Bukit Lambir and is covered by Mixed Dipterocarp Forest with much Gymnostoma (Casuarina) nobile at the higher levels. Soil surveys carried out by the Consultants have confirmed that the vast majority of the area is unsuitable for agricultural development. Streams are small and recreational opportunities for the general public are severely restricted.

It is, however, recommended that picnic places and rest areas should be developed in a zone flanking the Miri-Bintulu Trunk Road; a number of suitable sites exist and their development should be combined with roadside erosion control. On the other hand, any proposal to drive a tourist road deep into the rugged central area, or even to the summit of Bukit Lambir itself, should be resisted as this would have little point and would result in an unsightly scar visible from far off. A few forest footpaths would, however, be acceptable; for example, a path to the well known waterfall on the western side of Miri-Bintulu road. But generally all the area, except the strip adjacent to the highway, should be zoned as a Wilderness Area devoted to forest, wildlife and watershed protection.

9.3.5 Sungai Dalam National Park

Since the original proposal for Sungai Dalam was made the northern edge of the area has been affected by extension of Miri airport and a further part damaged by fire in 1972. Forest Reserve protection has also been withdrawn.

This land, which is easily reached from Miri, is also the most accessible example of kerangas in the neighbourhood. About one-third of the area has now been classed as of limited value for agricultural development, but the whole of it is probably best retained as forest. National Park, however, is not the correct designation and some other title such as Miri Forest Park is suggested. Alternatively the forest could be retained as a Research Reserve by the Forest Department.

9.4 ADDITIONAL CONSERVATION AREAS PROPOSED

9.4.1 Tanjong Lobang

The Tanjong Lobang area contributes much to the pleasant setting of Miri town. The bold scrub - covered sandstone headland with its sea caves and outlying stack forms something of a local landmark. There is a good variety of wildlife surviving in the remaining scrub, including monitor lizards, macaques, squirrels and many species of birds and bats, but how much of the rather rare and specialised flora of coastal cliffs can be found here is difficult to determine without hazardous exploration.

This natural asset is being threatened from seaward by an apparent increase in coastal erosion and from the land by carelessness and the expansion of high-income housing on the outskirts of Miri. Drainage water from the College playing field and buildings is discharged over the cliff and this, together with adjacent scrub cutting and burning, has resulted in a recent rock fall. There has been some attempt at replanting this section of cliff top with Acacia and Casuarina, but little now separates the mown area of the field from the cliff edge. To the north of the headland there has been a recent extensive landslip, involving largely untouched scrub, where deep soil covers the steeply seaward-sloping Miri sandstones and shales. Smaller slumps occur just above high water mark round Loak Bay due to undercutting by the sea. The largest remaining area of scrub faces Loak Bay and has several small streams running through it to the beach. This slope has been undercut and laid bare by earth moving machinery in one place behind the new housing development so that the approach to the bay has been largely spoiled.

Whether sand mining from the beach between Loak Bay and Kampong Baluboh could possibly be associated with the reputed

deepening of the sea immediately under Tanjong Lobang is difficult to say, but the possibility should be investigated in view of the disastrous effects that have resulted from beach mining of the coastlines of other countries. Around Miri the coastal sand movement appears to be mainly north to south, and deepening water under Tanjong Lobang, like the erosion of Miri spit, is most probably associated with the seaward movement of the Baram mouth, but there is some return drift from south to north during the months of June to November (Wilford, 1961).

It is suggested, therefore, that a small coastal protection reserve (Tanjong Lobang Park?) should be established along the headland from the last house on Loak Bay northwards to the bathing station and recreation area on Brighton Road. The boundary should be drawn immediately seaward of the house gardens and College playing fields. Much of this area is, theoretically, already Government Reserve under the Land Code. The seaward end of the playing field should be fenced off and planted with trees and shrubs. Great care should be taken to avoid further scrub or grass fires in this area, and safer disposal of surface drainage should be arranged.

A cliff-top track, with access to the beaches in places, could be constructed from Brighton Road to Loak Bay. Further scrub clearance in the area for housing and other buildings should be avoided.

9.4.2 Bukit Dulit

Only half this mountain, and hence only the extreme northwest end of the Dulit Range, comes within the Study Area. Here and on Bukit Skalap to the southwest are the only occurrences of montaine forest (poor in dipterocarps and rich in conifers, Fagaceae and Lauraceae) within the Study Area boundary. Part of the lower Skalap forest is within a Forest Reserve, but that of the Dulit Range is presently completely unprotected. Bukit Dulit has a fairly long history of biological investigation, from the animal collecting expeditions of Hose at the turn of the century to the plant ecological investigations of Richards in the mid-thirties. The Medway checklist of Bornean mammals cites Dulit as a habitat of many of the rarer animals of Sarawak as well as the common forms found at higher elevations. The forest on the summit plateau, while stunted, is not a particularly mossy example, but the cliff of Miocene/Pliocene sandstone which encircles it to north and northeast appears from the air to have an interesting flora.

It is, therefore, recommended that the whole of the Dulit Range should be considered as a special conservation area, with Bukit Dulit and other summits above 3 000 feet having the special status of Nature Reserves or Virgin Jungle Reserves. The

outer boundary should lie around the 2 500 feet contour, but the steepness and erodibility of the spurs running from the escarpment east to Batang Tinjar would suggest a lower limit of some 600 feet from Sungai Ghipidi to Sungai Lobang.

9.4.3 Lobang-Salai Limestone Outcrop

According to Haile (1962) a small cave in this outcrop of Melinau limestone is the best known and most productive (of edible swiftlet nests) in the Long Lama area. There is a second smaller cave, frequented by a large number of bats but devoid of swfitlets. The outcrop lies west of the Baram, about a mile west-north-west of Sungai Liang, and is thus within the Study Area, unlike the Batu Gading limestone north of Long Lama which lies east of the Baram. The swiftlets which nest in the Lobang-Salai cave belong to a different species from those at Niah and produce the more valuable white nests. No further information seems to be available on the scientific value of the locality, but there may possibly be some botanical interest too.

Haile also mentions at least six caves to the east of Beluru, which are surrounded by limestone outcrops in the Lambir Formation, but does not say if they harbour swifts or bats.

The general lack of scientific information concerning all the limestone outcrops (other than the one at Niah) makes it difficult at this time to give a firm recommendations for the conservation of any particular limestone area; but it is evident that biological surveys of the various outcrops and their cave fauna should be conducted before it is too late. Limestone is already in great demand throughout the State for road metal and other purposes and this demand is bound to increase rapidly, especially within the Study Area, as the road building programme gets under way. The Batu Gading limestone is already being quarried at one place and, although the idea of quarrying the Gunong Subis main massif has been abandoned, pressure for opening workings may build up as communications improve and demand increases. Already an expatriate firm has shown interest in quarrying in the Study Area. It should be possible to allocate the limestone outcrops to commercial working or to nature conservation according to scientific value, accessibility and all relevant factors; but a biological study must be undertaken before a reasoned decision can be made.

APPENDIX I

APPENDIX I

SECURITY OF TENURE FOR FORESTRY

Most Forest Policies, and Sarawak's is no exception, owe much to Indian experience where saving the forests from destruction came first and correct land usage second. Thus in Sarawak, Forest Policy, as approved by the Governor-in-Council on the 23rd of December, 1954, there is clear implication of permanency in the constitution of Forest Reserves but to a slightly less extent in Protected Forests when "extensive Permanent Forest is constituted in little-known territory, where the correct use of all the land cannot yet be determined". Unfortunately, the laudable aim of introducing the idea of correct land usage here undermines the meaning of the word "Permanent".

In Sarawak now, and particularly in the Study Area, a degree of sophistication has been reached in which it seems possible to eliminate technical doubts on the meaning of permanency as applied to Reserved and Protected Forests. Where land capability has been determined on the basis of semi-detailed soil surveys, the way is clear for legal procedure through all stages to final reservation of land classified as without agricultural capability. The division between forestry and agriculture as shown on the land capability maps, (map number 7, 14, 15 and 19) however, can only be tentative, especially in regard to complex units, until there has been a follow up with semi-detailed soil surveys. The question is how to save the forest in the meantime, even when it is mostly remnant forest. To follow through to the end the carefully devised legal procedure designed to produce Permanent Forests when in fact a future revision, possibly close in time, will amend the boundaries, undermines the meaning of the work "Permanent". Fortunately the initial procedure for proposing reservation, as carried out at present can give an immediate and complete protection to the growing stock, and the current method of demarcation precludes any likelihood that delay in final gazetting will cause any hardship to the local community. This is because the fact of forest destruction is accepted whether claimed rights can ultimately be proved legal or not. In the present method of marking boundaries the use of aerial photographs assists the adjustment of cut lines on the ground to exclude from the proposal any secondary vegetation, whether Temuda, Damun or Pengerang. The demarcation lines are, ideally, cleared close to the ground, with straight edges and retention of all possible shade to reduce the frequency and costs of upkeep. Prominent notice boards are fixed at salient points and serially numbered triangular aluminium tabs at every chain of cut line. The protection is normally honoured by country people and can be checked periodically be forest staff who patrol the boundary to re-fix lost notices and tags and ensure complete observance. That the boundaries are normally honoured in the Study Area has been remarked upon by the Consultant's soil survey teams.

The phrase "agricultural capability" can change in meaning with advances in agricultural research and changes in population pressure. But is it too much to hope that a policy declaration can be made which will give real meaning to the word permanency in relation to finally gazetted Forest Reserves and Protected Forests? The wording might be: A Reserve Proposal can be used to protect from damage forest on land requiring, in part, further investigation to determine agricultural capability. Land finally reserved after agricultural capability has been fully determined should not have its usage questioned for at least a full rotation of the timber crop after initial harvesting.

APPENDIX II

APPENDIX II

This Appendix is a copy of the plan for Silvicultural Research drawn up by the Forest Department when planning their research programme in the Niah Forest Reserve. Brief comments on this programme follow at the end of this Appendix.

