TABLE OF CONTENTS

LIST OF MAPS

1. BACKGROUND

The Crocker Range is the mountain range which rises from the western coastal plains of Sabah around 10 to15 km inland from the coastline. The main ridge of this range varies in altitude from about 3,000 to 6,000 feet above sea level (Map 1). The term "Crocker Range foothills" refers to the hilly land at the base of the Crocker Range, situated between the flat lands which are largely inhabited and the forest covered, high elevation ridges and peaks.

Crocker Range Forest Reserve was established in 1969 (139,919 hectares; Appendix 1). It is clear from the gazette notification that commercial timber extraction was not intended. It would seem that one of the original purposes of protecting a large part of the Crocker Range as a Forest Reserve was to secure a sustainable supply of forest products for the inhabitants of surrounding villages.

The boundary of the Forest Reserve was essentially arbitrary, however, bearing little relationship to topography, altitude, vegetation or proximity to existing villages. In 1969, for example, all or most of the existing village gardens in the Ulu Membakut and Ulu Bongawan areas were at least 6 km. from the Forest Reserve boundary.

With the passage of the Parks Enactment 1984, the Crocker Range Forest Reserve was converted to Park status, with the name of "Taman Negara", under section 17 of the Enactment. In 1996, the name was changed to Crocker Range Park (CRP; Map 1). As a Park, no form of exploitation of natural habitats is permitted within the boundary. The boundary of CRP cuts across the foothills of the Crocker mountain range. Most parts of the CRP boundary bear no relationship to any physical or ecological features. There is much steep land and a significant amount of natural forest remaining outside the CRP boundary.

Land immediately outside the CRP boundary was (at the time of gazettement) and largely still is State land under natural forest cover. Over the years, most of the land outside the CRP has been commercially logged, several times. In addition, a process of application for land, approval by government, and issuance of title has proceeded.

Sabah Conservation Strategy (SCS 1992) identified the Crocker Range foothills, outside CRP, as significant water catchment areas. These foothills supply water to villages (domestic water and irrigated rice fields), and represent potential future piped water supplies for urban and industrial use.
The distribution of the major water catchments of the Crocker Range is depicted on Map 2. For these reasons, SCS proposed that about 27,500 hectares of forested State land on the west side

of the Crocker Range and 23,000 ha on the east side be reserved as Protection Forest Reserve.

In early 1983, during an El Nino drought, much of the forest was burned on the southern fringes of CRP, along Padas Gorge and to the west of Tenom. Parts of the same areas caught fire again in dry periods in early 1990 and 1991. It is likely that parts of these areas burned during other dry spells between 1983 and 1998, but specific records are not available. In March 1998, during another major El Nino drought, a much larger area of forest around and in CRP burned, contributing to unprecedented haze on Sabah's west coast, including Kota Kinabalu.

Prior to 1997, land use in the Crocker Range foothills was largely forest (used for timber production) with some hill rice cultivation, rubber gardens and orchards. In 1997, some of the land in Ulu Membakut was converted to oil palm plantation.

2. OBJECTIVES

The objectives of the investigation of the Crocker Range Foothills under the IPPA were the following:

- To identify the main elements of biological diversity in the Crocker Range outside the Crocker Range Park (CRP).
- To investigate threats to the conservation of biodiversity in the Crocker Range.
- To make recommendations concerning biodiversity conservation in the Crocker Range.

MAP 1 LOCATION OF CROCKER RANGE PARK BOUNDARIES

3. METHODS

Due to the great size of the Crocker Range and constraints on the amount of survey work achievable, one sample area was chosen for emphasis in this study. Ulu Membakut was chosen because this area contains the only true lowland dipterocarp forest remaining in western Sabah. This type of forest is now probably the most endangered natural habitat in Sabah. In general, and in accordance with the purpose of IPPA investigations, emphasis was placed on forests outside CRP, as the forest inside this Park already enjoys strong statutory protection. For the purpose of this study, the area north of the Penampang - Sinsuron road was not investigated, as that area consists of mountainous land, with forest types already represented within CRP and Kinabalu Park.

Existing information was sought on biodiversity in the Crocker Range foothills. Botanical expertise to survey Ulu Membakut was sought but none could be secured before the occurrence of devastating forest fires throughout this area in March 1998. Brief surveys were conducted in Ulu Membakut of terrestrial wildlife (September 1998; *Background Paper 1*) and freshwater fisheries (March 1998; *Background Paper 2*).

Apart from conservation of biodiversity, the most important function of the Crocker Range Park is protection of the catchments of the many rivers that drain from this mountain range. Therefore, a preliminary assessment of the hydrological importance of the entire Crocker Range was done for this study (*Background Paper 3*).

Soil suitability of Ulu Membakut (*Background Paper 4*) and the characteristics and perceptions of local residents (*Background Paper 5*) were investigated. Both investigations have a strong bearing on generating realistic recommendations for biodiversity conservation and appropriate land use outside CRP.

An aerial survey was conducted in August 1998 to assess land use trends around the fringes of CRP (*Background Paper 6*).

4. FINDINGS

4.1 PLANT LIFE

Crocker Range is unique in Sabah in encompassing an undisturbed continuum of forest land from true lowland dipterocarp forest, below 500 feet altitude (Davies & Payne, 1982; SCS, 1992), to montane forest above 4,000 feet altitude.

Some tree species are believed to be endemic to (i.e. occur only in) lowland and hill dipterocarp forests of north-western Borneo (Table 1). Since these forests have almost entirely been converted to alternative land use or severely degraded elsewhere in western Sabah, the Crocker Range foothills represent the sole remaining area where these species can survive.

The list in Table 1 is not comprehensive. However, it serves to indicate that there are plant species, some known and probably some unknown (i.e. not collected or described scientifically), which are likely to be confined to the Crocker Range foothills. If this is so, the Crocker Range foothills support some highly endangered wild plant species.

