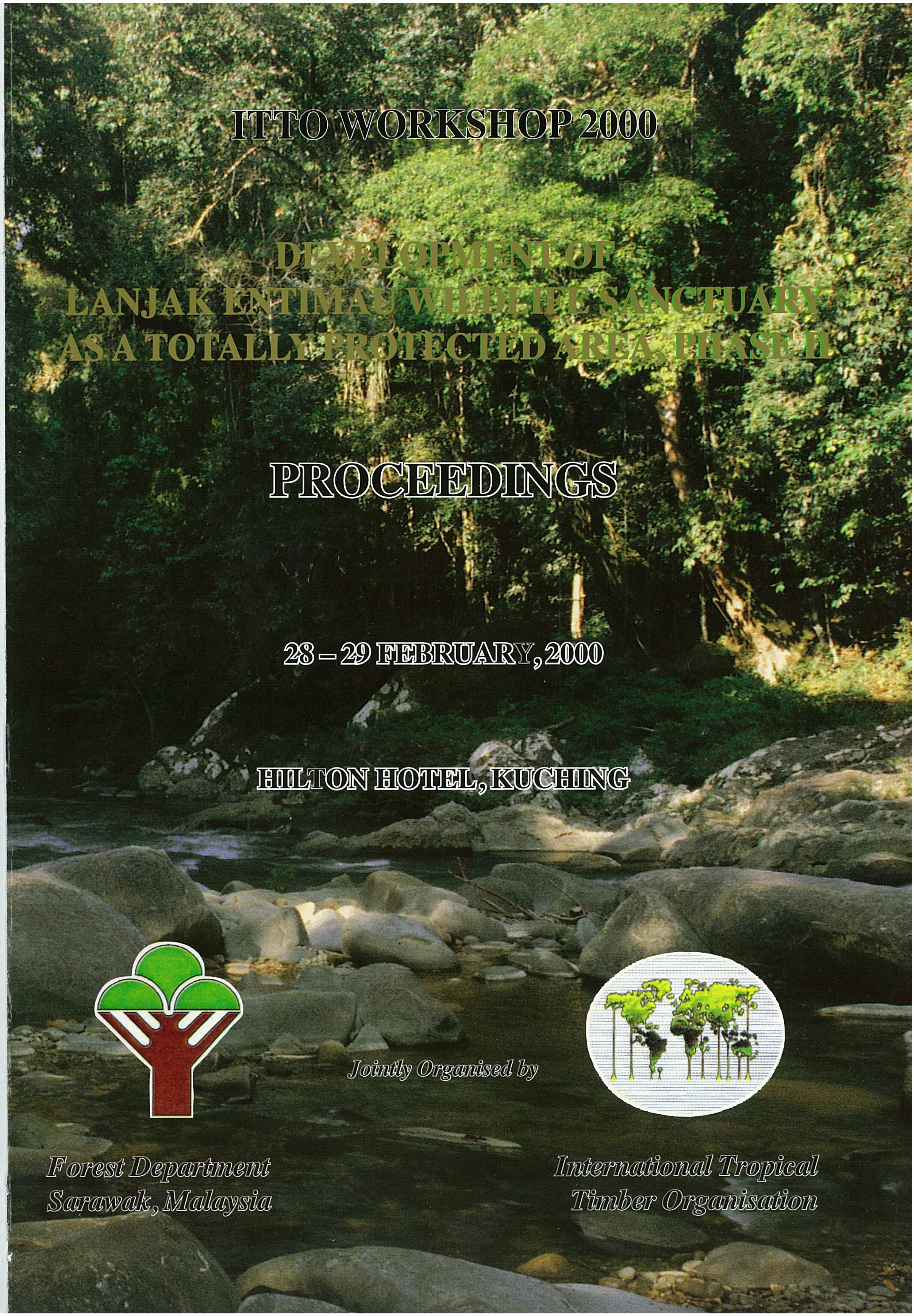

ITTO WORKSHOP 2000

DEVELOPMENT OF LANJAK ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA, PHASE II

PROCEEDINGS

28 – 29 FEBRUARY, 2000

HILTON HOTEL, KUCHING

Jointly Organised by

Forest Department
Sarawak, Malaysia

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Timber Organisation

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PROCEEDINGS OF ITTO WORKSHOP 2000

DEVELOPMENT OF LANJAK ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA PHASE II

Edited by

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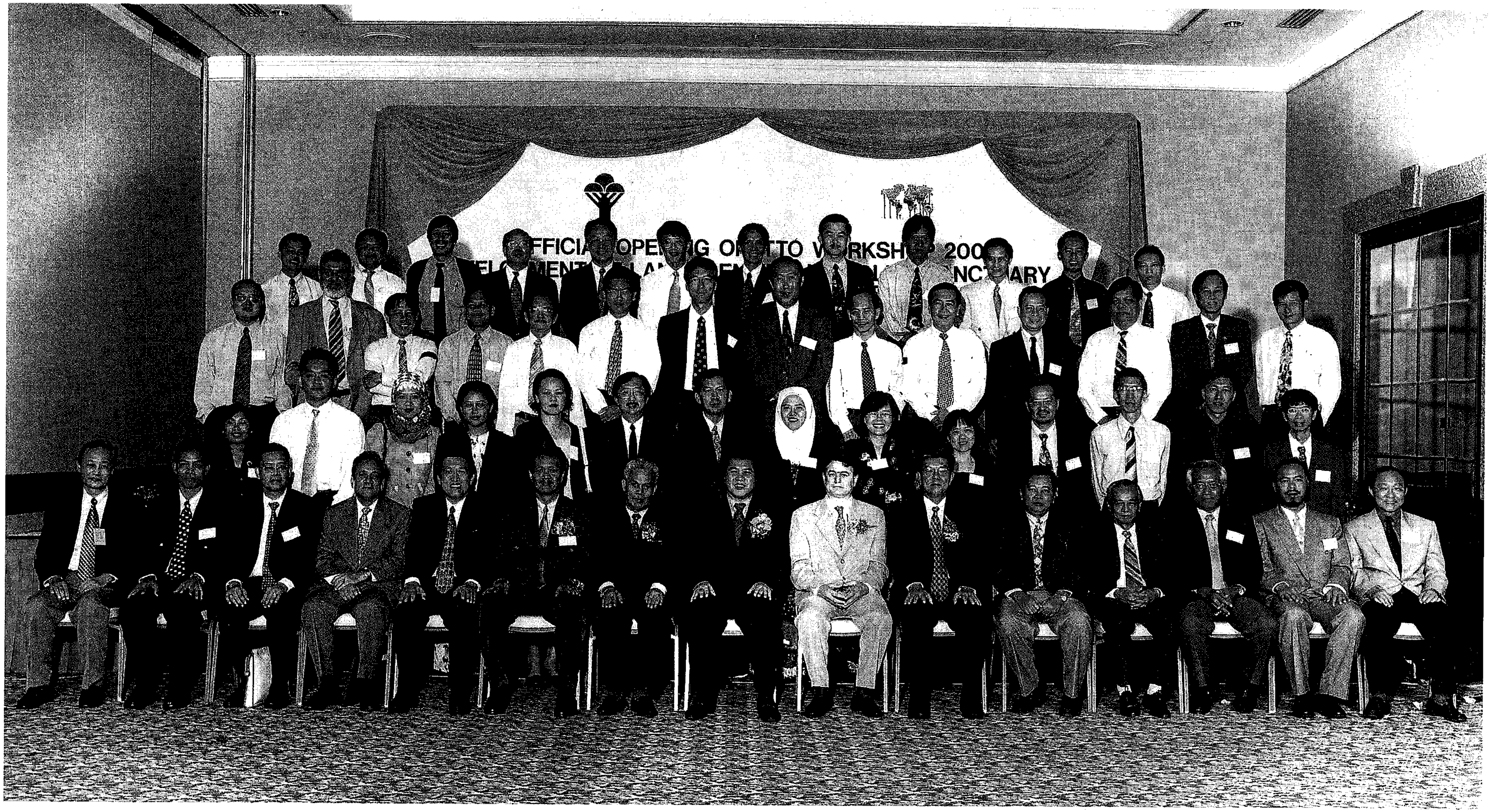

Participants with Assistant Minister, Yang Berhormat Datuk Awang Tengah Bin Ali Hasan

ITTO Workshop 2000

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FOREWORD

Following the recommendations of the ITTO Mission on "The Promotion of Sustainable Forest Management – A Case Study in Sarawak, Malaysia", the ITTO has approved six projects for implementation in Sarawak beginning in 1993. One of the six projects is the conservation of the biological diversity, maintenance of ecological balance, preservation of a complete range of habitats, and investigation into the ecology and biology of key plant and animal species. This conservation project is designed to ensure that a full range of biological diversity in the State is adequately preserved.