A PROJECTED PLAN FOR SILVICULTURAL RESEARCH INTO THE REGENERATION OF LOGGED-OVER MIXED DIPTEROCARP FORESTS

Location: Niah Forest Reserve

Duration: Long-term with project review set at the end of each 5-year Research plan period.

Background: The Mixed Dipterocarp Forests (MDF) which cover more than 17.28 mn acres of Sarawak of which 5.98 mn acres are reserved or protected will be the country's most valuable timber assets within the next decade. Its importance to the economy of Sarawak will be accentuated as the supply of timber from the peat swamp forests diminishes.

The FAO Inventory Survey indicates that 3 mn acres are likely to be commercially accessible within the next twenty-five years.

The Mixed Dipterocarp Forest is the most difficult forest type to manage silviculturally on a sustained yield basis because of the dearth of local silvicultural information on this forest type. This mainly due to the fact that full-scale harvesting of this forest type started only in the mid-1960's in Stateland areas and the first MDF reserve was not licenced for harvesting until 1969. This was the Niah Forest Reserve which was licenced to the Niah Native Logging Co. Sdn. Bhd.

As it is the only reserve systematically worked under Working Plans prescriptions, its importance as a centre for silvicultural research cannot be overemphasized. Other areas available for research e.g. the Bakas Stateland which are older logged-over areas, had not been worked on regeneration concepts and hence the results of research conducted on such areas would have no direct bearing on the silvicultural management of the 3 mn acres of MDF projected to be released for harvesting over the next 25 years.

Research Status

The importance of Niah F.R. for silvicultural research was realised right at the outset. In 1970, within a year after the first logging coupe was opened for exploitation, the first research plot(RP), namely RP 53, was established in Block 4 of Coupe 1. RP 53 forms the base for the following Silvicul-

tural Research investigations:

Investigation 29: Need for silvicultural treatment in Mixed Dipterocarp Forest immediately after harvesting.

Investigation 30: Amount and severity of damage caused by harvesting in Mixed Dipterocarp Forest.

Investigation 31: Stand table structure and specific composition of Mixed Dipterocarp Forest immediately after harvesting.

Investigation 32: Recruitment, survival and growth of the seedling population in harvested Mixed Dipterocarp Forest.

Investigation 42: Survival and growth of trees in harvested Mixed Dipterocarp Forest.

The status achieved and further work planned under each of the above Investigations have already been summarised in Part I of the 1971-1975 Silvicultural Research Programme.

In the same year, on the advice of Dr. H.C. Dawkins from Oxford, 12 x 2.5 acre plots (RPs 54-65) were established adjacent to RP 53. These RPs cover Investigation 45 entitled "Rapid acquisition of increment data for desirables in harvested Mixed Dipterocarp Forests."

Preliminary analyses of Investigation 29 and 45 indicated that a high proportion of the harvested forests examined was unstocked by desirables. The potential second crop trees, were frequently impeded by larger undesirables or defective relic desirables. As a result, Investigation 47 was opened in 1971 to "Determine the effect on the regeneration of desirable species of four poisoningtreatments in Mixed Dipterocarp Forest immediately after exploitation." The treatments vary from a very intensive poisoning involving the removal of undesirables down to ten feet in height to a nil-treatment control. Each treatment was replicated six times in a Randomised Complete Block design in RP 68.

In 1973, Investigation 51 was initiated in Coupe 4 of the Niah Native concession in Niah Forest Reserve as part of Dawkins' recommended project to discover species capable of producing high value or decorative woods suitable for plantation in logged Mixed Dipterocarp Forest. Procurement of seeds of fast-growing hardwood species had been a problem. Raising of planting stock is another as we have no previous experience in nursery technique of fast-growing hardwood species and have to rely heavily on information received from organisations which sent us seeds.

Of the 15 species of fast-growing hardwood species for which seeds were received, sufficient number of seedlings were raised from only six species for inclusion in a replicated Randomised Block Experiment in RP 79, located in Logging Block

8 of Niah Native Coupe 4. In RP 79A adjacent to RP 79, an unequally replicated trial was established using the balance of seedlings of the same six species used in RP 79.

Niah Silvicultural Research Sub-Station

Because of the importance of Niah Forest Reserve as a centre for silvicultural research, it was proposed during the writing of the 1971-75 Silvicultural Research Programme that a Silvicultural Research sub-station be set up in Niah. Estimates were made and funds were allocated for the construction of two Class IV quarters-cum-office and a four-door forest barrack. By mid-1973, the buildings were almost completed.

The need for more intensified research in Niah Forest Reserve

Data accumulated from the present Investigations are insufficient to enable the Forest Department to draw up with confidence prescriptions for the silvicultural management of Mixed Dipterocarp Forests in the future. While we have to draw up empirical prescriptions based on the data accumulated so far, there is an urgent need at the same time to intensify research in the Niah Forest as staff resources build up. Because of acute staff shortage during the early part of the Second Malaysia Plan period, research has, thus far, been restricted to the more urgent applied side of the problem. It is also to be noted that research has so far been concentrated on subtypes within the Mixed Dipterocarp Forest. At the same time, there is a need to look more closely into the more basic ecological factors affecting post-harvesting regeneration environment. The most urgent need is for:

Continuing diagnosis of the Regenerating MDF

There is an urgent need to continuously diagnose the post-felling silvicultural conditions of the regenerating forest. This will be done by diagnostic sampling and will be the priority task for the staff that will take office at the Niah Silvicultural Research sub-station in early 1974. So far, staff and finance had only enabled diagnostic sampling to be started on approximately 2 500 acres in the Reserve.

As a start, Diagnostic Sampling transects will be cut at the intensity of 1 per cent over coupes 1 and 2. It will then be extended to the newer coupes. The transects will be marked for permanent re-location because for diagnostic sampling to be useful, it has to be recurrent. This means assessing the lines annually for the first five years, then biennially for up to the 10th year and then five-yearly thereafter in order that a dynamic picture of the forest regeneration may be obtained. For this very important work to be carried out efficiently, the Forest Department must be guaranteed security of tenure for at least 40 years.

Diagnosis is aimed not only at detecting the amount of advance growth, the amount of recruitment, the competitive status of the stems that are potential second-croppers, but also at detecting the severity of damage to the regeneration, soils, streams and generally the environment. With the accumulation of the valuable data, extended over all the MDF sub-types, the Forest Department will be able to predict with confidence post-felling conditions likely to result in any sub-type, in any terrain-class so that safeguards may be taken in future management practices in MDF to see that conditions that will adversely affect the regenerating environment are not created.

At the same time as diagnostic sampling which is extensive in nature, there is a need to initiate intensive research into:

The Soil conditions of MDF after exploitation

The only detailed examination of the soils of the Niah F.R. by the Forest Department (reported in Report F6) was carried out in 1970 in RP 53 over two lines covering only 6.275 acres. The same site was covered in a study of the variability of soils over short distances and preliminary observations on the soil damage caused by tractor logging. This soil examination was static in nature and therefore not likely to be useful in tracing the post-felling soil development with time and how changes in soil might affect the regeneration of the MDF.

It is proposed therefore, that the soil studies initiated in 1970 be extended to cover all the different annual coupes and at the same time, plots established for soil examination be marked out for periodic reassessment, again for the purpose of developing a dynamic picture of soil changes as a result of tractor logging. The establishment of these long-term soils studies plots again calls for non-disturbance and security of tenure of the exploited forest sites.

Associated studies should be carried out at the same time on:

The Ecological conditions of logged-over MDF

The study of the ecology of Mixed Dipterocarp Forest is covered under Project E6 but work so far had been restricted to the virgin forest. Results therefore would not directly be applicable for the interpretation of the ecological conditions of the post-exploitation forest. Project E6 will therefore be extended to include logged-over areas in Niah Forest Reserve.

Research plots will be established to accumulate data for the harvested forests on:

(i) The interval between successive flowerings
(ii) Flowering months
(iii) Species flowering patterns
(iv) The physiological and climtological factors relating to flowering
(v) Abortive flowering
(vi) The flowering process in Dipterocarps
(vii) Insect attack
(viii) Control of weevil attack
(viv) Seed distribution
(vv) Seed establishment
(vvi) Distribution of seed bearers

Poly-cyclic fellings

The system of harvesting a given area of Mixed Dipterocarp Forest at shorter intervals than at present, for example, in two periods of 25 to 35 years each instead of a single felling followed by a Silvicultural operation and a subsequent period of rest for 50 to 70 years is now receiving the attention of tropical foresters. This exercise is of great economic and forest management significance. The FAO Project in Malaysia is actively examining this management system and is enlisting the services of an expert to establish research plots to cover the mosaic of forest types in the MDF. The Niah FR will be one of the areas wherein a series of such plots will be established.

Enrichment Planting

Diagostic sampling carried out extensively over the harvested coupes will indicate aberrant areas in the forest that are not capable of regenerating on its own: To such areas spread over the various terrain classes, Investigation 51 will be extended. A forest nursery will be developed at the Niah substation for the production of seedlings for the field trials.

The planting will start at the species elimination trial level, moving on to adapt line-planting techniques used overseas for Sarawak conditions. The trials will be replicated over all the MDF sub-types using proven fast-growing hardwood species.

Close plantations

Where line-planting proves an unsuitable techniques for regenerating aberrant areas, close planting will be tried. For these trials, long-fibre tropical softwood species will also be tried besides fast-growing hardwood species. The trials will be an extension of close planting trials planned for remnant MDF in Stateland areas where it will assume greater importance.

Associated with these plantation trials will be fertiliser trials.

Staff and Financial Requirements

All projects discussed above will be carried out within staff resource and financial resource estimated for and provided within Development Plan period.