Table 1: Some rare plants species of the Crocker Range foothills

Durio crassipes	A wild durian, collected only in Tenom and Sipitang areas of Sabah
Durio kinabaluensis	A wild durian known only from the foothills of the Crocker Range and Mount Kinabalu, mainly outside Park boundaries.
Durio species "B"	A wild durian, not scientifically described; recorded only from Senegang Valley, between Tenom and Keningau
Melanochyla woodiana	A small tree of the family Anacardiaceae, recorded only from Beaufort area
Anisoptera grossivenia	A dipterocarp tree, recorded only from a few sites in lowlands of western Sabah
Dipterocarpus lamellatus	A species of keruing, recorded only from Labuan and Beaufort Hill

Dryobalanops aromatica	Of historical interest: the resin (camphor) of this species, Borneo camphorwood, was a major forest product exported from Sabah to China before the 19th century. Occurs elsewhere in Borneo, Sumatra and Peninsular Malaysia, but in Sabah now possibly confined to Crocker Range foothills.
Shorea kudatensis	A species of yellow seraya, recorded only from coastal hills at less than 100 feet altitude, in north and west Sabah, most of which have been burned or deforested
Shorea rubella	A species of red seraya, recorded only from Beaufort Hill and Brunei
Acanthehippium lilacinum	An orchid recorded only from Crocker Range foothills outside Park boundary
Arachnis grandisepala	An orchid which in Sabah occurs only in Crocker Range foothills outside Park boundary
Cymbidium chloranthum	An orchid which in Sabah occurs only in Crocker Range foothills outside Park boundary
Vanda hastifera var. *gibbsiae*	An orchid recorded only from Crocker Range and Mount Kinabalu foothills outside Park boundaries

(Source : Meijer and Wood (1964), SCS (1992), Soepadmo *et al* (1996))

Based on 1:50,000 scale topographical maps, there are 1,350 hectares of land below 1,000 feet altitude, the approximate zone of lowland and upland dipterocarp forest (Davies & Payne, 1982; SCS, 1992), within CRP. Of that, only 240 hectares is below 500 feet.

However, it appears that all forest below 500 feet altitude and most forest below 1,000 feet altitude was burned between 1983 to 1998. It is unknown whether any of the burned forest can or will regenerate as forest. Any further fire or logging will probably prevent forest regeneration.

4.2 TERRESTRIAL ANIMAL LIFE

Limited available published information on the animal life, invertebrate and vertebrate, of Crocker Range does not suggest the presence of any locally endemic or endangered species other than orang-utan (see below).

Based on a one-week survey, without trapping, at Ulu Losan, north of Tenom, Crocker Range foothills in 1980, Davies & Payne (1982) recorded 8 mammal species and 6 large bird species (Table 2). Ulu Losan was the only site out of 35 sites surveyed for wildlife in 1979-81 where no signs of primates were seen or heard. This absence of primates is attributable to heavy and long-term hunting pressure. Based on a survey in Ulu Membakut / Ulu Bongawan in September 1998, after heavy logging and extensive fire damage, Davison (1998; *Background Paper 1*) recorded only 2 mammal species and 26 bird species which are characteristic of forests. Twenty species of birds were recorded which are characteristic of open, non-forest conditions, in areas which one year previously had been regenerating dipterocarp forest. People involved in logging in this area reported that in early 1998, during the forest fires, they saw one large orang-utan and about 20 smaller orang-utans. During an aerial survey in August 1998 (*Background Paper 6*) and during the September 1998 wildlife survey, no definite signs of orang-utans were seen. These results provide some indication of the massive negative impact of fire in logged forests on animal diversity.

Table 2 Mammal species recorded in Crocker Range foothills

Giant squirrel	*Ratufa affinis*
Prevost's squirrel	*Callosciurs prevostii*
Whitehead's pigmy squirrel	*Exilisciurus whiteheadi*
Thick-spined porcupine	*Thecurus crassispinis*
Long-tailed porcupine	*Trichys lipura*
Yellow-throated marten	*Martes falvigula*
Bearded pig	*Sus barbatus*
Barking deer	*Muntiacus muntjak*

Table 3 Prominent bird species in Crocker Range foothills

Argus pheasant	Arg*usianus argus*
Bushy-crested hornbill	*Anorrhinus galeritus*
White-crested hornbill	*Berenicornis comatus*
Wreathed hornbill	*Rhyticeros undulatus*
Rhinoceros hornbill	*Buceros rhinoceros*
Helmeted hornbill	*Rhinoplax vigil*

Kinabalu Park and the Crocker Range are the only two areas in Malaysia where there are wild breeding populations of orang-utan in mountain ranges. Payne (1988) estimated that the size of the orang-utan population in the Crocker Range probably lies within the range 25 to 160 individuals, with some individuals ranging outside the Park in the Ulu Membakut to Ulu Kimanis area. Due to rapid and extensive loss of lowland forests in Sabah, the orang-utan is now an endangered species (Payne & Andau, 1997). Thus, Crocker Range has a potential role to play in conservation of this species. The impact of the 1998 forest fires on the orang-utan population is unknown.

4.3 FRESHWATER FISH

Thirty-five species of freshwater fish from 13 families were recorded in Ulu Membakut from 23-25 March 1998 by sampling from the main Membakut River and the tributaries of Agitan and Maginanau (*Background Paper 2*). Ikan *pelian* (*Tor douronensis*), still exists in the area, probably one of the few remaining rivers where this species still exists on the west coast of Sabah. Freshwater fisheries are not economically significant to most residents of Ulu Membakut.

4.4 HYDROLOGY

Some key results of the hydrological assessment (*Background Paper 3*) include:

- CRP protects significant areas of steep land, but large areas of "marginal" land are outside CRP. Inappropriate development in these areas will compromise water quality downstream.

- Swidden farming (see section 4.6), as traditionally practised in the Crocker Range foothills, appears to have no serious adverse hydrological impact. The only part of the Crocker Range where swidden farming has clearly been too intensive is Ulu Tuaran (outside the scope of this study).