Lanjak Entimau Wildlife Sanctuary, being the largest Sanctuary in Sarawak and having a rich fauna diversity, wide spread habitats with rich dipterocarp forest, unusual habitats with rare, endemic and endangered species, was chosen for the *in situ* conservation project. The project, "Development of Lanjak Entimau as a Totally Protected Area" which commenced in 1993 has undergone two phases. Phase II has just been completed. Phase III of the project which will focus on supporting the community development activities relating to conservation and sustainable forest management.

As an output of the project, the ITTO jointly with the Sarawak Forest Department would organise workshops to examine the findings of the various activities with a view to refining and improving the strategies in the sustainable use of the natural resources. An International Seminar on the "Development and Management of Lanjak Entimau Biodiversity Conservation Area" was organised for Phase I in 1996. This two-day workshop would provide an insight into the rich biological diversity of LEWS and other aspects of its living resources and community related activities.

I am very privileged that the workshop was officiated by YB Datuk Awang Tengah Bin Ali Hasan, the Assistant Minister of Planning and Resource Management/Assistant Minister of Rural and Land Development. The presence of Dr. Sobral, the Executive Director of ITTO, and YBhg. Datuk Wira Abdul Rahman, Deputy Secretary-General of Ministry of Primary Industries highlighted the commitments of ITTO and the Federal and State Governments respectively to conserve the rich and diverse resources in the state.

I wish to express my thanks and appreciation to Mr. Penguang Manggil for his role as the ITTO Projects Coordinator, Sarawak; the Chairmen and members of the Organising Committee and the Sub-committee; Session Chairmen and Rapporteurs; Speakers, and the staff of the Forest Deparment, Protocol office and Hilton Hotel for their contributions towards the successful organisation of the Workshop; and Miss Chiang Moi Sien and Miss Angelia Muri who had painstakingly typed the final proceedings.

Cheong Ek Choon
Director of Forests
Sarawak

Date: 14 April, 2000

OPENING CEREMONY

WELCOME ADDRESS BY DR LEE HUA SENG, DEPUTY DIRECTOR OF FORESTS, SARAWAK

YB Datuk Awang Tengah Ali Hasan
Assistant Minister of Planning and Resource Management/
Assistant Minister of Rural and Land Development Sarawak

YBhg Datuk Wira abdul Rahman Jamal
Deputy Secretary-General
Ministry of Primary Industries, Malaysia

Dr. Manoel Sobral Filho
Executive Director of ITTO

Mr. Haryadi
Head of Indonesian Delegation

Mr Rahim Sulaiman
Deputy Director of Forestry, Sabah

Invited Guests, Ladies and Gentlemen

It is my great pleasure to welcome you all to the opening of this Workshop, and especially to YB Awang Tengah who has kindly consented to declare the Workshop open this morning.

I would like to express our sincere thanks to Dr Manoel Sobral, Executive Director of ITTO for his presence here today and for delivering a keynote address in this morning's session. In the last ten years or so, Malaysia has sought the support of ITTO in financing projects in the Peninsula, Sabah and Sarawak. In Sarawak, ITTO has so far financed six projects related to sustainable forest management. ITTO's support are mainly in the form of providing expertise in various fields. In this respect, ITTO has been encouraging the use of local specialists in the implementation of projects. I would also like to take this opportunity to gratefully acknowledge the generous support given by the Federal Government through the Ministry of Primary Resource (KPU) in providing logistics and infrastructure. KPU is a signatory to all the Malaysian projects funded by ITTO.

The project on the Development of Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area commenced in 1993. It has since undergone two phases, with Phase II ending in April, 2000. Phase III has been approved for implementation. At the end of each phase, a Workshop is organised to present the findings of the various activities to exchange views and to develop ideas and strategies for the Sanctuary's management by the executing agency. The first workshop was successfully organized in 1995 to discuss the findings and the management plan prepared at the end of Phase I. During this workshop, findings from Phase II will be presented.

Please allow me to list a number of significant achievements from the Project. Firstly, with the discovery and documentation of an extremely rich flora and fauna, Lanjak Entimau

Wildlife Sanctuary has become an important centre for conservation in Sarawak. Secondly, through the effort of the State Government and ITTO, Lanjak Entimau Wildlife Sanctuary became an integral part of the Trans-boundary Conservation Area with Betung Kerihun National Park in West Kalimantan in 1994. This trans-boundary reserve of one million hectares will become an important centre for conservation and research in Borneo. Thirdly, many officers of the Forest Department who participated in the project as counterparts and assistants have greatly benefited from the training particularly in the field of biological resource inventories and research techniques. Fourthly, Lanjak Entimau Wildlife Sanctuary is serving as a model where conservation and economic development can be integrated through sustainable utilisation of natural resources.

The Sanctuary is also the first TPA in the State where the active participation of the local communities in management is emphasised through the Special Wildlife Committee formed under the Department. As the executing agency of this and other ITTO-financed projects on sustainable forest management, the Forest Department will continue to give its full support in ensuring the smooth implementation of each project.

Lastly, I would like to express my appreciation to the Organizing Committee and members of the Department who have helped to organize this Workshop.

KEYNOTE ADDRESS BY DR. MANOEL SOBRAL FILHO
EXECUTIVE DIRECTOR
INTERNATIONAL TROPICAL TIMBER ORGANIZATION (ITTO)

Distinguished Participants,
Ladies and Gentlemen,

I am very pleased to have the opportunity to address this gathering today, because it will be discussing the achievements and the scientific results of what might be considered the most important ITTO-supported conservation project in Malaysia: the Lanjak Entimau Wildlife Sanctuary.

It may be recalled that this project was designed following the ITTO independent Mission to Sarawak in 1990, which found that the totally protected area network was inadequate to preserve the full range of biological diversity in the state. It encouraged the State Government of Sarawak to develop project proposals for submission to the ITTO for assistance to expand the State's protected area.

But before I say more about Lanjak Entimau, I would like to say a few words about ITTO for the benefit of participants not familiar with the Organization.

The International Tropical Timber Organization was established in 1986 under the International Tropical Timber Agreement of 1983. The ITTA of 1983 was a commodity agreement negotiated under UNCTAD, but a rather unconventional one where conservation and trade were accorded equal importance, under the underlying concept of using the tropical timber industry and trade to manage and thus conserve its own resource basis, the tropical forest. A successor agreement was successfully negotiated under UNCTAD in 1993/1994 and adopted in 1994. The ITTA 1994 strengthens the provisions for mutually-supporting conservation and development action, and entrenches ITTO 2000 Objective firmly within its text. To this end, a special fund, the Bali Partnership Fund, has been established under the agreement to provide the needed assistance to producer countries.