The following are the staff allocation:

(1) Existing Investigations

Establishment and assessment of all research plots

- 2 AFO's, 4 FG's

(2) Diagnostic Sampling

- 1 AFO, 4 FG's

(3) Soil Survey

A research team of 1 AFO and 2 FG's carrying out soil sampling; and 1 AFO organising laboratory analysis

- 2 AFO's, 2 FG's

(4) Ecological studies of logged-over MDF

Establishment and assessment of ecological plots

- 1 AFO, 2 FG's

(5) Poly-cyclic fellings

The same teams operating in (1) will operate here.

(6) Enrichment Planting

Raising of nursery stock

- 1 AFO, 2 FG's

Establishment and assessment of Planting trials

- 1 AFO, 2 FG's

(7) Close plantation

The same staff as for (6) will operate here.

SUMMARY OF SILVICULTURAL RESEARCH WORK AND FOREST AREAS INVOLVED UNDER SILVICULTURAL RESEARCH PROJECT IN MIXED DIPTEROCARP FOREST 1974-1980

Location: Niah Forest Reserve (47 504 acres)

Investigation: Recurrent Diagnosis of harvested MDF: Diagnostic Sampling

Each coupe is further stratified according to forest sub-type, based on terrain class and timber volume.

Areas involved:

Year	Coupe	Age	Acreage forest	Acreage sample	Sampling intensity per cent
1974	T/0169/1 (1969/70)	F + 5	1 927	20	1.04
	T/0169/2 (1970/71)	F + 4	3 734	40	1.07
	T/0169/3 (1971/72)	F + 3	5 761	60	1.04
	T/0169/4 (1972/73)	F + 2	7 700	80	1.04
	T/0169/5 (1973/74)	F + 1	4 500*	45	1.00

* Projected

1975-80: Annual increase in forest area to be diagnostically sampled = 4 500 acres.

Investigation: Soil conditions of MDF after harvesting - Extension of project SL 2

Nature of work: Soil Sampling

Area involved: 10 per cent random sub-sample of diagnostic sampling transects.

Soil characterisation of sites: Method to be employed as described by I.C. Baillie in Forest Soil Surveyor's End of Tour Report (1972) involving assessment of

(a) Site characteristics

(i) Topographic position
(ii) Slope gradient
(iii) Microterracing
(iv) Surface stones
(v) Litter thickness

(b) Profile characteristics

(vi) Matrix colour
(vii) Mottling
(viii) Structure
(ix) Clayskins
(x) Moistness
(xi) Consistence
(xii) Macro-pores
(xiii) Root abundance
(xiv) Stones

Physical properties

(i) Bulk density
(ii) Shear strength
(iii) Penetrometer resistance
(iv) Stones content
(v) Stone density
(vi) Moisture content
(vii) Particle density
(viii) Linear shrinkage

Chemical properties

Determination of pH, organic carbon total nitrogen;
Mechanical analysis
Exchangeable and reserve nutrients using Auto-analyser.

Investigation: Ecological conditions of logged-over MDF - Extension of Project E6

Research Plots for this investigation will be established in conjunction with those for the investigation of tractor logging damage.

Two one-acre linear plots will be set up in each of the following MDF sub-types:

4.11	4.22	4.31	4.42
4.12	4.23	4.32	4.43
4.13		4.33	

Each plot will be broken up into 40 ½ chain x ½ chain recording units.

Investigation: The possibility of introducing polycyclic felling in MDF

A management experiment in which the following treatments may be tried in a Randomised Block design:

A. Removal of all stems to 4 feet girth limit (control - existing management prescription)

B. Removal of all stems to 5 feet girth limit.

C. Removal of all stems to 6 feet girth limit.

D. Removal of all stems to 8 feet girth limit.

Treatment will be applied to plots 10-acre in area with four replicates of each treatment.

The following will be assessed at establishment in the 5 x 5 chain assessment core:

(i) Volume of timber removed
(ii) Residual basal area (all stems more than one foot girth)
(iii) Basal area of merchantable stems
(iv) Damage to residual stand following criteria adopted for Research Plot 53
(v) Leading desirables in each of the 100 ½ chain x ½ chain recording units or quadrats - size, crown form, crown position, impedence.

The plots will then be assessed annually for the first six years, then biennially to the 10th year for

- (i) girth increment
- (ii) basal area increment

At age F+1, a simple Treatment - No treatment experiment involving removal of weed trees down to four inch diameter of 12 inch girth will be superimposed to gauge the effect of the treatments on:

(i) girth increment of effective stocking
(ii) crown form

(iii) crown position
(iv) residual stand basal area increment
(v) stand structure

Projections can then be made for each treatment to gauge the desired time for second felling. The benefits of more frequent (polycyclic) - smaller volume fellings will be weighed against the economics of the first felling.

Area involved: 4 x 4 10-acre treatment plots = 160 acres

Duration of investigation: 1974-1980

Investigation: Enrichment planting of poor logged-over MDF - Extension of Silvicultural Investigation 51

Areas involved: those areas where diagnostic sampling shows less than 25 per cent effective stocking.

Species: those suggested for Inv. 51 nursery stock which can be easily raised.

10-tree linear treatment plots will be established in a completely Randomised situation with replicates per species or treatment as nursery stock allows. Lines will be spaced at 33 feet and spacing within lines will be 15 feet.

Estimate of area involved: 200 acres in 1974 increasing at 200 acres annually after 1974.

Investigation: Close plantations of poor logged-over MDF with fast-growing exotic hardwoods

Schedule to start: 1975

Areas involved: those logged-over areas where diagnostic sampling reveals to contain less than 10 per cent effective stocking.

Species involved: those species found to be suitable for Sarawak conditions from Silvicultural Research Investigation 51.

Spacing: 20 x 15 feet spacing to be used.

Plans for dissemination of Research results

(i) Research results will be disseminated in the form of Research Note when results are available;
(ii) Interim reports will be issued at review dates;
(iii) Final reports at the close of the experiment.

COMMENTS ON THE FORESTRY RESEARCH PROGRAMME

In Chapter 5 it is mentioned that the diagnostic sampling undertaken during the Study suggests that differences in exploitation between operators is a more important factor affecting silvicultural management than exploitation methods, i.e. whether exploitation has taken place inside or outside the Forest Reserves. Thus, it is considered that in the case of the Bakas Stateland (an older logged-over area not worked on regeneration concepts) it would be more appropriate to suggest that results of research in this area would have "indirect relevance" to silvicultural management techniques in other areas, rather than "no direct relevance" as suggested in the research programme.

On the subject of continuous diagnosis of the regenerating Mixed Dipterocarp Forest it is suggested that yield plots under Project 1 (Dawkins, 1970) should be established for continuous inventory and not diagnostic sampling because, it is believed, repeated sampling would be impractical.

For enrichment planting the spacing of lines rigidly at 33 feet ignores the provision that the spacing should be up to 20 per cent more than the mean crown diameter of the healthy final crop trees. The planned spacing of the lines is too wide to take account of the losses (30 per cent). It is therefore suggested that five feet apart could be more appropriate (Dawkins' 1/6th to 1/7th of the distance apart of the lines). Certainly there are figures available for mean crown diameter of many of the exotics now being tried out.

APPENDIX III

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APPENDIX III

REFERENCES

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APPENDIX IV

APPENDIX IV

NIAH CAVES — A NATIONAL MONUMENT

IV.1 INTRODUCTION

Niah Caves (Figure IV.1) have been recognised as being of outstanding scientific importance in the international as well as National context for nearly 100 years. These interests are multidisciplinary and are principally archaeological, geological, and biological. Excavations during the 1950's and 1960's showed the continuity of habitation by man of differing races throughout 50 000 years. Also, occupation of the cave and surrounding forest by many different animals was shown by remains in strata representing the past 100 000 years (Medway 1964). Some of these animals still live in the around the caves while others have become extinct. Two animals, a gecko and an earwig (Erixenia esau), are only known from these caves and together with other specialist animals are ultimately dependent upon the bats and swiftlets who bring food (in the form of guano) on which this unique cave ecosystem exists. Many other unnamed invertebrates occur in the caves and some of these may well be unique to them.

Because of this immense interest in the caves much research has already been completed, notably by T. Harrisson, and many detailed reports have been published in the Sarawak Museum Journal and elsewhere.

The Consultants' primary aim, in a short study of the caves undertaken during February 1974, was to establish the feeding patterns and ranges of the bats and swiftlets and to assess the likely effects of the proposed developments in the surrounding area on these populations. Despite the vast amount of work already completed in these caves during the past century, it was most rewarding to discover both a swiftlet and a bat new to these caves during the 19 days field work, as well as recording new facets of behaviour.