- Before the March 1998 forest fires, all streams visited contained a diverse invertebrate fauna, except those streams within and draining oil palm plantations. This indicates that freshwater life can tolerate timber extraction and traditional farming, but not oil palm plantations.

- The upper Membakut, Bongawan and Kimanis catchments are in danger of becoming irreversibly degraded due to repeated logging and fire.

- The hydrology study has resulted in the production of a spatial database, using a Geographical Information System (GIS). If a development plan for the Crocker Range foothills is to be developed, it is recommended that additional information be incorporated into this database, and the GIS be used as a planning tool.

4.5 SOILS

The soils assessment of 5,600 ha of land at Ulu Membakut (*Background Paper 4*) found that up to about 17.8% of that area is suitable for tree crops, particularly rubber. Slopes in most of the area are 12 - 30 degrees or more. Much of the area is likely to lose more than 100 tonnes of soil/hectare/year if forest cover is removed. The assessment concludes that any agricultural development should be confined to the level and rolling land. The assessment recommends, however, that since such areas are scattered, it is best that the whole area be retained as a conservation area due to the highly erodible nature of soil. Ulu Membakut represents the part of the Crocker Range foothills that contains land at the lowest altitudes, and incorporates the Membakut River valley. For all other parts of the Crocker Range foothills, the percentage of land suitable for plantation development will be lower than 17.8%.

4.6 TRADITIONAL HUMAN USE

Traditional farming in the Crocker Range foothills is based on cultivation of hill rice on slopes, in fields typically of about 1 - 3 hectares in extent, with fallow periods that allow regeneration of tree cover. This farming system (known as swidden farming) has clearly been used for a very long time, and has not resulted in significant soil erosion or pollution of waterways.

Historically, hill rice farming communities have not been distributed evenly around the Crocker Range. In general there is a decrease in the number and extent of communities from north to south. In the north, there have apparently been Kadazan-Dusun communities, some farming at elevations above 2,500 feet, for at least hundreds of years. At the south end of the Crocker Range, the traditional distribution of Kadazan-Dusun people is in the flat plains of lower Membakut River. Historically the Ulu Kimanis, Ulu Bongawan and Ulu Membakut did not contain any villages or farming land. The villages of Ulu Membakut are relatively recent. Kg. Bambangan was reputedly founded by migrants from Kinabatangan in the late 19th century, while Kg. Minantul originated with migrants from the Kudat area in the 1930s and Kg. Minopon was initiated by a family from Penampang in the 1980s.

While it is the contention of this report that traditional farming in the foothills is not a major threat to slope protection, a possible exception would be farms that have established in association with logging roads. New roads have the potential to allow farming settlements to establish in steep areas that would not normally be accessible to traditional use, including areas that should be kept under forest cover. This is apparent to some extent in Ulu Kimanis and Ulu Membakut, and indicates a negative trend that could arise if logging activities are permitted to extend deeper into the Crocker Range.

MAP 2 DISTRIBUTION OF MAJOR WATER CATCHMENTS OF THE CROCKER RANGE

PLATE 1
The upper Papar River valley
The mix of undisturbed tall forest along the river valley, traditional swidden farming on slopes upstream and undisturbed montane forest at higher elevations is optimum for conserving the full range of natural biodiversity present within the Crocker Range as well as protecting water quality.

PLATE 2
Montane forest in Crocker Range Park
Retaining forest cover between the Park and the village communities will serve not only to represent the full range of biodiversity in the Crocker Range but also protect sources of forest products used by the communities.

4.7 MAJOR THREATS

There are various threats to the conservation of biodiversity in the Crocker Range, both outside and inside CRP. The following list summarises the major threats. However, it is not easy to pinpoint which are direct and which are indirect, as they represent a complex of trends in economic and social change:

- Commercial logging in State land and alienated land outside CRP.
- Illegal logging inside CRP.
- Approval of land applications outside and near to CRP, where the land is unsuitable for use other than natural forest.
- Approval of land applications outside and near to CRP, where conversion of forest to other land use has adverse ecological impacts downstream.
- Road access (usually associated with logging) into the Crocker Range foothills.
- Swidden farming in areas not previously farmed (mainly Tenom Valley area).
- Drought.
- Fire, which may be set deliberately or accidentally on the fringes of or within the Crocker Range foothills forests.

In general, swidden farming in traditionally inhabited areas of the Crocker Range foothills does not appear to represent a significant threat to biodiversity conservation.

PLATE 3
The Crocker Range forests help sustain the supply of clean water to villages, wet rice fields and fish ponds such as those of the Sinsuran farm shown here.

PLATE 4
A relatively recent approach to land use in the foothills is plantation agriculture, but this carries high risks of significant soil erosion and landslides, with further negative impacts on water quality.

PLATE 5 AND 6

Traditional farming, including swidden cultivation of hill rice is generally compatible with watershed protection. This is exemplified at the upper Apin-Apin catchment shown here.

Traditional farming is characterised by small fields and rapid regrowth of woody vegetation after fields have been harvested and left fallow. Small scale manual clearance of secondary forest for farming minimises soil erosion hazards even on steep slopes.

PLATE 7, 8 AND 9

Scenes of logging activities in Ulu Bongawan demonstrate the high levels of soil disturbance, erosion and pollution of waterways that arise from building logging roads in the steep Crocker Range foothills.

Knowledge exists in Sabah on means to minimise such damage, in the context of sustainable forest management. It is unfortunate that unnecessarily careless logging practices persist in important water catchments that supply Sabah's west coast rice fields and rural communities.

PLATE 10 AND 11
The conversion of forest on the steep foothills of the Crocker Range to oil palm plantations causes serious erosion and degradation of stream systems in these areas.

(*Left*) Gullying and bank collapse in a young oil palm plantation, Ulu Membakut;

(*Below*) severely degraded stream channel within a recently developed oil palm plantation in Ulu Membakut.