ITTO has several functions. Firstly, it provides and effective framework for consultation and cooperation. ITTO's Council and Permanent Committees provide the mechanism for bringing the producer and consumer sides of the tropical timber economy into active and continuing dialogue, which has proved to be a most effective way of reaching firm policy decisions. This is well demonstrated by the adoption of what has turned out to be the fundamental policy of ITTO – its Year 2000 Objective, which was itself the culmination of several other initiatives undertaken in the early days of the Organization.

From the beginning, ITTO focused its policy on the promotion of sustainable forest management. In 1988 the Organization implemented a study to assess the extent to which tropical forests were being managed on a sustainable basis. This study disclosed that very little of the world's tropical forests were being managed to sustainable standards and showed the enormous magnitude of the problem, but also pointed the way towards improvement.

The conditions which it found to be governing the administration of those forests which did qualify as sustainably managed – stability of tenure, effective planning and implementation of yield control and harvesting, for example – were the clues as to what had to be done. However, the methods for achieving these conditions tended to be quite specific to the countries in which sustainable management was found to be working, so they had to be incorporated into systems of general and practicable guidelines. This led to the development of the ITTO guidelines for the practice of sustainable forest management.

By 1992 four sets of operational guidelines for achieving sustainable forest management had been developed and adopted by Council. The first, for the management of natural tropical forests and thus applying to the greater part of the resource, dated from 1989. It was followed over the next couple of years by a set of guidelines for tropical forest plantations and a set for the conservation of biodiversity in tropical production forests. The fourth set, on prevention and management of fire in tropical forests was completed early in 1997, while a fifth – on the rehabilitation of degraded forest land – is currently under development.

Within this policy frame for work towards sustainability, ITTO is promoting groundwork action and financing over 200 national and regional projects in tropical timber producing countries in Africa, Asia Pacific, and Latin America/Caribbean region.

Most of these projects are promoting sustainable forest management through direct work with field foresters in training and demonstration projects. Currently, nearly all ITTO producer member countries are co-financing with ITTO the implementation of sustainable forest management operations in several demonstration forests which are protected and being brought under management by government agencies and in some cases conservation NGOs.

The relevance of ITTO's involvement in conservation reserves such as Lanjak Entimau might seem open to question in view of the Organization's forest management and trade orientation. The link, however, is far from tenuous. The starting point for a sustainable timber trade is a land use policy on which sustainable forest management can firmly be based. A key element of this is the identification and reservation of totally protected areas where environmental, conservation and social values are paramount. Thus, national parks, sanctuaries or biosphere reserves are not peripheral to ITTO's mandate, they are at its heart.

Lanjak Entimau is in fact part of a larger conservation reserve that straddles the border between Malaysia's Sarawak and Indonesia's West Kalimantan. The development of this reserve was achieved by an extraordinary degree of cross-border co-operation between the two countries, in which ITTO acted as a catalyst and facilitator. The Lanjak Entimau Wildlife Sanctuary in Sarawak has been supported by the ITTO Project PD 106/90 (F) and PD 15/95 (F), while the Betung Kerihun National Park in West Kalimantan is supported by the ITTO Project PD 26/93. Together, the Lanjak Entimau/Betung Kerihun Biodiversity Conservation Area covers a total area of almost one million hectares. It is perhaps the world's largest cross-boundary conservation area of tropical rainforests providing a unique opportunity for joint management to enhance its conservation value.

Discussion among members of the ITTO and during the Indonesia/Malaysia bilateral forestry co-operation dialogue gave birth to the idea of conducting a joint scientific expedition as an additional concrete step in implementing co-operation in the biodiversity conservation area. ITTO approved and provided financial resources to undertake such a scientific expedition at its Twentieth Council Session held in May 1996. The venture was named "ITTO Borneo Biodiversity Expedition 1997".

The Expedition involved biologists, anthropologists and social scientists from Indonesia and Malaysia and from the World Conservation Union, the International Plant Genetic Resource Institute, and the Royal Geographical Society of London. It was conducted in a very high spirit of co-operation and consequently yielded some very valuable information. It has, for example, greatly increased our scientific knowledge of the rich flora and fauna of the area. It has also led to a better understanding of the human communities in the area, which will provide a stronger basis for developing a comprehensive plan to manage the trans-boundary conservation area.

We are all proud of the joint conduct of the Borneo Expedition and of its main publications – a popular version and a scientific version of the report of the expedition's findings. The complete identification and cataloguing of the specimens collected during the expedition will take many years, as will the analysis and synthesis of the results. Nevertheless, it is apparent that the scientific understanding of the rainforest ecosystem will be of considerable importance to scientists and forest policy makers, not only in the region but throughout the world. The attributes of the huge conservation area – its large size, intact ecosystem, secure tenure, stable social and political systems, physical infrastructure, existing local research institutions, indigenous knowledge of biodiversity and its use among the local communities – make it a prime candidate to become a global center for field studies of tropical rainforest biodiversity. Indeed, IUCN's Dr. Don Gilmour said as much during the Borneo Expedition.

Malaysia's co-operation with Indonesia for the joint management of Lanjak Entimau and Betung Kerihun, which has also been undertaken under the Indonesian/Malaysian bilateral co-operation programme has opened new and exciting dimensions in trans-frontier co-operation. One should not underestimate the progress, both scientific and political, which we have made.

I also hope that ITTO will continue to expand its role in the establishment and management of trans-boundary conservation areas. Totally protected trans-boundary areas are an essential part of sustainable forest management for more than simple conservation reasons. They are also very important in helping to prevent and monitor illegal trade, which is within the mandate of ITTO. So right now we are working with the Government of Thailand to assist with the management of a conservation area on the border between Thailand and Cambodia, and with Ecuador and Peru to establish a trans-boundary conservation area on the border between those two countries. This later project will have the additional benefit of contributing to peace, because the area to be conserved is in the formerly disputed region between the two countries. Personally, I hope that within four years the area of conservation reserves developed with assistance from ITTO will have grown from its current 1.5 million hectares to around five million hectares. That would be quite rewarding.

I do wish to end my address to you today with an additional optimistic view: progress towards development and conservation of forests in Asia to a large extent depend on you, the Asian forest professionals, and we trust your ability and competence to deliver. Contrary to some of the other international development aid organizations, which rely mostly on foreign consultants to assist implementation of the projects they finance in the region, ITTO provides for the engagement of local experts, as we consider that local forestry experts are highly qualified professionals.

ITTO forestry projects in Asia are totally your projects: you identify the problems, propose the solutions, formulate the projects to deliver the identified solutions, and ITTO finances them. You have the control over their implementation and we are together responsible for their success. I am very proud to report that at ITTO headquarters, we have only 15 professionals overseeing the implementation of over 200 field projects, of which about 50 are in Asia, employing close to 150 professionals on a full-time basis.

We are partners, and it is as a partner that I wish to thank the Sarawak Forestry Department and Director Cheong Ek Choon for the excellent arrangements made for this Workshop. An impressive array of speakers and professionals have been assembled here. I have every confidence that the Workshop will generate ideas and guidelines to assist and advance us in our search for better ways and means to promote conservation of forest resources in Sarawak, Malaysia and in other tropical countries in the region.

Thank you.