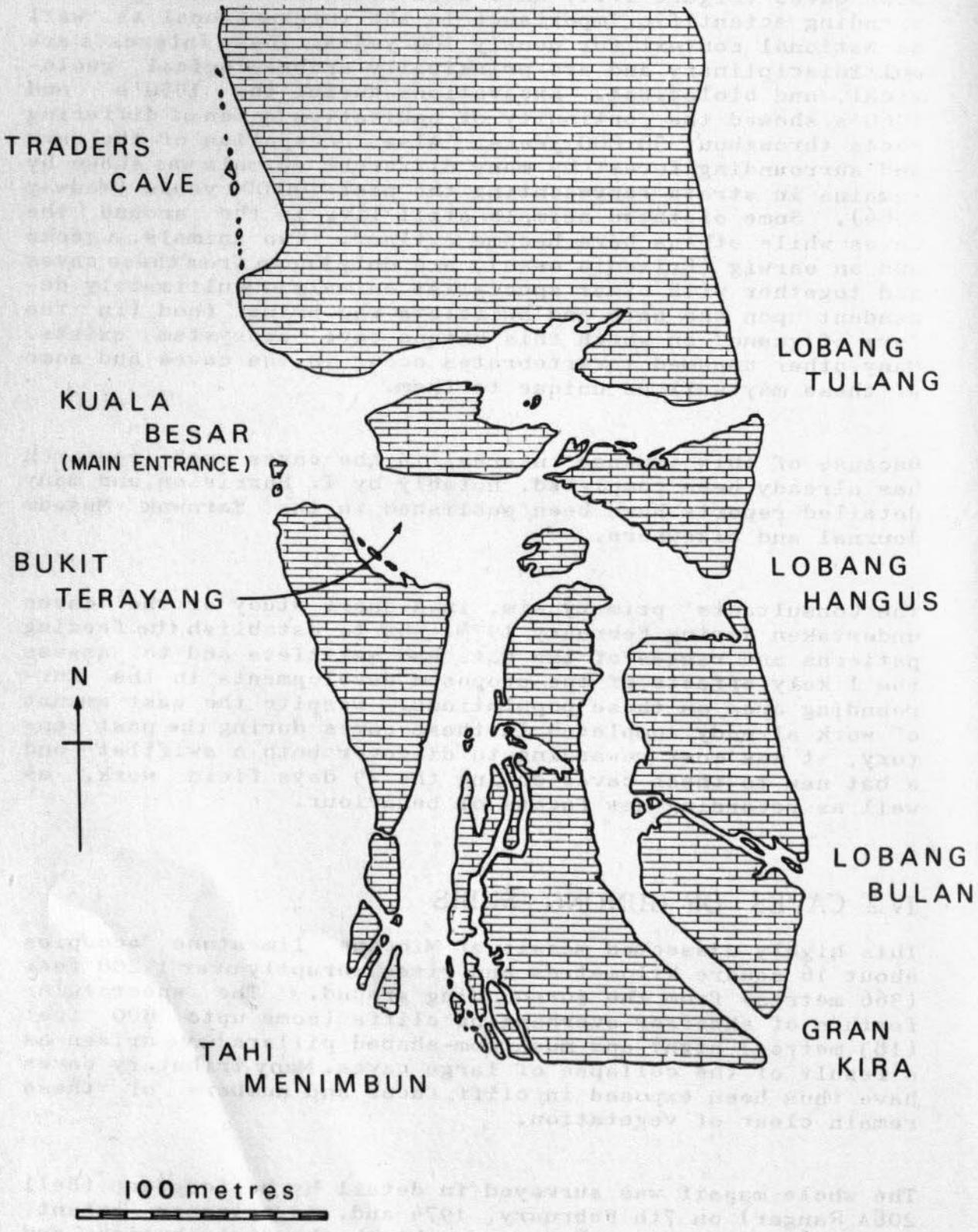
IV.2 CAVES OF GUNONG SUBIS

This highly dissected massif of Miocene limestone occupies about 16 square kilometres and rises abruptly over 1 200 feet (366 metres) from the surrounding ground. The spectacular feature of sheer or overhanging cliffs (some upto 600 feet (183 metres) high) and mushroom-shaped pillars have arisen as a result of the collapse of large caves. Many tributary caves have thus been exposed in cliff faces and numbers of these remain clear of vegetation.

The whole massif was surveyed in detail by helicopter (Bell 206A Ranger) on 7th February, 1974 and, to a lesser extent, on 23rd February in order to establish the distribution and number of caves and, if possible, their occupation by swiftlets and bats. Because of good flying weather it was possible

FIGURE IV. 1

CROSS SECTION THROUGH NIAH CAVE AREA



to fly very close to cliffs and into deep gorges and holes where wind currents often make such flying hazardous. With binoculars it was possible to look into the caves to check the presence of swiftlets or bats as well as bird nest collecting apparatus.

A total of 67 entrances was identified with sectional areas exceeding 900 square feet (83.6 square metres). These were concentrated in the north west and south east sectors of Gunong Subis (Figure IV.2). Four entrances had sectional areas exceeding 20 000 square feet (1 838 square metres). Additionally, several hundred small caves were seen and certainly many more were present but hidden by vegetation.

Of the 67 large caves, 13 were observed with swiftlets flying inside and six with bats (of which one contained large fruit bats): five entrances contained both swiftlets and bats. This is probably close to the true number of swiftlet-occupied caves. More caves could be expected to shelter bats: for example, no bats were observed in the six major entrances of Niah (Great) Cave where it is known that several hundred thousand bats roost. It is therefore probable that only where bats roosted near to cave entrances were they disturbed enough by the helicopter to take flight.

Apart from the Niah Cave there were six other widely separately and, by inference, non-connected caves in which poles and scaffolding used for nest collecting were observed.

As a result of these observations it was established that there were many caves in the area, some containing populations of swiftlets and bats. It is important to remember, therefore, that the populations in Niah (Great) Cave are only a part of the total numbers in the area. Additionally, there are other species of swifts and bats which do not inhabit these caves but live in the surrounding forest, and thus occupy the same general feeding area.

IV.3 SWIFTLETS

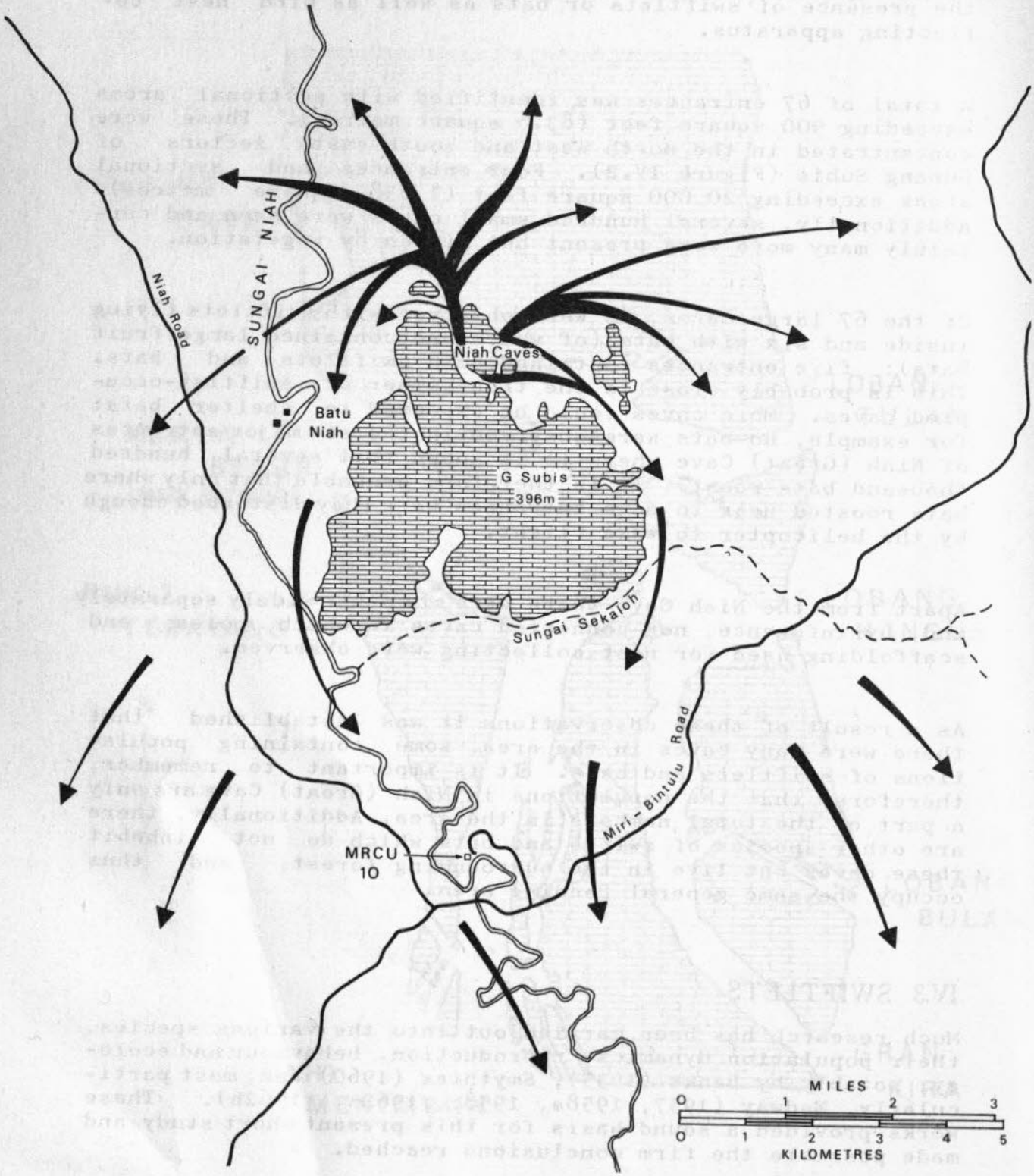
Much research has been carried out into the various species, their population dynamics, reproduction, behaviour and ecology; notably by Banks (1935), Smythies (1960) and, most particularly, Medway (1957, 1958a, 1958c, 1962a, 1962b). These works provided a sound basis for this present short study and made possible the firm conclusions reached.

IV.3.1 Population Estimates

Banks, Medway and Smythies all report the presence in Niah Cave of only three of the five swiftlets (Collocalia) that

FIGURE IV. 2

SWIFLET FLIGHT PATHS FROM NIAH CAVES



occur in Borneo, namely C. maxima lowi, C. salangana (formerly C. fuciphaga) and C. esculenta. C. maxima makes the low quality edible "black" nest of commerce while the other two make distinctive mossy nests - of no economic value. Each author has stated that no valuable edible "white" nests are present at Niah: these nests are produced by both C. Vestita and C. francica. However, five bracket-shaped white nests with characteristic lack of incorporated feathers were found fallen on the cave floor and these can be attributed to C. vestita. The presence of these birds was not confirmed by sight, but of the two species producing "white" nests C. francica appears to nest only in small coastal sandstone caves. Because of the large number of birds in these caves, it would be easy to overlook the presence of C. vestita, but if this species had been present earlier it seems likely that Medway would have found some "white" nests during his long visits. It is therefore probable that a small number of birds has become established during the past ten years. C. vestita is plentiful in caves around Long Lama and Long Laput only 44 miles (71 kilometres) south east of Niah. It would be interesting to know whether the birds nest collectors have recently gathered any "white" nests during their harvesting.