Continuation of practices such as those shown in the pictures poses risks of 'mass wasting' of hill slopes into the Membakut catchment during rainy periods. The soil survey conducted under this study recommends against converting forest to plantations in the Ulu Membakut foothills. If conversion is to be allowed, developers need to be obliged by law to implement erosion control

measures.

PLATE 12 AND 13
Extraction of trees (September 1998) in the logged forest recovering from fire (March 1998), Ulu Membakut.

This area was until 1998 very significant in containing the last remaining extensive lowland dipterocarp forest in western Sabah. It is essential that a clear policy decision be made on future use of land in the Crocker Range foothills, in particular land covered in regenerating burned forest.

5. DISCUSSION

5.1 BIODIVERSITY CONSERVATION

Several rare plant species, such as some of those listed in Table 1, are likely to go extinct if all forest is eventually replaced with alternative land use up to the CRP boundary. Forest at low elevations on the west side of CRP is likely to be most valuable for biodiversity conservation.

In the absence of adequate information on the identity and distribution of the endangered plant species, an indirect approach is required for identifying areas for biodiversity conservation. It is suggested that a "buffer zone" around CRP be identified, incorporating physically sensitive zones and some areas of less than 500 feet altitude (see section 5.6 below). The concept is that by protecting those specific areas likely to be most critical for water catchment protection, plus some adjacent low altitude sites, the State not only maximises prospects for conserving biodiversity in Crocker Range, but also supports water catchment protection and soil conservation.

5.2 LAND USE POLICY

The first six out of eight threats to the biodiversity of the Crocker Range listed in section 4.7 could, to a large extent, be prevented or minimised by Government. This points to the absence of a comprehensive land use policy for the entire Crocker Range foothills between CRP and existing human communities.

There appears to be no formal government policy or plan regarding (a) appropriate use of land immediately outside the CRP or (b) long-term tenure of land immediately outside the CRP boundary.

In order to jointly protect water catchments, conserve biodiversity and make productive use of land suitable for cultivation, the primary need is for a policy on the use of land in the Crocker Range foothills outside CRP.

An approach to addressing land use policy in the Crocker Range foothills is proposed in sections 5.6 and 5.7 below.

5.3 FOREST FIRE IN CROCKER RANGE FOOTHILLS

It is particularly noteworthy that the most extensive and damaging forest fires around CRP are associated with forest which was not traditionally farmed, but which instead has been commercially logged. The worst forest fire, in terms of extent and intensity, and in devastating the last remaining true lowland dipterocarp forest in western Sabah, occurred in Ulu Membakut and Ulu Bongawan. The sources of the Ulu Membakut fire could not be ascertained during this study. However, the vast extent of forest burned within a short time suggests that fires may have been set deliberately in many sites. Ulu Membakut village residents suffered much damage in terms of crop loss and there is no evidence that resident farmers were the cause of these fires. In contrast, areas which have traditionally been used for extensive hill rice farming (e.g. Keningau to Tambunan) have not suffered from significant forest fires.

5.4 LOGGING

Commercial extraction of trees from the Crocker Range foothills to date has been equivalent to mining. This is because, as State land, the assumption had been made that eventually all this land will be converted to use other than forest. Thus, forest at Ulu Bongawan, for example, is reported to have been logged four times. Any further logging in the Crocker Range foothills is unacceptable, for the following reasons:

- Unless the land is definitely going to be converted to non-forest use and very robust crops, further damage to soil through tractor compaction, erosion and increased fire risk should not be permitted.

- Traditional hill rice cultivation is mutually exclusive to logging because, for sustainability, the swidden system depends on extensive tree cover and suppression of weeds.

- Other forms of non-tree cultivation (e.g. vegetables) depend on constant clean water supplies, which are damaged by logging on slopes.

- Oil palm is demonstrated in Ulu Membakut to be an unsuitable crop except on lower, gentle slopes, which constitute only a small percentage of the foothills, along scattered valleys.

- Hydrology and water quality downstream will be increasingly damaged, whereas demands on the Crocker Range to supply adequate good quality water will increase with the increasing human population and economic activities in the lowlands.

- Further logging in the absence of any treatment or catchment planning will leave the foothills covered in unproductive scrub and lalang grass. These will be of no benefit, and expose CRP to a constant risk of burning during future dry periods.

Trees were being felled and removed from forest burned in March 1998. If allowed to continue, this will ensure that forest cannot regenerate, and that the affected areas become erosion-prone wastelands.

5.5 KIMANIS – KENINGAU ROAD

Apart from the Crocker Range foothills, another part of the Crocker Range which is threatened by inappropriate use is the land along the Kimanis - Keningau road. Small farms of limited productivity are being developed along the roadside. No further expansion of these farms should be allowed. This is because the income that they generate to the farmers is trivial in comparison to the potential damage that loss of forest might generate for the broader community, in terms of exacerbating flood damage downstream (along the Pampang, Liawan, Bongawan and Kimanis Rivers) and damage to the Park ecosystem.

5.6 DEFINITION AND TREATMENT OF ENVIRONMENTALLY SENSITIVE ZONES OUTSIDE CROCKER RANGE PARK

There is clearly a need to identify specific zones in the Crocker Range foothills, outside CRP, which are the most "environmentally sensitive" and which should be retained under natural vegetation with minimal disturbance. Once identified, statutory control of land use should be imposed without delay on these "environmentally sensitive" zones (see section 5.7).

Ideally, "environmentally sensitive" zones should be defined based on detailed studies of soil, slope and hydrology. However, such studies are likely to be impractical in terms of the cost and time that they would take. Experience to date (e.g. at Ulu Membakut) is that forest may be removed for private commercial plantation investments, even where soil and slope are unsuitable, where erosion potential is very high, and where public water supply schemes downstream are being upgraded. Small-holders have not been penalised for removing forest along the Kimanis-Keningau Road, even in the headwaters of the Pampang and Liawan Rivers, the rivers which caused great loss of human life in the 26 December 1996 Hurricane Greg storm event. Thus, it is necessary to provide criteria for definition of "environmentally sensitive" immediately (before extensive damage is done) and in a way that can be readily identified and appreciated by all stakeholders.