ADDRESS AND OFFICIAL OPENING
BY
YB DATUK AWANG TENGAH BIN ALI HASAN
ASSISTANT MINISTER PLANNING & RESOURCE MANAGEMENT/ ASSISTANT MINISTER OF RURAL & LAND DEVELOPMENT

Ybhg. Datuk Wira Abdul Rahman Jamal
Deputy Secretary-General, Ministry of Primary Industries,
Malaysia

Dr. Manoel Sobral Filho, Executive Director of ITTO, Yokohama,

Dr. Lee Hua Seng, Deputy Director of Forests, Sarawak,

Mr. Haryadi, Head of Indonesian Delegation,

Mr. Rahim Sulaiman, Deputy Director of Forestry, Sabah,

Invited Guests,

Ladies and Gentlemen,

As many of you are aware, our Chief Minister YAB Datuk Patinggi Abdul Taib Mahmud was very concerned with the sustainability of our forests. At the 6th Session of the International Tropical Timber Council Meeting which was held in Abijan, Ivory Coast on May 1989, and on behalf of the Malaysian Government, he personally invited the Council to undertake a study on Sustainable Forest Management in Sarawak.

In response to the invitation, the ITTO fielded a Mission to Sarawak between 1989 and 1990. The Mission had the task of:

- assessing the sustainable utilization and conservation of tropical forest and their genetic resources;
- identifying actions to be taken for proper and effective conservation and development of tropical timber forests to ensure their optimum utilization while maintaining the ecological balance;
- recommending actions for further strengthening of Sustainable Forest Management, policies and practices, including areas in which international co-operation and technical assistance will be helpful for achieving sustainable management of the resource and environment.

The Mission in its report, "The Promotion of Sustainable Forest Management – A Case Study in Sarawak, Malaysia" recommended, among others, the immediate action to protect the full range of habitats and biological resources in Sarawak in view of its rich and varied flora and fauna.

Lanjak Entimau Wildlife Sanctuary with an area of 168,758 hectares of pristine rainforest which are largely undisturbed, was selected for the *in situ* natural resources conservation and biological resources research in 1991. Besides being the largest totally protected area in Sarawak, it is particularly rich in fauna diversity and is a refuge for about 1,000 orangutan; a widespread habitats with rich dipterocarp forest which could be a possible source of genetic stock, and unusual habitats with rare, endemic or endangered species.

One very significant achievement by the State Government of Sarawak and ITTO in this region is the realization of the Trans-boundary Conservation Area which links Lanjak Entimau Wildlife Sanctuary in Sarawak and Betung Kerihun National Park in West Kalimantan, Indonesia. The Trans-boundary Conservation Area with a combined area of about one million hectares is the largest in the tropical world. It was launched by our Chief Minister and the then Indonesian Minister of Forestry at Batang Ai on 7th October 1994. The establishment of this conservation area is a positive move towards a bilateral conservation of biological resources between Malaysia and Indonesia and signifies the two governments' commitment in natural heritage and sustained development. Such collaboration is believed to be the first of its kind in the tropics. This new concept of Trans-boundary biological resources conservation is now being picked up by other countries such as Ecuardo and Peru, and Thailand and Cambodia.

During the past six years or so, the ITTO working together with the Sarawak Forest Department which is the Executing Agency of the Project, entitled "Development of Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area" have successfully completed research studies under Phase I and Phase II. The findings of the Phase II studies are to be presented to you in this workshop.

It is to be noted that Sustainable Forest Management and timber certification constitute an important part of the performance standards of ITTO Criteria and Indicators. In view of the tremendous economic potential of our timber industry, there is a need to enhance timber certification and to achieve the ITTO's year 2000 objectives to promote the State's timber and timber products in the global market. The protection of conservation area is part and parcel of Sustainable Forest Management in accordance with the said ITTO Criteria and Indicators and the Malaysian Criteria and Indicators. Thus, the implementation of the Lanjak Entimau Wildlife Sanctuary project is towards enhancing Sustainable Forest Management in Sarawak.

Sarawak has been in the forefront of ITTO due to its commitment to Sustainable Forest Management and participation in the recent ITTO Expedition jointly with Indonesia. The ability to implement projects smoothly has prompted continuous financial support from donor countries.

The Chief Minister has taken the first and a very courageous step to invite the ITTO to Sarawak to assess the sustainability of our forests. To date, three projects have been implemented while three others are on-going. Phase I and Phase II of the Lanjak Entimau Project could not have been smoothly and successfully implemented without the commitment and financial support of both the Federal and State Governments. Equally generous and committed to Sustainable Forest Management and biological resources conservation are Japan, Denmark and Switzerland who funded the projects. The close rapport and understanding between the ITTO Secretariat and the Sarawak Forest Department has facilitated the technical and administrative procedures. I am glad to note that Sarawak has secured approval of the Federal and State Governments to continue the project under Phase III. Phase III will focus on supporting the community development activities relating to conservation and Sustainable Forest Management. The perception of the local communities towards creation of totally protected areas is most encouraging as they now realise the many benefits that could be derived through forest protection and conservation.

Another aspect of the project which I would like to mention and I am very happy to note is the employment of Malaysians particularly the Sarawakians as consultants. This puts our own people at par with the expatriates and proves that they can also do a good job if given the opportunity to do so.

Before I conclude I would like once again to thank the ITTO, the Federal Government and the Sarawak Government for the roles they each plays in the implementation of the project.

I hereby declare the ITTO Workshop on Lanjak Entimau Wildlife Sanctuary open.

WORKSHOP SESSION I

FLORA INVENTORY

CHAIRMAN	:	DR. EFRANSJAH
RAPPORTEURS	:	MS. RUNI SYLVESTER PUNGGA MISS MOHIZAH BT. MOHAMAD

Inventory of Vascular Plants

by
Paul P.K. Chai
Forest Ecologist
LEWS Project, ITTO
Sarawak

and

Stephen P. Teo
Forest Botanist
Forest Research Centre
Forest Department, Sarawak

Abstract

Lanjak Entimau Wildlife Sancutary (LEWS) is known to possess eight distinct forest types. This wide range of habitats support a flora that is extremely diverse. To-date 1,114 species of vascular plants representing 125 families have been recorded from this and three other previous inventories. Together with the data obtained from ecological studies, LEWS now has a total of 2,807 species of vascular plants comprising 1,896 trees and 911 non-trees. The significance of the flora in biodiversity conservation is discussed.

1.0 INTRODUCTION

Borneo has been acknowledged as one of the most important centres of plant diversity in the world and is conservatively estimated to harbour between 12,000 and 15,000 species of vascular plants, representing about 5 to 6% of the world total (Merrill, 1950). Of these, 40 to 50% are endemic to the island, and up to 80% of the endemic species in Borneo occur in Sabah and Sarawak (Soepadmo, 1995). Unfortunately, Sarawak is represented by one of the lowest collection densities of herbarium specimens of any place in the world and documentation of the flora is still far from satisfactory. As of 1997 about 80,000 collections had been made under the Sarawak Forest Department label, giving Sarawak a collection density of 61 specimens per 100 square km (Pearce, 1999).

For Lanjak Entimau, botanical expedition only commenced in March 1974 when the area was visited for the first time by the Botany Unit of the Forest Department in one of their annual collecting programmes. A total of 391 specimens were collected, and a number of new species discovered. LEWS was gazetted as a Totally Protected Area (TPA) in 1983 covering an area of 168,758 hectares and protects a significant portion of the State's remaining virgin forest. In June and July 1993, botanists involved in the preparation of taxonomic accounts for the Tree Flora of Sabah and Sarawak made an expedition to LEWS. A total of 618 herbarium specimens, representing 550 different species were collected. During Phase II of ITTO Project, over 2,000 specimens were collected.

2.0 OBJECTIVES

The objectives of the floristic inventory are as follows:

- to obtain as much baseline data as possible and to store these data in a database to facilitate its retrieval and analysis;
- to produce as complete a list as possible of the plant species currently known to be present in LEWS;
- to investigate the habitat range, rarity and endemism of species found in LEWS, and
- to recommend ways to conserve and manage the flora of LEWS for the future.