Banks (1935) estimated the number of breeding birds on the basis of quantity of nests produced from a harvest. A maximum yield of about 850 000 black nests in January-March 1931 implied a minimum population of 1.7 mn C. maxima. However, it was unlikely (even impossible) that every nest was removed and, together with immature birds, an estimate of 2.2 mn might be more realistic for that species. Banks did not quote estimates of population for C. salangana and C. esculanta. Medway (1962) and Medway in Smythies (1960) confirm a population in Niah Cave of about 2 mn adult C. maxima, C. salangana and C. esculanta combined and also support an estimate of 1.5 mn for C. maxima alone. However, this still implies higher numbers when considering immature and non-breeding birds and, in fact, Medway (1962b) does suggest a total of 4 mn C. maxima and C. salangana living in the area.

During this study several days were spent counting and estimating swiftlet movements in and out of entrances. Work was concentrated on two entrances (Kuala Besar and Lobang Tulang) so as to establish the normal daily variability and only short visits were made later to the other four large entrances. Counts were made from positions close to the entrance where, by lying on the ground and looking up, the whole entrance was in view and the birds silhouetted against a light sky. The numbers of birds leaving and entering were counted for two minutes each, every fifteen minutes, the count being halved to give minute rates. No attempt was made to count the species separately but care was exercised in distinguishing birds that were wheeling about the entrance from those making positive flights in or out of the cave. By using mechanical counters rates up to 500 per minute could be recorded accurately but above this a combination of counting and estimating was adopted. Counts were begun before dawn (about 0515, before many birds had left) and continued until after

TABLE IV.1 SWIFTLET MOVEMENTS - NIAH CAVE

TIME	KUALA BESAR 11/2/74				LOBANG TULANG 14/2/74			
	IN	TOTALS	OUT	TOTALS	IN	TOTALS	OUT	TOTALS
0530	10		30				15	
0543	10		50				17	810
0600	10	630	60	2 925	1		22	
0615	12		55				7,200	
0630	15		4 200		650		5,400	
0645	28	1 695	2 700	132 300	870	33 030	2,900	293 175
0700	32		1 200		530		2,570	
0715	38		720		152		1,475	
0730	34		537		260		710	
0745	31		545		235		390	
0800	44		620		91		305	
0815	54	4 335	643	72 855	110	12 075	53,294	53 294
0830	35		729		55		830	
0845	55		783		38		690	
0900	36		1 000		16		331	
0915	39		397		21		81	
0930	45	2 040	234	10 995	22		50	
0945	52		102		17		46	
1000	55		82		17	1 860	47	5 280
1015	67		81		15		42	
1030	34		55		17		48	
1045	32	4 455	67	6 360	15		38	
1100	32		58		57		49	
1115	33		53		37		38	
1130	44		28		27		35	
1145	25		95		41	4 230	40	3 750
1200	13		102		60		53	
1215	22		70		60		35	
1230	47	2 940	81	10 605	77		32	
1245	34		101		78		31	
1300	30		122		91	6 555	38	3 255
1315	25		136		107		51	
1330	11		41		84		65	
1345	15		15		131		47	
1400	32		15		124		46	
1415	54	4 590	17	4 395	141	8 220	42	2 670
1430	38		24		152		43	
1445	37		8		202		166	
1500	26		22		200		60	
1515	12		7		211	16 605	66	5 955
1530	53		24		208		45	
1545	13		105		286		60	
1600	15		15		319		94	
1615	110		19		328		43	
1630	44		38		314	25 890	71	5 190
1645	44		39		367		55	
1700	40	6,510	55	5 820	398		83	
1715	64		50		500		120	
1730	62		47		550		327	
1745	70		140		1 000	81 750	310	25 605
1800	106		240		1 600		400	
1815	130		380		1 800		550	
1830	1 700		44		3 000		500	
1845	1 800	173 040	17	10 215	3 000	189 000	140	9 600
1900	4 500		0		6 000		0	
1915	2 500		0		600		0	
1930	800		0					
		199 605		256 470		379 215		408 584

Note: The apparent discrepancy between out and in-going birds can be explained by the fact that few birds leave the cave before 'first light' when counts can be reasonably accurate, while many birds return long after dark.

dark (1930 hours) at which time birds were still returning. By this means total numbers of bird movements at two entrances were determined and spot checks of the other four main entrances as well as holes in the cave roof allowed reasonably accurate estimates to be made for the Niah Cave as a whole.

Total numbers of swiftlets leaving Kuala Besar and Lobang Tulang in one day were 256 470 and 408 584 (Table IV.1). Bird movements at Tahi Menimbun were similar to Lobang Tulang while at Gran Kira, Lobang Bulan and Lobang Hangus they were similar or smaller than Kuala Besar. The numbers of swiftlets leaving through the cave roof holes some 300 feet (91 metres) above the floor were substantial but although they could not be estimated accurately there were certainly fewer than Kuala Besar. The maximum number of bird exits daily could not therefore much exceed 2.2 mn. Medway (1962a and b) states that while some birds apparently fly out of the cave once per day returning at dusk (notably C. maxima), others (particularly C. esculenta) make several flights. Birds incubating also often stay on their nests for 24 hours. By using a telephoto light amplification system (which does not disturb birds at roost), counts of nests occupied by C. maxima were made and nest visiting behaviour was recorded. About 11 per cent of all whole nests were occupied on 18th February at 1035 hours and this proportion did not change throughout a 2.5 hour watch. However, there were occasional changes in nest occupation implying that most birds leave the cave at least once each day.

If it is assumed that individuals of each of the four swiftlet species averages 1.5 flights from the cave each day (and this may be a conservative figure), then the maximum number of all Collocalia sp. occupying the cave could not exceed 1.5 mn - C. maxima is by far the most abundant species.

Of this total it was estimated that the similar sized C. maxima, C. vestita and C. salangana number about 1.3 mn and the small C. esculenta 200 000.

It would appear that the swiftlet populations have declined considerably and possibly by as much as 60 per cent since 1931.

It was not known whether this decline occurred recently and suddenly or whether it was a progressive change over the last 15 years since Medway last estimated the population sizes. The size of normal population fluctuations is not known, and particularly the response to lack of food which Medway (1962a and b) considers to be a limiting factor. He recorded large losses amongst fledglings which were attributable to starvation . Certainly even in equatorial regions there are great seasonal variations in numbers of flying insects. At Singapore, Ward (1968) recorded changes in excess of twice the lowest monthly values, with more insects flying in the wettest

periods. Fogdon (1968) has also recorded large variations in Sarawak where most insects fly from December-July. It would be interesting to know, therefore, whether the current low population of swiftlets at Niah is a result of the prolonged and exceptional drought of early 1973. However, as will be shown later, no similar decline has been detected for the bats.

If drought is not the cause then it is difficult to account for the decline. As far as could be established there was no significant change in land use or its management within the swiftlet feeding areas until 1971. Since then about three per cent of the swiftlet range (mostly primary rain forest) has been cleared and part has been planted with oil palm. Assuming a large reduction in the insect population had occurred over that area, it would not be likely to have caused a 60 per cent swiftlet decline, especially as much of the area is at the extreme limit of the feeding range. Large numbers of swiftlets were seen feeding over the recently planted oil palm plantations but it was not known whether insects originating from these areas were being taken or whether the insects flew or drifted from adjacent forest.

The main factor that has not been examined (although samples await analysis) is the possibility of pesticide poisoning (Moore, 1967). During the past few years there has been a concerted effort to eradicate malaria from the area and large quantities of persistent organochlorines such as DDT have been used. During the visit men were seen spraying the many thousands of pools around G. Subis. More recently inorganic and organic pesticides have been used in the oil palm plantations, but nothing is known of the pathways these chemicals follow after spraying operations. This is an area where study is urgently required, together with regular annual monitoring of the swiftlet population sizes.

IV.3.2 Biomass and Food Consumption

Taking a mean body weight for the three larger species of 16 grams (with gut empty of food) then total weight of 1.3 mn swiftlets was 20 800 kilograms (20.471 tons). The 200 000 C. esculanta average 8 grams each and total 1 600 kilograms (1.375 tons).

C. maxima caught during mid morning returning to the cave had crops containing 4.5 grams of insects. It would be reasonable to suggest the swiftlets normally consume at least 50 per cent of their body weight per day and this would mean about 12 000 kilograms (11.8 tons) of insects. Medway (1962b) states that Hymenoptera (mostly ants) constitute the main diet.

Medway (1962b) has already described in detail the types of movements observed at Niah Cave entrances. Apart from stating he had not seen C. maxima or C. salangana more than 15 miles from the cave, he did not indicate where or when. Seven days and several other shorter periods were devoted to ascertaining flight paths, flight speeds, altitudes and feeding behaviour away from the caves using landrover, longboat and a helicopter.

Speeds: flight speeds were estimated by various methods, under differing conditions. Consistent results were obtained. By using a stop-watch swiftlets were timed past fixed points at cave entrances: C. maxima and C. salangana flew at 12 to 14 metres per second when flying horizontally or in slight climb but at 17 metres per second in downward flight, particularly when leaving Lobang Tulang. During the day when aerial bird density was low, speed of exit generally exceeded entry. Of particular interest was the substantial increase in speed of inflying birds at nightfall. At 1830 hours when birds were still leaving the cave, flight speeds were between 12 to 17 metres per second. Then, shortly after 1850 egression ceases and re-entry speeds gradually increase to about 30 metres per second at about 1900, possibly as high as 40 metres per second at Lobang Tulang. These last birds arrive from a very steep dive beginning at about 2 000 feet (610 metres) altitude. As the birds enter the cave mouth, wings and tails were extended to slow down to in-cave flight speed of two to three metres per second during darkness. This abrupt braking causes ripping sounds from the feathers and these facilitate ingress flight densities to be estimated at last light. After dark, returning birds are flying much more slowly but no reliable estimates could be made.