Based on the hydrological and soil assessments done for this study, and an examination of topographical maps and aerial photographs, the following criteria and factors are used to identify land outside CRP which is likely to be the most "environmentally sensitive". This generally refers to land most likely to be important for water catchment protection, forest land unsuitable for farming and low altitude sites most likely to contain endangered plant species.

- For the west side of the Crocker Range, most land higher than 500 feet elevation above sea level should be regarded as "environmentally sensitive", due to prevailing steep slopes, high rainfall and thin topsoil, coupled with the need to protect domestic water supplies and rice fields downstream.

- On the east side of the Crocker Range, most land higher than 2,000 feet elevation above sea level should be regarded as "environmentally sensitive" for the same reasons as above. ("Environmentally sensitive" land is defined by a higher elevation on the east side because the settled land downstream is higher [2,000 feet at Tambunan and 1,000 feet at Tenom, compared to less than 100 feet on the west coast plains]. In addition, annual rainfall [the

main factor in soil erosion other than soil characteristics and slope] is lower on the east side.)

- Land outside the CRP boundary along the that section of the Kimanis - Keningau Road which bisects CRP should be regarded as "environmentally sensitive" due to high rainfall, steep slopes and poor soils.

- Some forest land in valleys below 500 feet should be retained on the west side, to incorporate habitat of known rare plant species.

Based on the above, "environmentally sensitive" zones in the Crocker Range foothills have been mapped at 1:250,000 scale (Map 3). Areas excluded from the highlighted zone are those that were noted at the time of this study (i) to be heavily degraded, (ii) to support intensive traditional farming and (iii) to be successfully cultivated with tree crops. This assessment should not be taken to imply that all other land outside CRP may be deforested, or can be converted to alternative use.

Apart from exceptions outlined below, land within the "environmentally sensitive" zones should remain under natural tree cover, irrespective of the ownership of the land.

Two kinds of exceptions may be permitted for non-forest use of "environmentally sensitive" zones in the Crocker Range foothills. Firstly, genuinely traditional farming may be permitted in those areas already settled and farmed. New settlements and farms should not be permitted. Traditional use may be defined as: cultivation of hill rice and vegetable crops associated with hill rice on plots less than 3 hectares in total contiguous extent; cultivation of mixed species fruit trees; and cultivation of rattan. A second exception may be where the owner of land within this zone is able to present to government a specific, properly researched and convincing plan for change in land use. The planned change must have no significant adverse impact on land occupants downstream, and should be beneficial to the local socio-economy.

MAP 3 CROCKER RANGE : PROPOSED CONSERVATION AREAS ("ENVIRONMENTALLY SENSITIVE ZONES")

5.7 STATUTORY PROTECTION FOR ENVIRONMENTALLY SENSITIVE ZONES

Statutory protection must be imposed on the "environmentally sensitive" zones if the concept is to be effective. Several possible options are available. Existing options, together with their strengths and weaknesses, include:

5.7.1 Native Reserve under Land Ordinance, 1930

This option has precedents for forest land and allows management decisions on land use to be made at local level. However, it is likely that different communities would have different views and approaches. This would make it difficult to ensure the necessary holistic approach to management of the various zones in different localities. Alienated land would need to be acquired, while approved applications for State land would have to be cancelled, leading to delays and the need for compensation payments.

5.7.2 Protection Forest Reserve under the Forest Enactment, 1968 and its amendments

This option was proposed by Sabah Conservation Strategy (1992) but is judged to be unsuitable, as it would prevent any form of human use of the forest or land. Also, alienated land would need to be acquired, while approved applications for State land would have to be cancelled, leading to delays and the need for compensation payments.

5.7.3 Park under the Parks Enactment, 1984

An extension could be made to the existing CRP, but this option is judged unsuitable, as it would prevent any form of human use of the forest or land. Also, alienated land would need to be acquired, while approved applications for State land would have to be cancelled, leading to delays and the need for compensation payments.

5.7.4 Conservation Area under the Cultural Heritage (Conservation) Enactment, 1997

This option is aimed primarily at sites of cultural, historical or natural heritage, rather than environment or biodiversity protection.

5.7.5 Conservation Areas under the Conservation Of Environment Enactment, 1996

This legislation is for "provisions relating to the conservation of environment" and is designed to allow measures to be taken for environmental protection where other options are difficult or impossible. This option would seem to be ideal for Crocker Range foothills outside CRP, where a mix of alienated land, State land and land under customary tenure are involved.

5.7.6 Sabah Water Resources Enactment, 1998

Since a major purpose and benefit of the protecting the "environmentally sensitive" zones is for water catchment protection, this option may be suitable. However, the date and means of implementation of this legislation have not yet been determined.

5.7.7 Summary

In summary, the Conservation of Environment Enactment would seem to be most suitable for the purpose of protecting and managing the "environmentally sensitive" zones of Crocker Range foothills.

5.8 REHABILITATION OF BURNED FOREST LAND

5.8.1 Need for rehabilitation

Most of the forest land on the west side of the Crocker Range which was burned in 1998, and certainly all that is within the "environmentally sensitive" zones (Map 3), is not suitable for plantation crops and should ideally remain under forest cover. It is best that these areas are left to regenerate naturally, but repeated logging has removed most seed trees.

In theory, leaving burned land to develop vegetation cover naturally, without any form of intervention, would be acceptable in terms of being the cheapest way to cover exposed soil. However, without any intervention the chances are high that burned land would degenerate to *lalang* grass and scrub. Such land is economically useless, almost impossible to rehabilitate for productive use at a later stage, and facilitates future fires escaping into CRP.

Measures to enhance prospects of forest regeneration should be decided and implemented before forest and soil conditions deteriorate further. In particular, all efforts should be made to prevent the spread of *lalang* grass into these areas, as this grass is almost impossible to eliminate once it has become widespread.