3.0 METHODOLOGY

The flora inventory was carried out over a period of approximately six months covering all the major habitats such as lowland mixed dipterocarp forest, old secondary forest, alluvial forest, riparian forest, submontane forest and montane forest. The ITTO Borneo Biodiversity Expedition in 1997 (IBBE 1997) added further information to the flora.

Standard herbarium collection procedures were used, whereby up to six replicates of each flowering and/or fruiting plant specimen were collected. For each collection, full notes were taken as to its location, habitat and characters such as habit, height, diameter, the colour of bark, flower and fruit.

Specimens were identified to family and generic level in the field where possible. Details of its local name and uses (if any) were noted where available or relevant.

The specimens were pressed, dried, mounted, labelled and later identified to species level (where possible) in the herbarium.

4.0 FINDINGS

4.1 Collections

Todate the total number of herbarium specimens collected from LEWS including the present inventory and IBBE (1997) now stands at 3,500 representing 125 families and 1,114 different species. The five most commonly collected families are Rubiaceae (91 species), Euphorbiaceae (85 species), Palmae (68 species), Melastomataceae (42 species) and Zingiberaceae (41 species). The flora of the major forest types are highlighted below.

4.1.1 Lowland Mixed Dipterocarp Forest (LDF)

This forest has a dominance of dipterocarps comprising up to 30% of the total number of species recorded. Up to 56 species of the Dipterocarpaceae were recorded from the present inventory with species of *Shorea* forming the bulk. Members of *Dipterocarpus* and *Vatica* are less common while only one species of *Aniosptera (A. costata*) was encountered. Non-dipterocarp emergents include *Sindora* sp., *Diospyros laevigata*, *Gironniera subaequalis*, *Polyathia hypoleuca*, *Ochanostachys amentacea* and *Neoscortechinia kingii*.

Trees and shrubs of the lower storeys belong mainly to members of the Euphorbiaceae, Melastomataceae, Myrsinaceae, Ochnaceae and Rubiaceae. Palms and climbers (including rattan) are common (Table 1).

Table 1 Common palms of Lowland MDF

Areca minuta	*Ceratolobus* sp.
Arenga undulatifolia	*Korthalsia* sp. nova
Calamus caesius	*Licuala pygmaea*
Calamus javensis	*Pinanga mooreana*
Calamus laevigatus var. *mucronatus*	*Pinanga sessilifolia*
Calamus paspalanthus	*Salacca vermicularis*
Calamus tenompokensis	*Salacca affinis* var. *borneensis*

Good collection was made of the herbs belonging to the families of Begoniaceae, Gesneriaceae and Melastomataceae. A wide variety of *Begonia* species differing in habit, leaf shape, leaf coloration and flower features, was particularly remarkable. Owing to the lack of reference material in the herbarium, the identification of many species particularly *Begonia,* would take sometime.

Where thick accumulation of leaf litter occurs, saprophytic plants such as *Sciaphila* (Triuridaceae) are found. This has so far been known to occur in the primary forest only. Among the gymnosperms were *Agathis borneensis* and *Gnetum* spp. The former was collected at a low altitude.

4.1.2 Old Secondary Forest

This forest is concentrated on low undulating hills near rivers. The Iban people first cleared the forests when they migrated from the Ulu Batang Ai to the Katibas about 300 years ago. Older secondary forests between 30 and 150 years old are common.

Old secondary forest of up to 100 years or more is similar in appearance to the primary LDF. Ecological surveys have revealed a significantly low number of dipterocarp species compared to the primary forest. Both forests share a similar group of the dominant families although the species and frequencies differ. Some species are good indicators of former disturbance such as *Cratoxylum arborescens* and *Tristaniopsis sumatrana* which are common in the older secondary forest.

A much larger selection of climbers was collected compared with the lowland dipterocarp forest. As climbers thrive well in the canopy gaps and edges of the forest, they naturally become more abundant in the secondary forest where tree densities are much lower (see Table 2).

Table 2 Some common climber species in old secondary forest

Apocynaceae	*Willughbeia* spp. *Kopsia* sp.
Gnetaceae	*Derris* spp.
Gramineae	*Dinochloa* sp.
Leguminosae	*Bauhinia* sp. *Derris* spp.
Rubiaceae	*Uvaria* sp. *Psychotria* sp.
Symphoremataceae	*Sphenodesma* sp
Vitidaceae	*Pterisanthes* sp.

One notable feature of the old secondary forest was the abundance of tree species that produce edible fruits. The presence of such trees might be due to seeds of fruit trees having been discarded in areas once used for shifting cultivation by the Ibans migrating through the area in the past (Table 3).

Table 3 Common wild fruit trees found in the old secondary forest

Mangiaceae	*Alangium* sp.
Bombacaceae	*Durio lanceolatus*
Clusiaceae	*Garcinia bancana*
Euphorbiaceae	*Baccaurea macrocarpa*
Fagaceae	*Castanopsis* sp.
Gnetaceae	*Gnetum gnemon*
Leguminosae	*Dialium maingayi*
Moraceae	*Artocarpus elasticus* *Artocarpus integer*
Polygalaceae	*Xanthophyllum amoenum*
Sapindaceae	*Dimocarpus longan*
Saurauiaceae	*Saurauia* sp.

In the old secondary forest, most of the collections were shrubs and herbs which belong to the families of Acanthaceae, Euphorbiaceae, Rubiaceae, Saurauiaceae, Amaryllidaceae, palms, ferns, Hypoxidaceae, Marantaceae, Myrsinaceae and Piperaceae. Species such as *Ixora*, *Pavetta*, *Psychotria* spp. (Rubiaceae) and *Papualthia*, *Popowia* and *Pseudouvaria* spp. (Annonaceae) were commonly encountered. The secondary forest has better developed undergrowth than primary forest due to the lower tree density and more open canopies allowing more light to reach the forest floor. A number of secondary species have taken advantage of the conditions of higher light intensity to colonise the new niches.

4.1.3 Alluvial and riparian forests

These forests on the flat ground in the flood zone of rivers are subject to periodic disturbance due to flash floods. They are characterised by high light intensities at waterway margins, high relative humidities and the intermittent action of fast-flowing currents. Many herbs, climbers and epiphytes are adapted to these conditions. Mossy condition has also developed.

Some of the common tree species are *Dimocarpus longan*, *Dipterocarpus oblongifolius*, *Pometia pinnata* and *Parashorea macrophylla*. A dipterocarp of alluvial forest (which also occurred on hill slopes further from the river) was *Shorea macrophylla*. Some individuals of *S. macrophylla* have reached giant size and the species was found to be regenerating well in the area as many seedlings were encountered. Many members of the Euphorbiaceae (*Baccaurea, Aporusa* spp. and Myrtaceae (*Eugenia* spp.) also occur in this forest type and *Eugenia* spp. were common.

Palms characteristic of alluvial and riparian forests are *Areca jugahpunya*, *Pinanga mooreana*, *Plectocomiopsis geminiflora*, *Salacca dransfieldiana* and *Salacca vermicularis*. Climbing palms include *Calamus* spp., *Daemonorops* spp., *Korthalsia rostrata*, *Korthalsia rigida* and *Korthalsia robusta*. Herbaceous flora are very well-represented by the families Begoniaceae, Gesneriaceae, Rubiaceae and Zingiberaceae (Table 4). The alluvial and riparian forests are particularly rich in epiphytes, including many orchids. As many as 1/3 of the orchid specimens were collected from these forests.