Away from the caves C. maxima and C. salangana were paced by landrover, travelling along the Miri-Bintulu road through the recently cleared forest areas a few miles east of Sungai Serkaloh. Birds were feeding along a low ridge about 150 metres parallel to the road and were paced for 300 to 400 metres. These were flying at 13.5 metres per second, under windless conditions.

On 23rd February the flight speeds of C. maxima and C. salangana were measured from a helicopter shortly after the birds had left Lobang Tulang at 0705, flying south easterly between 800 and 1 000 feet (244 to 305 metres) altitude. It was apparent that the swiftlets were not frightened by the helicopter until approached within about 200 metres. Birds flying horizontally in front and to the side were flying at speeds from 24 to 29 metres per second and none seemed to be feeding. Occasionally when the helicopter approached closely behind a swiftlet the latter would begin a twisting, shallowly diving flight reaching 36 metres per second before turning off sharply.

Flight speeds of C. esculenta were not accurately assessed

but several observed feeding in the forest were flying at about five metres per second.

Flight and feeding altitudes: these were established for C. maxima and C. salangana from the ground initially in relation to the limestone massif and then during helicopter flights where accurate figures were obtained. Normal direct flights to and from the caves were mostly between 400 to 800 feet (122 to 244 metres) with some flying up to 1 000 feet, (305 metres) especially early in the morning. By mid morning most swiftlets were feeding from canopy height to 500 feet (152 metres) and this increased to 800 feet (244 metres) by early afternoon. Towards 1800 hours away from the cave, when the main return flights began, most would be flying below 200 feet (61 metres) with a tendency to get lower as darkness fell. As the birds approached the caves large numbers built up at 1830 hours and they tended to wheel about 2 500 feet (762 metres) awaiting their chance to enter the cave.

There was no indication that these swiftlets normally feed or fly at heights of several thousand feet, as other swifts are known to do and as Medway (1962b) suggested these species might also.

Pathways: it was found that around Gunong Subis C. maxima and C. salangana had flight paths which were invariably followed night and morning. These pathways were established by direct observation from many points both on the ground and in the air taking frequent compass bearings (see Figure IV. 2).

At no time were swiftlets seen to fly over Gunong Subis. The flight behaviour of swiftlets passing over the Public Works Department Mechanical Road Construction Unit No. 10 camp some five miles (eight kilometres) due south of Kuala Besar was of particular interest, though unexplained. Observations were made on three separate evenings but those of the evening of 22nd February are illustrative.

Collocalia were observed passing over a 450 feet (150 metres) wide section of forest. Numbers, speed and direction were noted from 1800 hours to darkness at 1900. From 1815 to 1830, 275 birds passed flying towards due north to 23 degrees west of north: this course would take the birds around but close to the western limestone cliffs of Gunong Subis. Thereafter the birds progressively took a more westerly path until 1900 hours when all were flying between 40 to 43 degrees west of north, taking them two to three miles west of the cliffs in a big sweep. A further 292 birds passed during the 30 minutes. This total of 567 birds birds flying over a 450 feet corridor at five miles radius would represent, if a consistent density were maintained around the caves, 191 132 birds in 45 minutes.

Feeding area: during radiating journeys from the caves to establish total feeding range great care had to be exercised to identify the Collocalia from other swifts. Only C. maxima and C. salangana were recorded since C. esculenta is known to roost in situations other than caves. Subjective observations indicated that the other swifts (and swallows)increased in density with increasing distance from the cave as swiftlet density decreased, so that swift/swiftlet density was similar whatever the distance from the caves. Figure IV.3 shows the limits of observed C. maxima and C. salangana: where these limits could not be checked in inaccessible regions the probable limits are indicated. It appears, therefore, that the swiftlets are confined to the Batang Suai, Sungai Niah and Sungai Sibuti watershed area which covers 1 350 square miles (3 496 square kilometres). One bird was seen just west of the new Sarawak Oil Palms factory some 26 miles (42 kilometres) from Niah Cave; the furthest distance recorded.

Because of the flight speed of the swiftlets and the fact that they do not feed at night (Medway 1962a and b), it was surprising that many continue to return hours after nightfall. Even from 26 miles and flying at the lowest speed, the return journey should take no more than 58 minutes.

IV.4 BATS

Medway (1958b, 1971) again has provided a substantial basis to bat studies in Niah (Subis) cave. (Figure IV.1).

IV.4.1 Population Estimates

As with the swiftlet work, effort was concentrated on gaining knowledge about the numbers, distribution and density of bats roosting within the cave (using a telephoto light amplification system - Zeniscope) as well as establishing possible feeding areas. Medway (1958b) records seven species, with estimates of population size. Present studies have included an eighth species. Results are presented species by species.

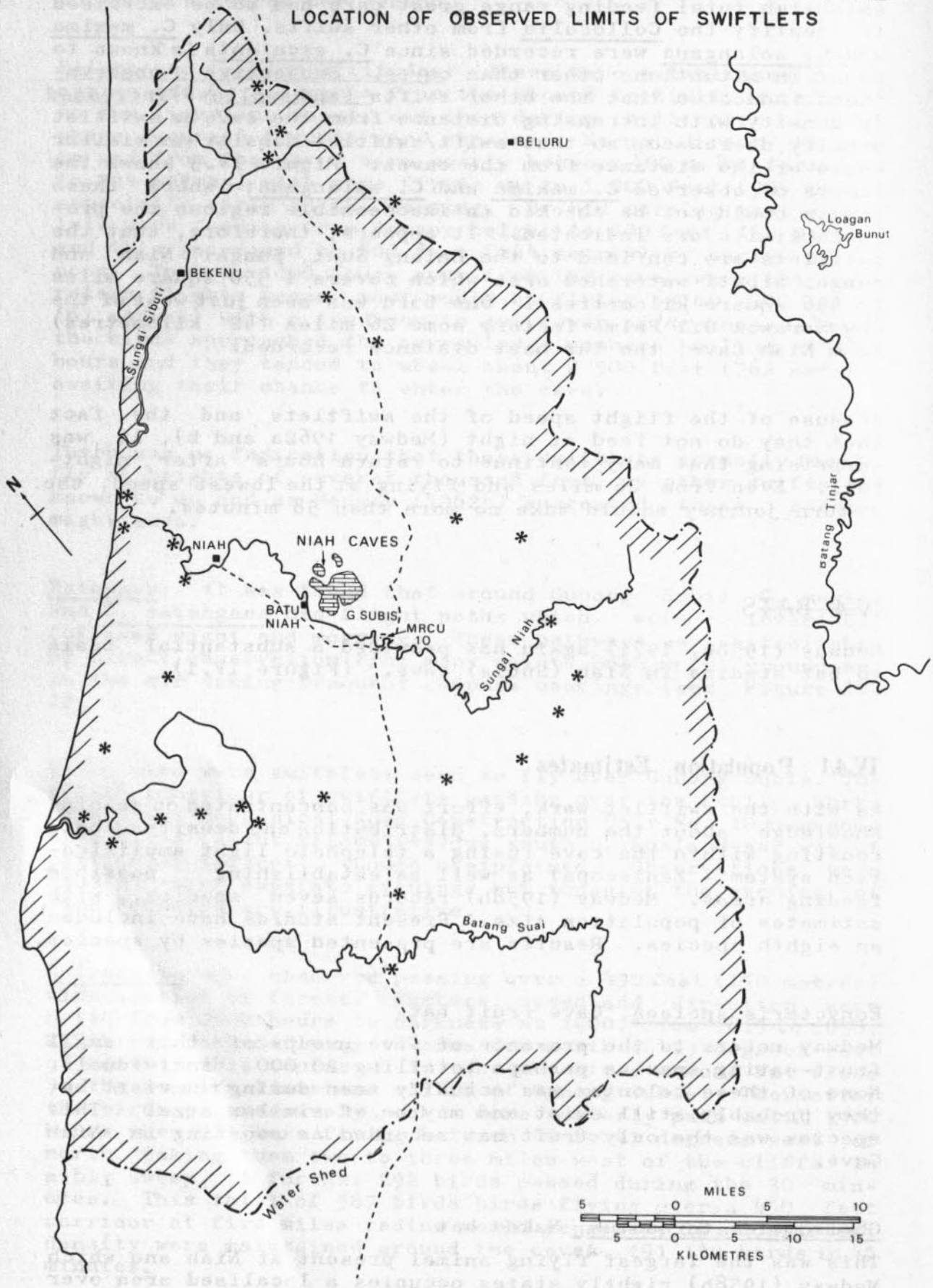
Eonycteris spelaea, Cave fruit bat

Medway refers to the presence of five groups of this small fruit-eating species perhaps totalling 20 000 individuals. None of these colonies was actually seen during the visit but they probably still exist and may be of similar size. This species was the only fruit bat recorded as roosting in Niah Cave.

Cheiromeles torquatus, Naked bat

This was the largest flying animal present at Niah and which Medway (1958b) rightly states occupies a localised area over

FIGURE IV 3


LOCATION OF OBSERVED LIMITS OF SWIFTLETS
BELURU
Loagan Bunut
BEKENU
Sungai Sibuti
Batang Tinjar
N
NIAH
NIAH CAVES
BATU NIAH
G SUBIS
MRCU 10
Sungai Niah
Batang Suai
Water Shed
MILES
5 0 5 10
5 0 5 10 15
KILOMETRES

the hill Bukit Terayang 600 feet (200 metres) inside Kuala Besar. The lowest roosting bats (measured optically) were 170 feet (52 metres) above the cave floor and the highest reached beyond 260 feet (80 metres) in the large bell holes (Wilford, 1966) where most were concentrated.

Medway suggested a probable 18 to 20 thousand individuals and counted up to 8 000 leaving in the characteristic but very variable emergence streams. Mr. Gasing, Assistant Curator, Sarawak Museum, thought the number currently had declined to about 8 000 (personal communication, 1974).