Individuals and companies that have been granted interests on land within the "environmentally sensitive" zones should take on much of the responsibility for stewardship of that land. This includes holders of licences to fell and remove timber from "environmentally sensitive" zones and applicants for land within the "environmentally sensitive" zones.

Among the key elements for successful rehabilitation are those outlined in sections 5.8.2 - 5.8.5.

5.8.2 Security of land status

For viability of purpose, any treatment of land requires long term security of the status of that land. This can be achieved adequately by statutory means such as use of the Conservation of Environment Enactment to establish "conservation areas".

5.8.3 Stakeholder consensus

It is necessary to carry out a process of consultation with main stakeholders associated with the "environmentally sensitive" zones. Their mutual understanding and support of the goal of rehabilitation is required if the risk of future uncontrolled fires is to be minimised.
Main stakeholders include those listed below:

- Representatives of farming communities downstream
- Owners of new oil palm plantations in and near the Crocker Range foothills
- Department of Irrigation and Drainage

- Department of Agriculture
- Department of Fisheries
- Representatives of village residents in the foothills near to burned areas
- Holders of licences to fell and remove timber from "environmentally sensitive" zones
- Buyers of timber from the Crocker Range foothills
- Sabah Forestry Department, including advisers from Forest Research Centre
- Applicants for land within the "environmentally sensitive" zones

5.8.4 Rehabilitation Plan

Piecemeal efforts at rehabilitation of burned forest land are unlikely to be successful. There must be a realistic rehabilitation plan, incorporating input from all the main stakeholders. Responsibility for implementing the plan needs to be determined.

5.8.5 Funds

Funds will be needed to implement rehabilitation. If security of land and support from main stakeholders can be assured, there is a possibility of seeking "carbon offset" funds. However, such "joint implementation" arrangements may not be endorsed by some government authorities and non-governmental organisations.

5.9 PREVENTION OF FUTURE FIRES

All possible steps should be taken to minimise the risk of future fires spreading into CRP and other areas of the Crocker Range which merit forest conservation measures. Since the most damaging fires in 1998 were clearly associated with logging and logging roads, the most important step will be to phase out all commercial logging from the Crocker Range foothills.

In order to reduce the risk of any future fires spreading into Crocker Range forests, opportunities should be investigated for creating fire breaks. Future land use in and around the Crocker Range foothills is likely to include a complex mix of forest, swiddens, orchards, homesteads and farms, and plantations. It will be impractical to form and maintain a uniform fire break around the entire Crocker Range. A practical approach may be to identify more precisely the areas to be retained under forest cover in the long term and to assess which of these zones are likely to be at highest risk from fire. Having done this it will then be necessary to decide upon a practical form of fire break on a zone by zone basis. For example, a clear oil palm-forest boundary may be adequate in some sites, while a physical break made by a bulldozer tractor and re-cleared during dry periods might be necessary at 'high risk zones'. The criteria for classifying 'high risk zones' and the different approaches to establishing fire breaks should be determined through further studies and consultation with experts in this field.

5.10 POSSIBLE INTRODUCTION OF ORANG-UTANS

Consideration may be given to the possibility of introducing orang-utans into the Crocker Range forests. The reasons for considering this include the following:

- The species was probably once more widespread throughout the Crocker Range but has declined due to hunting pressures (for example, according to local residents, the species was hunted in the Tambunan area in the early years of this century, but it is now extinct there). This indicates that the natural habitat is suitable to support orang-utans.

- There are orang-utans displaced permanently from forest land recently converted to plantations in eastern Sabah.

- Expertise for capturing orang-utans in one area and releasing them elsewhere exists in Sabah.

- Other sites where displaced orang-utans have been released previously (notably, Sepilok Forest Reserve and Tabin Wildlife Reserve) are probably full to carrying capacity.

This study recommends that the possibility of moving displaced orang-utans from eastern Sabah to the Crocker Range be discussed by relevant authorities (notably, Sabah Wildlife Department and Sabah Parks) and experts. The proposal might be rejected for any of a number of reasons. If it is deemed worth pursuing, no action should be taken to introducing orang-utans immediately. Before any such action is taken, it will be necessary to select specific potential areas for introduction, and to discuss the proposal with a wide array of people in the nearest villages. It should be stressed that there is a possibility that introduced orang-utans may raid crops. The proposal should be pursued further only if there is support from local residents for the idea, and strong indications that there will be community support for preventing the hunting of introduced animals.

6. CONCLUSIONS

If most land in the "environmentally sensitive" zones of the Crocker Range, outside CRP, is retained under natural forest cover, without further logging but with moderate amounts of traditional farming and orchards, then the following benefits will accrue:

- Most natural biodiversity would be conserved.
- Water supply and irrigation schemes downstream would be afforded a fair degree of protection.
- Productivity of rice and other traditional crops would be sustained.
- Natural forest would regenerate to supply cost-free local timber supply in the long-term future.

If most land in the "environmentally sensitive" zones of the Crocker Range, outside CRP, is allowed to be degraded through further logging, fire and forest clearance, then the following losses are likely to be incurred:

- Most natural biodiversity would be lost, including extinction of several localised plant species.
- Water supply and irrigation schemes downstream would be damaged, with loss of property (including wet rice fields), possible loss of life, and increased cost of water treatment.
- Productivity of traditional crops would decline and be lost in some areas.
- Natural forest disappears and future wood supplies would have to be purchased or foregone.

If land in the "environmentally sensitive" zones of the Crocker Range, outside CRP, is allocated for development, such as plantations, intensive farming or quarries, then the following losses are likely to be incurred:

- Most natural biodiversity would be lost, including extinction of several localised plant species.
- Water supply and irrigation schemes downstream would suffer damage, in addition to loss of property (including wet rice fields), possible loss of life, and increased cost of water treatment.
- The loss of aquatic life and significant reduction in freshwater fisheries downstream would be experienced.