Table 4 Herbs of alluvial and riparian forests

Genus	No. of species	Genus	No. of species
Acranthera (Rubiaceae)	5	*Cyrtandra* (Gesneriaceae)	15
Begonia (Begoniaceae)	10	*Globba* (Zingiberaceae)	6

Other plants of the undergrowth consists of *Donax canniformis* and *Phrynium capitatum* (Marantaceae), *Bhesa pinnata* (Celastraceae), *Elatostemma* (Urticaceae), *Argostemma* (Rubiaceae) and *Homalomena* spp (Araceae).

5.0 SUMMARY OF FINDINGS

5.1 Habits of Plants occurring in LEWS

The specimens represented a wide range of vascular plant types. The majority of the specimens so far collected from LEWS are trees but the non-tree flora, including herbs, shrubs, climbers and epiphytes, is also extremely rich and has been well sampled. Hemi-parasites (with more than 10 species of Loranthaceae) and saphrophytes (two species of *Burmannia* [Burmanniaceae]) have been collected.

5.2 New Species

Korthalsia rostratioides Mogea (Palmae) collected in Katibas, has been recognised as new (Mogea, pers. comm.). A species of *Microtropis* (Celastraceae) collected twice during this project, appears new as it is not described in the recent revision of this family (Kochummen, 1995). It is very likely that new species of *Acranthera* (Rubiaceae), *Agrostistachys* (Euphorbiaceae), *Begonia* (Begoniaceae, *Cyrtandra* (Gesneriaceae), *Eugenia* (Myrtaceae), *Garcinia* (Clusiaceae), *Helicia* (Proteaceae), and *Psychotria* and *Urophyllum* (Rubiaceae) can be described after further taxonomic work.

5.3 New Records for Sarawak and Borneo

Seven new records were noted (Table 5). This number is likely to increase as more such records are detected on further examination of relevant literature. It is significant that all but two of the newly recorded taxa were collected in lowland forest and of these, *Calophyllum mukunense* was collected from secondary forest. *Garcinia bancana* var. *curtisii* and *G. dumosa* were collected in hill dipterocarp forest.

Table 5 Taxa collected from Lanjak-Entimau Wildlife Sanctuary which represent new records for Sarawak and Borneo

Family	Species	Status (N.R. = New Record)	Habitat (forest type)
Anacardiaceae	*Semecarpus sandakanus*	N.R. Sarawak	Lowland D.F.
Clusiaceae	*Calophyllum mukunense*	N.R. Sarawak	Secondary F.
	Garcinia bancana var. *curtisii*	N.R. Sarawak	Hill D.F.
	Garcinia dumosa	N.R. Sarawak	Hill D.F.
Myrtaceae	*Eugenia burkilliana*	N.R. Sarawak	Lowland D.F.
Polygalaceae	*Xanthophyllum monticolum*	N.R. Sarawak	Lowland D.F.
Rubiaceae	*Urophyllum sessiliflorum*	N.R. Borneo	Lowland D.F.

5.4 Rare Species collected in LEWS

Rarity of a species was stringently defined for the purpose of this project. Only species represented by at the most two specimens in SAR, or reference to two specimens in the literature, were taken to be rare. This totalled 29 species in 19 families. Interestingly nearly all of these occur in lowland or hill forest. *Iguanura chaiana* (Palmae) is the one rare species that was found limited to hill and submontane forests. *Medinilla allantocalyx* (Melastomataceae) occurs in montane forest but is not limited to this habitat. *Knema mucosa* (Myristicaceae) occurs in the summit ridge forest.

5.5 Endemic Species

Endemism can only be determined for groups where an up-to-date taxonomic revision is available. Endemism of the species occurring in the TPA has been ascertained for 25 families so far revised under the Tree Flora of Sabah and Sarawak Project : (Alangiaceae, Anacardiaceae, Anisophyllaeaceae, Burseraceae, Capparidaceae, Celastraceae, Chloranthaceae, Crypteroniaceae, Ixonanthaceae, Juglandaceae, Leeaceae, Loganiaceae, Ochnaceae, Olacaceae, Oxalidaceae, Pittosporaceae, Rhamnaceae, Rhizophoraceae, Rutaceae, Sapindaceae, Scyphostegiaceae, Simaroubaceae, Styracaceae, Ulmaceae and Winteraceae) (Soepadmo & Wong, 1995; Soepadmo, Wong & Saw, 1996). Endemism in the

Dipterocarpaceae (Ashton, 1968, 1982), ferns (Parris & Latiff, 1997), rattans (Dransfield, 1992), Meliaceae (Mabberly, Pannel & Sing, 1995) and Euphorbiaceae (Airy Shaw, 1975) has also been determined. The TPA has been found to be the home to at least 61 endemic species including 17 rattans, 15 Euphorbiaceae species and 13 dipterocarps, chiefly *Shorea* species, with *Shorea flava* and *Shorea iliasii* being endemic to Sarawak and the remainder endemic to Borneo.

5.6 Plants of Significance to Wildife.

As Lanjak Entimau is a wildlife sanctuary, plants of significance to wildlife ought to be highlighted. The abundance of *Aristolochia* and *Thottea* (Aristolochiaceae) is of significance as it is the food plant of the caterpillars of the Rajah Brooke's birdwing (*Troides brookiana*). Food plants of other caterpillars are also found in abundance *viz*, Moraceae and Convolvulaceae. Wild fruit trees such as *Aglaia*, *Litsea* and *Ficus* spp. are also abundant. These fruit trees serve as a dependable source of food for wild animals like hornbills, orang utans and other primates.

Numerous plants also serve as shelter for the wild animals. The tall emergent *Koompassia malaccensis* is abundant in the Sanctuary and harbours millions of bees. The trough formed by massive and cylindrical trees, often highly buttressed such as *Koompassia malaccensis* and other dipterocarp species also serve as a breeding ground and home to a number of amphibian species, while the hollow bole of big trees are home to a variety of birds including the magnificent rhinocerous hornbills.

5.7 Plant Genetic Resources and Germplasm Conservation

LEWS is a very suitable location for the establishment of *in situ* genebanks. It is the single largest Totally Protected Area (TPA) in Sarawak and protects a significant proportion of the State's remaining virgin forest. It supports large areas of lowland and hill dipterocarp forests, the backbone of Sarawak's timber industry. The forest is also rich in wild fruit trees, ornamental plants, food crops (e.g. Piperaceae and Zingiberaceae) and plants of medicinal value. They form an important genetic resource and *in situ* germplasm for breeding and crop improvement in a non-destructive way in future. Seed of useful trees for planting needs elsewhere in the state can be collected in certain zones of the TPA.

5.8 Plants with Ornamental Potential

There are a number of plants with ornamental potential, particularly from the herbaceous group. These are mainly from families Acanthaceae, Araceae, Asclepiadaceae, Begoniaceae, Commelinaceae, Dilleniaceae, Ericaceae, Gesneriaceae, Melastomataceae, Myrsinaceae, Orchidaceae, Palmae, Rubiaceae and Zingiberaceae. The study and introduction of species with ornamental potential is one way in which the Sanctuary's non-timber resources can be sustainably utilised.

6.0 CONCLUSION

LEWS is fortunate to have a wide range of habitats and the lowland areas visited are extremely rich in terms of species diversity. The total number of plant species known from the TPA now stands at 2,807 comprising 1,896 trees and 911 non-trees, the latter in the form of palms, climbers, herbs and epiphytes. The importance of LEWS as a valuable resource area for conservation has been established. It will be an important area for future studies on the rich biodiversity of Borneo.

Given its size, collections from more parts of the conservation area are required as only a small area was sampled and the remote central core is yet to be explored. Botanically speaking, LEWS is represented by a collection density of only 5 specimens per 100 square kilometer (compared with 61 per 100 square kilometer for Sarawak). Much remains to be done and further collection from the less widely distributed forest types is required. Hill dipterocarp forest and quartzite ridge forest need to be the focus of further collections. Quartzite ridge forest could be investigated where it occurs at Bukit Entimau and Bukit Sengayoh in LEWS. Submontane and mossy montane forests (Bukit Lanjak) need further collection and investigation. The responsibility of future work and continuing efforts lie with the Executing Agency.