Detailed counts and flow rates were made on eleven nights (Table IV.2) with the most spectacular emergence stream occurring at Lobang Tulang on 19th February beginning at 1802 hours. Swiftlets were flying in and out as usual. By 1810, 131 Cheiromeles had emerged. Two minutes later entry and exit of birds ceased totally for 33 minutes with none visible. During this time more than 158 000 Cheiromeles emerged from that entrance and about 5 000 were seen emerging from an entrance to the south, probably Gran Kira. The following evening 22 500 left from Kuala Besar. Bats, like many other animals, are creatures of habit and individuals usually follow the same flight path out of roosts each night, and, it is unusual for every member of a colony to leave with a main stream. Because of these possibilities it is suggested that the total Cheiromeles population in Niah Cave is approximately 200 000. (The minimum possible is 165 000).

Hipposideros diadema, Diadem Roundleaf Horseshoe bat

This species is also large and Medway (1958b) tentatively suggested a population of about 5 000 scattered through the southern parts of the cave. Despite the fact that some were also found roosting high in the northern cave sectors, 5 000 individuals would still seem to be a reasonable estimate.

Hipposideros galeritus, Cantor's Roundleaf Horseshoe bat

This is a small species widely distributed throughout the caves, most particularly in the northern sectors and roosting from six feet to 300 feet above the cave floor. Medway (1958b) estimated the total population to be between 220 000 to 250 000. Four nights were spent estimating the flow rates and duration of three simultaneous streams leaving Kuala Besar. Because the streams were only six to nine feet wide reasonably accurate estimates were possible. Combined totals varied between 96 000 and 180 000 emerging on 11 and 15 February respectively. During five nights observations at Lobang Tulang none was seen. After the emergence steams had finished some bats always remained at roost. Thus a minimum population of 250 000 was estimated.

Rhinolophus boneensis, Borneo Horseshoe bat

This species, which was of similar shape and size to H. galeritus and would only be separated from it by close inspection, has hitherto not been recorded from Niah. It was first

TABLE IV. 2 CHEIROMELES TORQUATUS EMERGENCE STREAM COUNTS IN NIAH CAVE DURING FEBRUARY 1974

Date	Entrance		Gran Kira	Emergence times
	Kuala Besar	Lobang Tulang		
Feb.				
14		1 896		
15	1 116			1835-1905
18	242			1838-1853
19		158 890 +	c. 5 000	1802-1850
20	22 500			1800-1835
21		279		1824-1855
23	816			1836-1900
24	4 932			1754-1840
25	0			Heavy rain
26		2 632		1820-1859
27		836		1 at 1755
				2nd et seq
				1840-1900

found roosting under large boulders three to six feet from the ground and occasionally in small dense clusters, characteristic of the genus. (Individuals of H. galeritus were never found in contact with each other). Close examination of small low-roosting Borneo Horsehoe revealed a minimum population of about 3 000 but vast numbers roosting high in the roof could not be inspected. It is possible that many of the estimated H. galeritus were actually R. borneensis.

Miniopterus australis, Lesser Bentwinged bat

This is the smallest bat, occurring mainly in the southern parts of the cave. Medway (1958b) estimated a population of upto 10 000.

Little information was gained by estimating populations at roost but one instream was recorded on the morning of 19 February. (Medway noted three out-flying streams). At 0628 a sudden stream of bats (two caught) began entering Kuala Besar very close to the ground - often only 10 to 15 centimetres above but all less than six feet (two metres). The main stream began to slow at 0645 and finally stopped at 0652. About 9 000 entered during the 24 minutes. A minimum of 12 000 were estimated to roost in the cave.

Taphozous melanopogon, Black-bearded Tomb bat

Doubt exists as to the correct identification of this bat referred to in Medway (1958b) as T. longimanus albipinnis(Pied Tomb bat). However, whichever species it is, only a small number, about 150, roost near Kuala Besar.

Myotis horsfieldi, Horsfield's bat

Only one specimen was found in similar roost position to Miniopterus australis:Medway (1958b) recorded only five. It was unlikely that any substantial population existed in Niah Cave, or exists there today.

The total population of microchiropteran (insectivorous) bats was estimated to be at least 470 000 which was nearly 200 000 more than that suggested by Medway (1958b). From the evidence presented by that author it was unlikely that there has actually been any significant change in bat numbers. If the spectacular exodus by Cheiromeles on 19 February had not been witnessed then the estimate for that species would have been about 30 000 - the greatly revised estimate for the naked bat accounts for the bulk of the difference.

IV.4.2 Biomass and Food Consumption

A number of each bat species was caught at roost during the day and weighed with empty guts. Cheiromeles and Miniopterus were caught in cave mouths on their return from feeding and the weights of full guts ascertained. From observations on bats in temperate zones Cranbrook (1965) demonstrated the very rapid throughput of food from first bite to resultant faeces. This was timed to take about 30 minutes.Cheiromeles weighing about 170 grams were caught 45 minutes after exit with stomachs containing about 30 grams of insects. Miniopterus weighing six grams caught returning shortly after sunrise contained 2.4 grams of food. From these figures, which were comparable to those for similar sized bats living in cool temperate regions, conservative estimates of food intake were made for each species (Table IV.3). Although the total weight of insectivorous bats (36 727 kilograms or 36 tons) far exceeded that of swiftlets (22 400 kilograms or 22 tons), daily food consumption by the latter (12 000 kilograms or 11.8 tons) was much higher than for the bats (7 551 kilograms or 7.4 tons). Food extraction of this order from the surrounding country in itself implies a very large feeding area.

IV.4.3 Flight Patterns and Feeding Areas

Since bats' activity periods are almost totally nocturnal, little direct observation on feeding ranges was possible. It also proved impossible to gain positive information about the maximum time individuals spent out of the cave, although H. galeritus and M. australis form out-streams at sunset and in at sunrise. Flight paths and feeding ranges would take many months to determine by direct observation.

H. galeritus were seen both at dusk and dawn feeding in the upper parts of the forest but keeping below the canopy. Their flight speed was slow, as it was when flying in streams,

TABLE IV.3 POPULATION SIZES, BIOMASS AND FOOD CONSUMPTION BY THE INSECTIVOROUS BATS ROOSTING IN NIAH CAVE. FEBRUARY 1974

Species	Estimated population	Body weight (n) g	Population weight kg	Estimated mean daily food intake per individual g	Total weight daily food taken kg
Cheiromeles torquatus	200 000	172 (78)	34 400	30	6 000
Hipposideros galeritus	250 000	8.0 (6)	2 000	5	1 250
H. Diadema	5 000	44 (6)	225	15	75
Miniopterus australis	12 000	6.3 (15)	75.6	5	60
Rhinolophus borneensis	3 000	7.7 (3)	23.1	5	15
Taphozous melanopogan	150	24 (6)	3.6	7	1
Myotis horsfieldi	1+	7.5 (1)	-	-	-
Total	470 151		36 727.3		7 401

covering only two to three metres per second. Because of this slow, somewhat irresolute flight it seemed probable that this most abundant bat species would not travel further than about seven miles (11 kilometres)from the cave, though this could not be substantiated. If individuals feed throughout the night, they could, however, cover a very large area.

M. australis has a much more rapid twisting flight (c. seven miles per second). It was observed only once in large numbers in the gorge below Kuala Besar, flying in the lower half of the forest often close to ground level. Again its range could not be established.

The only other species for which any information was obtained was the naked bat, Cheiromeles torquatus. This was a strong, fast flier covering ten to thirteen metres per second.

On the evening of 19 February when at least 158 000 emerged from Lobang Tulang the following pattern was noted. After the initial slow egress lasting ten minutes, there was a sudden outrush which maintained the same rate for 23 minutes of about 100 per second. From calculations made during and after this event the degree of aerial density or packing was probably the maximum possible through this relatively restricted entrance. The column of bats was about 24 feet wide by 30 feet (24 by 30 metres) high which, with an exit speed

of ten metres per second, would imply each 0.68 metres wing-span bat occupying an air space of two cubic metres.

After leaving the entrance the column expanded and flight speed increased; all bats flew on a bearing five degrees north of east for nearly five minutes. By this time the column was 1 200 feet (400 metres) wide and had reached between 750 and 1 500 feet (250 and 500 metres) altitude. Most bats formed a left-handed double spiral some 3 000 feet (1 000 metres) in diameter, while about ten per cent formed a mirror image to the right. During this spiral flight bats reached an altitude of 3 000 feet (1 000 metres) and then continued to rise, flying north then west, and finally going from view some 13 000 feet (4 700 metres) north of Niah Cave, upto 4 500 feet (1 500 metres) high. The ten per cent of right-handed bats continued similarly to the south. Similar behaviour has been described in Texas where several million bats roost in a single cave (Davis Herreid and Short, 1962).

None of the bats in the main outrush appeared to feed, while the late stragglers began feeding just above forest canopy immediately upon emerging. On this occasion the first returning bats arrived at roost just over two hours after emergence, having flown about 56 miles (90 kilometres). It seems probable that the majority must feed over a very wide area, possibly as large a range as the Collocalia swiftlets.

On the evening of 22 February, while counting swiftlets passing over the Mechanical Road Construction Unit No.10 camp, a number of Cheiromeles passed low overhead coming from a direction 20 degrees east of north and continuing in a south-westerly direction. Extrapolating back along the same bearing, the indications were that these bats had passed around the eastern cliffs of Gunong Subis. If this was so, then they would have covered 9.5 miles (15 kilometres)and, therefore, must have left the cave about 1840 hours. This was consistent with the normal emergence times (Table IV.2)

In conclusion, Cheiromeles would appear, from circumstantial evidence, to have an extensive feeding range, perhaps as far as 30 miles from the caves. Since it is a large bat it could be expected to feed mainly on commensurately large flying insects. Faeces and pellets collected from beneath the roost have yet to be analysed to determine prey species.