7. RECOMMENDATIONS

7.1 IMMEDIATE PROTECTION MEASURES

In order to minimise the risks of further and irreversible damage to the proposed "environmentally sensitive" zones, immediate efforts should be made to prevent any further clearance of natural vegetation, any timber extraction and fire in these zones.

ACTION 1
Relevant authorities (Secretary of Natural Resources; District land authorities of Penampang, Papar, Beaufort, Tenom, Keningau and Tambunan; Forestry Department; Department of Agriculture) to be requested to reject all new applications and to freeze existing applications, permits and licences for land clearance and timber extraction in the environmentally sensitive zones shown in Map 3, pending the outcome of Actions 3 and 4, below. This recommendation refers to State land applied for under Country Land (CL) lease and under any kind of temporary occupation licence. The recommendation need not apply to land applied for and /or used under native customary tenure.

Implementation : Ministry of Culture, Environment and Tourism (MOCET) to write to the above authorities.

Timing : December 1998

ACTION 2
Ensure road access into Ulu Membakut and Ulu Bongawan is broken to prevent vehicle entry, as soon as any current licensed logging operations cease.

Implementation : Forestry Department to instruct all holders of licences for timber removal

Timing : December 1998

7.2 CHOICE OF SUITABLE MECHANISM FOR LONG-TERM PROTECTION

A consensus is required regarding the most suitable mechanism for long-term protection of the "environmentally sensitive" zones in terms of legislation and management authority. It is suggested that designation of the “environmentally sensitive zones” as conservation areas under the Conservation of Environment Enactment would be the most suitable option. Copies of this report should be submitted to the most relevant governmental authorities for consideration and comment. Ministry of Culture, Environment and Tourism (MOCET) and Department of Environment Conservation (ECD) should ensure that the relevant authorities meet and that a decision is made enabling the process outlined below to be followed through.

ACTION 3
Copies of this report to be submitted to: Secretary of Natural Resources; Director of Lands and Surveys Department; District Offices of Penampang, Papar, Beaufort, Tenom, Keningau and Tambunan; Forestry Department; Department of Irrigation and Drainage; Town and Regional Planning Department; and Sabah Parks. MOCET/ECD to request for comments on the recommendation to use “conservation areas” under the Conservation of Environment Enactment. MOCET / ECD to call a meeting at which a decision should be made on which agency (or agencies) is/are to carry forward the recommendations outlined below and which legislation will be most appropriate to provide statutory protection for the environmentally sensitive zones.

Implementation : MOCET

Timing : January 1999

7.3 APPROVAL FOR STATUTORY PROTECTION FOR ENVIRONMENTALLY SENSITIVE ZONES AROUND CROCKER RANGE PARK

Due to the large extent of forested land included within the "environmentally sensitive" zones (Map 3), it is considered necessary to seek Cabinet endorsement for applying statutory conservation measures.

ACTION 4
A paper on the need for statutory protection of the ‘environmentally sensitive’ zones to be prepared and submitted to cabinet. The paper would be based on this report and on comments made at the meeting held under Action 3.

Implementation : the lead agency, as determined as the meeting held under Action 3.

Timing : February 1999

7.4 DECLARATION OF CONSERVATION AREAS

It is assumed that the Conservation of Environment Enactment or some similar means to protect the "environmentally sensitive" zones is chosen which does not require acquisition of alienated land or cancellation of land applications. Based on decisions made under Actions 3 and 4, then all those parts of the Crocker Range outside CRP shown as "environmentally sensitive" on Map 3 should be provided with the approved statutory protection, which is recommended to be as “conservation areas” under the Conservation of Environment Enactment. Apart from exceptions outlined below, all land within the "environmentally sensitive" zones must remain under natural tree cover, irrespective of the ownership of the land.

The statutory designation of the "environmentally sensitive" zones should state that all land within these areas must remain under natural tree cover at all times except :

(a) for traditional use, defined as: cultivation of hill rice and vegetable crops associated with hill rice on plots less than 3 hectares in total contiguous extent; cultivation of mixed species fruit trees; cultivation of rattan; or

(b) where the owner of land within the zone is able to present to government a properly researched and convincing plan for change in land use which would have no significant adverse impact on land occupants downstream. In this case, the land owner must be able to present a specific plan for change in land use and to satisfy the relevant authorities that there are sufficient mitigation measures to counteract any adverse environmental impacts of any proposed change in land use.

ACTION 5
Areas shown in Map 3 as environmentally sensitive zones to be provided with statutory protection under the legislation approved under Actions 3 and 4.

Implementation : the lead agency, as determined as the meeting held under Action 3.

Timing : May 1999

***ACTION 6* :**
The government intention to provide protection for environmentally sensitive zones to be explained to residents in and near these zones.

Implementation : MOCET / ECD, in collaboration with the relevant District Offices and local community leaders.

Timing : June - September 1999

7.5 CONDITIONS OF LAND TITLE

It is assumed that a means is chosen to protect the "environmentally sensitive" zones that does not require acquisition of alienated land or cancellation of land applications. It would be advisable for the relevant authority to write to land-owners informing them of the additional condition of title and/or ensure that title documents are issued incorporating this condition.

ACTION 7 :
All existing owners of land within the environmentally sensitive zones to be informed in writing of the addition to conditions of title, and the exceptions applying to hill rice, mixed fruit trees and rattan.

Implementation : Director of Lands and Surveys

Timing : June 1999 onwards

The conditions imposed on any land titles issued in the future within and overlapping with the "environmentally sensitive" zones must include a statement that land use may not be altered from natural tree cover to different use without prior consultation with and approval by the Director of the statutory management authority.

The condition may be phrased as follows : "The land described in this title falls within a conservation area declared under (the Conservation of Environment Enactment). Notwithstanding any other terms or conditions of this title, the owner shall retain natural tree cover on this land at all times, except for cultivation of hill rice and vegetable crops associated with hill rice on plots less than 3 hectares in total contiguous extent; or cultivation of fruit trees of mixed species; or cultivation of rattan. The owner may apply to the Director (of the Department of Environment Conservation) for consideration to use the land for purposes other than the above, but such an application may not necessarily be granted."