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DISCUSSIONS

Dr. Soepadmo

Could you clarify whether there is any plan to conduct a soil and geological survey to determine what types of soils match up the forest types. Secondly there are secondary forests of different ages, some were cleared cut about 100 years ago and some of younger ages. I think it will create a golden opportunity to study the changes not only in terms of composition and size of population of several keystone species but also how these forests recovered after being cleared cut. Data gained from such studies will be extremely useful in assessing how much of the original genetic resources of the forests were lost or regained during the period.

Dr. Paul Chai

The answer to the first question is yes. A soils survey conducted in Phase I identified three main soil types, namely the Alluvial Soils, Red-Yellow Podzolic Soils and Skeletal Soils. We have established some correlation between the physical and chemical properties of soils types and the forest types. In the Alluvial Soils the forest is good. For the dipterocarps the good forests are found in the deep Red-Yellow Podzolic Soils whereas the forests that are characterised by pole-size trees are associated with the Skeletal Soils. These forests are found on the steeper slopes and narrow ridges.

At the end of Phase I, we have made a recommendation to study the species succession and forest dynamic of the secondary forest. This proposal was not taken up as our priority then was to look into the resource inventory of flora and fauna, and community related activities.

Dr. Efransjah

Could Dr. Soepadmo elaborate the term 'keystone' species?

Dr. Soepadmo

What I mean is that detailed study on the population dynamic and structure to determine the genetic variability of forest trees can only be focussed on the so called keystone or indicator species of a particular forest type. This is because our available manpower, expertise and facilities will not allow us to study all species. Under the prevailing circumstances, you have to focus on the keystone or indicator species.

Julaihi Abdullah

The Speaker said that the botanical specimens collection from LEWS was five specimens per 100 km^2. This is very low. As LEWS is a very important area for conservation and sustainable management, has ITTO any plan to collect more specimens and would ITTO finance future research?

Dr. Efransjah

ITTO has no specific plan to sponsor the detailed study as described by Dr. Soepadmo. The role of ITTO here is to assist the Government, firstly to secure areas for the purpose of increasing the number and the size of TPAs, then to encourage research, such as floristic research. However floristic research itself can go on to numerous different studies, e.g. to map the genetic variation of forest trees, to study the population dynamic of forest trees focussing on the keystone species so that we can understand the needs for conservation. Currently ITTO has limited fund. Should you think that there be a need to continue research, you have to justify and convince the donors. However, if the research is important to the Forest Department, it has to continue even without the ITTO. The emphasis on Phase III will be community-based activities relating to conservation and sustainable forest management.

Dr. Paul Chai

The reasons we changed the emphasis from resource inventory to community-based in Phase III are to encourage and support the development of economic activities by the local communities to enable them to share the benefits of biological resources and to promote conservation and sustainable forest management. It is our view that the Forest Department shall continue the botanical exploration and collection of botanical specimens as this is a continuous process.

Dr. Nengah

I would like to comment on the classification of forest types. There are two ways of doing it. One is by floristic composition and the other is through a physical classification by topography, geology and soils. In the management of wildlife it is very important to know, through your flora inventory, the species distribution, particularly on the distribution of fruit plants as the wildlife move to where the food is.

Dr. Lim Meng Tsai

For rapid but 'coarse' classification of forest types of LEWS, the use of aerial photographs or satellite imagery should be considered.

Dr. Paul Chai

We have explored the possibility of using satellite imagery and aerial photographs. But at that time the satellite imagery were not available and the aerial photographs were either out of date or did not quite cover the LEWS. Our forest classification map was based on the Forest Type Map prepared by the Sarawak Forest Department using the 1970s aerial photographs. The Forest Type Map, which provides information on crown density and terrain classes, was produced for the purpose of estimating the timber resources before the area was constituted as the Sanctuary. Using the Forest Type Map as a basis plus the information we collected, we have been able to classify LEWS into the buffer zone, wilderness zone and core zone, and identify which areas are critical and which habitats require more protection.

Ernest Chai

I would like to ask the speaker how he determined the age of the secondary forest? What is the size of the secondary forest in LEWS? What species are found there and what is the species density? Sarawak exports about 200 species of timber. Could we find the bio-genetic conservation of these 200 species? And from the species we could probably identify whether they occur in LEWS, and among them which are the fastest growing species.

Dr. Paul Chai

There is no way we can ascertain the age of a secondary forest. Our knowledge on the age of the secondary forest is based on information provided by the local communities through intensive interviews with the elders in the longhouses. A few of these elders could still remember events that happened about two generations ago. They estimated that their great-grand parents migrated to Katibas about 300 years ago. A secondary forest of younger age can be ascertained more reliably. A man showed us the area where his father cleared for padi planting when he was a 16-year old boy. That secondary forest which we visited was 30 years old. We established our ecological plots in between 30 and over 100 years old secondary forest.

Even with the aid of aerial photographs, it is very difficult to ascertain the size of secondary forest, particularly the fully re-grown ex-shifting cultivation areas. Sometimes it may be difficult to differentiate the old secondary forest from the primary forest even on the ground without the indicator species such as the dipterocarps. However the young secondary forest in LEWS is about 2,000 ha. On species composition and species density you may refer to my report entitled "A Final Report on the Vegetation and Flora of Lanjak Entimau Wildlife Sanctuary" which is available in the ITTO office. The species density and species composition are broadly similar to that of a mixed dipterocarp forest. In species diversity it is a very rich forest.

On the 200 odd species of timber we export and the bio-genetic it is more of a suggestion than a question. In the export declaration, the timber is rarely identified to species level. In the case of *meranti*, it is grouped under red *meranti*, light red *meranti* or just *meranti*. If you want to study this, you will need a lot of efforts.

Dr. Efransjah

What is the extent of the secondary forest in the area?

Dr. Paul Chai

The extents of secondary forest and shifting cultivation areas are large. When the Iban community migrated to the area they settled along the river systems of Sungai Katibas, Sungai Mujok, Ulu Batang Ai and Sungai Engkari. The forests along these rivers and the tributaries were cleared for shifting cultivation and it is not possible to exactly estimate the size of the secondary forest. We need aerial photographs to interprete the forest types. Young secondary forest is easily recognised from aerial photographs but a fully re-grown secondary forest may be more difficult.

Tachrir Fathoni

Have you in your flora inventory study in LEWS established a relationship between the wildlife distribution and availability of food? The availability of food is needed to sustain the wildlife.

Dr. Paul Chai

We carried out a preliminary study on the primates in Phase I. The orangutan, in particular, were found in the North-Western part of LEWS where there is a high concentration of fruit trees. The study had identified 91 species of fruit trees that were used by the primates including the orangutan, birds and ground mammals. I agree that this is an important aspect of the study and more knowledge on the interaction between wildlife and fruit trees will help us in the management of the Sanctuary.

Dr. Efransjah

Have you explored the entire LEWS?

Dr. Paul Chai

The study only covered the periphery of the Sanctuary.

Dr. Efransjah

The ITTO project has developed a successive method of flora and fauna assessment and it can provide scientifically correct estimators. This Rapid Assessment method was presented by a group of Philippinos from Los Banõs during the ITTO Council meeting in Chiengmai in June 1999. They have developed the software, which can automatically calculate the flora or fauna richness indices, biodiversity index, etc. Though this Rapid Assessment method was developed to assess the endangered species in the production forests in the Philippines and if this Rapid Assessment can be used in LEWS or Betung Kerihun NP, we can explore the rest of the areas of these two TPAs. On the part of ITTO and the donor countries, we are interested in a method, which can assess the biological resources rapidly and correctly in less time and is cost effective.