IV.5 EXPLOITATION OF NIAH CAVES AND ITS MANAGEMENT

Niah Cave currently provides full-time and part-time employment for about 50 persons as well as providing raw material for some of the local Iban farmers. They are an attraction to tourists and constitute an immensely important research site for scientists. The multi-purpose functions of the caves was examined in order to establish whether any of the current

practices were harmful to other interests and whether they were inconsistent with the caves' designation as a National Monument.

IV.5.1 Guano Extraction Industry

Wilford (1952) was the first to map the caves accurately and to ascertain the distribution, depths and chemical composition of the guano deposits. In 1951, there was approximately 500 tons of fresh surface guano, notably concentrated in two areas, and 28 200 tons of fossil deposits distributed in eight regions. More than 50 per cent of the 23 acres of cave floor had no significant deposits.

Since the 1950s when the archaeological and scientific importance of the caves became known, control of the previously somewhat haphazard removal of guano became the responsibility of the Curator of Sarawak Museum, Kuching. The Curator has absolute power to decide whether and where guano should be extracted, and to issue or rescind licences. Two types of licence are issued. Type A to Muslims who are allowed to extract guano for five or six days each week (five at present), and who sell the product. Type B is issued to local Iban farmers who are allowed to extract guano for their own use on one day each week (Fridays). In practice, there has been a continued history of over-exploitation which has now reached such proportions that much of the value of the cave has been destroyed.

During the week 11 to 16 February a census was made of the amount of guano being extracted (Table IV.4). Most workers managed three loads a day and each load averaged a little more than one pikul. The total removed in one week was 517.51 pikul which for a 50-week year amounts to 25 875 pikul. Wilford (1952) recorded the guano extraction in 1951 as being 10 903 pikul and that had more than trebled since 1946.

TABLE IV.4 GUANO EXTRACTION FROM NIAH CAVE DURING WEEK OF 11-16 FEBRUARY 1974. NONE WAS EXTRACTED ON 16 FEBRUARY.

Date	Number of workers	Number of loads	Weight of Guano Pikuls
11 Monday	21	60	67.50
12	35	104	117.00
13	22	60	67.50
14	39	116	130.51
15 Friday	42*	120	135.00
Total		460	517.51

* 19 Muslim
23 Iban

In the regulations laid down by the Sarawak Museum, workers may collect the guano by sweeping only, but in fact most workers dig into the fossil deposits and this was usually done surreptitiously. The amount of fresh guano arriving in the cave was estimated to allow only five loads to be extracted daily.

The extent of the guano digging was mapped and depths removed measured. These were compared with Wilford's detailed report. Original surface levels were usually conspicuous as dark brown lines on the cave walls due to the highly organic nature of fresh guano. Fossil deposits lose their organic content and become cream coloured. In all it was estimated that 35 per cent of the fossil deposits had been removed while the regulations have stipulated that none should have been taken. In places over 30 feet (nine metres) of deposits were removed often exposing boulders, many of which were poised dangerously above steep slopes or cliffs. Most serious was the removal of the very important archaeological deposits inside Kuala Besar. These were still being removed at the time of the visit. The irreparable damage caused to this world-renowned site cannot be overstressed.

Additionally, because of the over-enthusiastic removal of fresh guano (mainly produced by the swiftlets that have themselves declined), the other dependent animals with their own unique and intricate inter-relationships have also declined. Unfortunately, no detailed description of this food web within the cave has been published and no population sizes accurately documented. However, from general cave descriptions by various authors the impression given was that the cave floor and walls once supported very dense populations of cockroaches and large numbers of the predatory crickets, spiders and centipedes. These populations were very sparse during the current visit.

It is strongly recommended that the present extraction of guano should be suspended until a thorough appraisal of guano input has been made. Following this, exploitation rates could be assessed, consistent with maintaining representative examples of the cave ecosystem and maintaining an attractiveness which will be sought by the increasing number of tourists.

IV.5.2 Swiftlet Nest Harvesting

Black nests of Collocalia maxima are harvested twice yearly, December to January and June to July. Detailed descriptions of the methods and yields have been published by Banks (1953), Medway (1957, 1958a and c, 1962a and b), Smythies (1960) and need not be elaborated here. Medway (1962b) and in Smythies (1960) presents sound and reasoned accounts illustrating the lack of any effect on population sizes caused by nest harvesting. This would be even more true at Niah now, since each

year a smaller proportion of nests are removed due to fewer men willing to undertake this hazardous occupation. Many of the climbing structures have collapsed and are no longer replaced.

There appears at present to be no reason to change the current policy and arrangements of nest harvesting. However, especially now that tourism will increase because of the improved communications, it would be prudent to remove many of the disused and dangerous structures - they are unsightly as well as dangerous.

IV53 Tourism

This aspect of cave use is only now beginning since the road from Miri to Batu Niah was completed. A census carried out from 10 to 15 February of visitors entering Kuala Besar revealed that 21 were Iban from the local Longhouse, Rumah Tangap (marked Rumah Ugop on the 1:50 000 scale Map) while six were Chinese and two other Iban, all native to Sarawak. Scrutiny of the visitors' book in the fenced excavation area inside Kuala Besar showed a continual but erratic trickle of visitors from all parts of the world.

Considering that Niah Cave is a National Monument in a Protected Forest, it is completely lacking in any of the amenities visitors could expect when visiting such an important and interesting feature. The only notice present simply states what the visitor must not do: no information is provided about any aspect of the cave.

Sarawak lacks many of the features tourists seek but this heightens the need to foster carefully those sites where potential exists. Niah Cave and the forest approach is one such site where, with careful planning, low density tourism could be developed providing income for the local community. Very great care would be required to prevent damage to the scientific interest, but at current prices it is envisaged that for 100 visitors a day sums of about $3 500 daily could accrue to hoteliers, boatmen and the State. No elaborate facilities should be provided but a comprehensive illustrated leaflet produced in several languages should be issued on payment of an entrance fee. The pathway, consisting largely of a raised plank-walk from Pangkalan Lobang to Niah Cave, already provides an ease of access which potentially could lead to over-visiting by tourists. Certainly no attempt should be made to improve or duplicate the path which would act as useful limiting value to the number of visitors.

Within the caves a certain amount of tidying up is urgently required. There are several thousand bottles, as well as tins, barbed wire and other litter which apart from being unsightly is dangerous. This would take about 30 man per days to clear.

The site of archaeological excavations, at the approach to Kuala Besar, could be tidied up and potentially would be a valuable asset for education. Since the lowest levels occupied by man still have not been reached(and as archaeological techniques develop) it is envisaged that there will be a continuing history of excavations. These will add to the attraction of the caves for the type of tourist that would be most likely to visit the area.

If the caves are to be thought of for tourism then an essential pre-requisite would be the appointment of adequate staff. The permanent officer-in-charge should preferably have had a scientific education and be familiar with the historical and biological aspects of the cave. He could also make routine observations and give talks. Support staff need not be full-time employees but would be required for wardening, litter collecting and ticket duties. Two full-time support staff or equivalent would be adequate to cope with up to 100 visitors per day.

IV.5.4 Education

This has already been mentioned as an important potential use of Niah Caves. During the next 25 years, education in Sarawak will make tremendous advances and field studies are acknowledged as being of immeasurable value. Many disciplines can be covered and illustrated by examples in and around the caves.

IV.5.5 Scientific Research

Niah Caves are one of the most important archaeological sites in South-East Asia. Much of the history has already been documented but much more remains to be done. Of great concern is the deterioration and damage being suffered by the cave paintings, which remain unique to Borneo. Measures are urgently required to conserve and protect these.

Biological aspects have barely begun to be studied, apart from some studies of the most obvious swiftlets and one species of bat. No work has been completed on the many specialist and some unique invertebrates living within the cave and which ultimately depend on swiftlets and bats.

Because of these many and often conflicting interests in Niah Caves, it is essential that this potentially important National asset should be managed to the advantage of all.

IV.6 IMPLICATION OF DEVELOPMENT PROPOSALS

These fall into two main categories:

(a) direct effects of changes in land use, and

(b) management techniques.

(a) Within primary forest there is an enormous diversity of insect species and any change from forest will inevitably involve species composition changes even if the total number of biomass is not substantially altered. Similarly, by phasing out or limiting the areas of shifting cultivation (an ancient land use with its own animal communities) other species composition changes will occur. With the introduction of large areas of perennial mono-crops such as oil palm, rubber, cocoa, and grassland, insect diversity will be reduced drastically. Although no figures exist as to whether changes in insect biomass occur over mono-crops after clearing rain forest, a consensus of subjective comments by people familiar with insects in equatorial forest regions suggest that density will decline. If insect biomass density is reduced either totally or seasonally then one can expect a corresponding reduction in numbers of swiftlets and bats. Medway (1962a and b) has already shown that food availability is a major limiting factor for swiftlets and this also probably applies to bats. Again this is a topic where further study is required.

(b) Crop management techniques are paramount to the survival of bats and swiftlets, and pose the greatest threat. The use of persistent and broad spectrum pesticides must be avoided as far as possible. It has often been demonstrated that liberal use of pesticides to control crop pests creates a situation where natural predator species of insects are killed, necessitating a continued use of pesticides. Samples of bats, swiftlets and guano have been taken for pesticide analysis to establish the present load being carried by the cave ecosystem. Both bats and swiftlets are highly susceptible to pesticide poisoning and therefore regular monitoring could provide a means whereby total pesticide loads in the area could be estimated. This is most important because of the possibility of pesticides building up in food crops.

In conclusion, it is probable that the proposed extensive developments in the Study Area will lead to population changes within Niah Caves, but it is hoped that with the careful use of management techniques, these changes will not be too drastic. However, it is considered essential that regular monitoring should be undertaken immediately of the predatory fauna in the forest ecosystem, including the Niah Cave swiftlets and bats.

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APPENDIX V

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