ACTION 8 :
All new land titles within or overlapping with the environmentally sensitive zones must bear the additional condition stated above.

Implementation : Director of Lands and Surveys

Timing : June 1999 onwards

7.6 REHABILITATION SCHEME FOR BURNED FOREST LAND WITHIN ENVIRONMENTALLY SENSITIVE ZONES

A rehabilitation scheme for burned forest land within the "environmentally sensitive" zones can be initiated as soon as the process represented by Actions 3 - 8 are underway.

***ACTION 9* :**
Process of consulting main stakeholders (as listed in section 5.8.3) to be undertaken.

Implementation : the lead agency decided under Action 3.

Timing : July 1999

***ACTION 10* :**
Agency to prepare plan to be identified and (if necessary) authorised by Government.

Implementation : to be determined.

***ACTION 11* :**
Agency to implement plan to be identified and (if necessary) authorised by Government.

Implementation : to be determined.

***ACTION 12* :**
Source of funds to implement plan to be identified and (if necessary) authorised by Government.

Implementation : to be determined.

7.7 FIRE BREAKS TO PREVENT FUTURE FIRE DAMAGE

Fire breaks should be planned for, particularly in 'high risk zones' around the Crocker Range in order to allay the potential of future destructive forest fires within and outside Crocker Range Park.

ACTION 13
An assessment to be conducted to identify likely high fire risk zones around the Crocker Range foothills. Suitable forms and locations of fire breaks to be identified.

Lead agencies: Sabah Parks in consultation with Sabah Forestry Department
Supporting agencies: Department of Environment and Conservation (ECD) and District Offices.

Timing : June 1999

7.8 EXPANSION AND USE OF THE CROCKER RANGE GEOGRAPHICAL INFORMATION SYSTEM

The geographical information system (GIS) initiated for this study has the potential to be expanded, enhanced and used for long-term environmental management of the Crocker Range

ACTION 13 :
Government of Sabah to acquire the computer software and data base, and to expand and utilise for management of Crocker Range and downstream land.

Implementation : MOCET / ECD

Timing : any time

7.9 DISCUSSION ON POSSIBLE INTRODUCTION OF ORANG-UTANS

ACTION 14 :
Relevant authorities and experts to discuss merits, constraints and problems associated with introduction of orang-utans from elsewhere into the Crocker Range forests, as outlined in Section 5.9.

Implementation : Sabah Wildlife Department

Timing: any time

REFERENCES

Davies, G. & Payne, J. (1982) *A Faunal Survey of Sabah*. WWF Malaysia, Kuala Lumpur.

Meijer, W. & Wood, G.H.S. (1964) *Dipterocarps of Sabah (North Borneo).* Sabah Forest Record No. 5, Forestry Department, Sandakan.

Payne, J. (1988) Orang-utan Conservation in Sabah. WWF Malaysia, Kuala Lumpur.

Payne, J. & Andau, P.M. (1997) *The Orang-utan in Sabah - an endangered species.* The Journal of Wildlife Management and Research, Sabah. 1:40-46.

SCS (1992) *Sabah Conservation Strategy*. Report prepared by WWF Malaysia for Ministry of Tourism and Environmental Development.

Soepadmo, E., Wong, K.M. & Saw, L.G. (1996) *Tree Flora of Sabah and Sarawak. Volume Two*. Forest Research Institute Malaysia, Sabah Forestry Department and Sarawak Forestry Department, Kuala Lumpur.

IPPA BACKGROUND PAPERS

1 Davison, G.W. (1998) *Wildlife Surveys around the Crocker Range Foothills*. SBCP-IPPA Specialist Study.

2 Mohd. Saini bin Suliansa (1998) *Some Aspects and Status of Fisheries at Ulu Membakut, Crocker Range Foothills.* SBCP-IPPA Specialist Study.

3 Greer, T. (1998) *Hydrological Assessment of the Crocker Range.* SBCP-IPPA Specialist Study. SBCP-IPPA Specialist Study.

4 Paramanathan, S. (1998*) Assessment of soils, Ulu Membakut area, Papar and Beaufort Districts.* SBCP-IPPA Specialist Study.

5 Lye, T.P. (1998) *Report on the sociological needs of Ulu Membakut, Crocker Range.* SBCP-IPPA Specialist Study.

6 Payne, J. (1998) *Report on Aerial Survey of Crocker Range, 25 August 1998*. SBCP-IPPA Specialist Study.

APPENDIX 1 ESTABLISHMENT OF CROCKER RANGE FOREST RESERVE

The Crocker Range Forest Reserve was established through State government gazette notification No. 596 of 1969, under section 12 of the Forest Enactment 1968, which declared the Reserve to be effective as of 25 September 1969.

The gazette notification states : "The inhabitants residing in the districts of Beaufort, Keningau, Kota Kinabalu, Papar, Penampang, Ranau, Tambunan, Tenom and Tuaran have been conceded the privileges subject to the general provision of any Rules made under section 42 of the Forest Enactment

- (i) of cutting in and removing from the said land any timber, atap or other forest produce which may be necessary (a) for the construction or repair of any dwelling house for the abode of any such native and his family, (b) for the construction of fences and temporary huts on any land lawfully occupied by any such native, (c) for the construction and repair of native boats, (d) for the upkeep of fishing stakes and landing places owned or used by any such native, (e) for firewood for domestic purposes of any such native, or (f) for the construction and upkeep of any work for the common benefit of the native inhabitants of any kampong in the above-mentioned districts,
- (ii) of collection (of) minor forest produce from the said land for sale, (iii) of fishing in any river in the said land, and (iv) of hunting in the said land subject to the provisions of the Fauna Conservation Ordinance No. 11 of 1963."