Dr. Paul Chai

I have had some discussions with Dr. Lim Meng Tsai on the application of Rapid Assessment method on ecological survey. Another quick way of assessment is to establish plots along a transect at regular intervals. This method will not be as complicated as the one proposed by the Los Banõs team.

Genebank Establishment In Lanjak Entimau Wildlife Sanctuary

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Abstract

In situ genebanks were established in Ulu Engkari and Ulu Mujok in Lanjak Entimau Wildlife Sanctuary. A total of 42 species from 602 individuals were selected in a 4.42 ha plot in Ulu Engkari and 62 species from 643 individuals were encountered in the 6.29 ha plot in Ulu Mujok. The species selected include dipterocarp and non-dipterocarp timber trees and wild fruit trees. Criteria for genebank establishment are discussed. This genebank establishment is an example of how the Sanctuary's resources can be put to good use through the concept of sustainable management. The genebanks would act as a gene pool in the supply of seeds for the State's long-term tree plantation programme.

1.0 INTRODUCTION

Forestry is an important economic activity in Sarawak. Lately, as a result of increased activities in timber logging, land clearing for oil-palm plantations and shifting cultivation, forest clearing and habitat degradation have gathered momentum in many areas in the State. In order to achieve the objective of sustainable management of forest resources in Sarawak, the State Government is planning to establish one million hectares of forest plantations by 2013. Various indigenous dipterocarp and non-dipterocarp species that are suitable for forest plantation crop would be used. A large supply of seed will thus be needed. Suitable tree species can be selected through the establishment of genebanks in Total Protected Areas such as the Lanjak Entimau Wildlife Sanctuary which are free from disturbance.

An *in situ* genebank is an area of natural forest where breeding populations of selected useful species are conserved for future use as a source of propagation material and for use in breeding programmes to improve local useful species. The genebank should contain a sufficient number of healthy individuals of selected species to provide sufficient seed for use in enrichment planting, plantation schemes and genetic improvement work in perpetuity. As timber from plantations will be required for a variety of purposes, seeds of a wide range of species including dipterocarp and non-dipterocarp timber trees should ideally be available.

Lanjak Entimau Wildlife Santuary (LEWS) is a suitable location for the establishment of *in situ* genebanks. It is the largest Totally Protected Area (TPA) in Sarawak and supports large areas of mixed dipterocarp forest that forms the backbone of Sarawak timber industry. Recent studies have shown that the Sanctuary is rich in both dipterocarp and non-dipterocarp timber species and wild fruit trees. (Chai, 1995).

2.0 OBJECTIVES

The objectives for the establishment of genebanks are as follows:

- To locate, identify and mark mature trees of commercially important timber species and other useful species such as wild fruit trees for potential seed resources;
- To produce species maps for timber trees and other economically important species in the genebanks;
- To develop appropriate methodologies for phenological studies, plot monitoring, seed collecting as well as plot maintenance;
- To train Forest Department staff and local community in basic phenology, seed collection and other activities in genebank establishment, and
- To identify criteria for development of genebanks in other areas in Sarawak.

3.0 CRITERIA IN GENEBANK ESTABLISHMENT

Genebank establishment is a relatively new activity in Malaysia. In the past with vast natural forest resources, it was considered not necessary to have genebanks. In order to develop large scale forest plantations and the availability of planting stocks becomes critical. Necessary information for genebank establishment such as phenology and genetic variation of species are lacking as these studies are always long-term in nature. The criteria set below are believed to be important in genebank establishment.

3.1 Prospecting of a suitable site in the area

A site that is accessible, rich in suitable species, with sufficient number of individuals and of suitable terrain to permit genebank establishment, monitoring and maintenance and fruit collection shall be selected.

3.2 Selection of suitable species for inclusion in the genebank

Dipterocarps are the most important and abundant timber species in mixed dipterocarp forest in Sarawak. These dipterocarps of sizes and form suitable for timber production are likely to comprise the bulk of the genebank trees. These species are medium to slow growth but produce solid hardwood for various uses. Non-dipterocarp timber species, both well-known and lesser known, shall also be included to widen the range of timber types available. Wild fruit tree species are included as potential genetic sources and for improvement of local fruit species.

3.3 Selection of suitable individuals for inclusion in the genebank

Trees capable of producing a reasonable amount of fruit shall be selected by setting a lower size limit at 20 cm diameter at breast height (dbh). It was found appropriate at LEWS. Only healthy trees of good form are included.

3.4 Identification of each genebank tree to species

Efficient, rapid, accurate identification of trees to species level, allowing the inclusion of the largest number of suitable trees in the shortest field time, is accomplished by comparing a sample of leaves, fallen or catapulted from the crown of each tree, with Sarawak Forest Department Herbarium specimens. The vernacular name of each tree, supplied by knowledgeable members of the local community shall also be recorded to aid identification.

3.5 Recording of the position of each tree in its subplot

A sketch map shall be prepared to show the subplots, relief and the location of each tree included in the genebank.

3.6 The genebbank plots to be permanently marked

As the genebank is a long-term undertaking, the plots must be marked and maintained in such a way that they will be able to last several decades and can be being easily found when the plots are visited.

4.0 METHODOLOGY

4.1 Plot Selection

Based on the above criteria, Tintieng Geronggang/Ubah Ribu Ridge at Ulu Engkari and Sg. Ensirieng at Ulu Mujok were selected for the establishment of genebanks. These areas represent some of the richest dipterocarp forest in LEWS and the accessibility is good.

The Ulu Engkari Genebank is situated at Tintieng Geronggang to Ubah Ribu Ridge in the southern part of LEWS (1° 26.5' N, 111° 59.6' E). It is accessible by half a day's walk from Ng. Segera Ranger Station. The forest type consists of lowland/hill dipterocarp forest transition to hill dipterocarp forest at altitudes between 600 to 700 m a.s.l.

The Ulu Mujok genebank is at Sg. Ensirieng on the western part of LEWS (1° 38.7' N, 112° 08.7' E). It is accessible within a day from Ng. Ju Ranger Station by boat, and on foot from Nanga Jepiu. The forest type consists of lowland dipterocarp forest at 230 to 250 m a.s.l.

4.2 Plot Demarcation

After the site was selected, belian pegs of sizes 6 x 6 x 150 cm with subplots numbers were placed at all corners of the plots. The location of each peg was indicated on the genebank map. The absolute location of the genebank was determined by establishing the tie point to the plot. Grid reference of the plot was also determined by using a GPS unit.

Subplots of 10 m x 10 m were then laid out where there were suitable tree species for inclusion in the genebank. The subplots were flagged, numbered in running order from side to side of the plot and the terrain surveyed.

4.3 Data Collection

Suitable species were identified to family, genus and species where possible in the field and leaf specimens were collected for confirmation of the species later in the Sarawak Herbarium. The trees were numbered in running order and their exact position were marked on the map. For each tree, the tree number was punched onto an aluminium tag and painted onto an orange plastic tag. A length of brass wire that includes an allowance of *c.* 30 cm for further diameter increment was used to attached the two tags to the bole of each tree. Tree diameter at breast height, tree height and condition of each tree were recorded.

5.0 RESULTS

5.1 Ulu Engkari Genebank

A total of 42 species from 602 individuals were selected in 4.42 ha at Ulu Engkari genebank. These included 14 species of dipterocarps and 9 species of wild fruit trees (see Table 1). *Shorea parvifolia* (*meranti sarang punai*) with 123 trees is the species with the highest number of individuals recorded. Other common species are *Vatica odorata* (*resak runting kesat*), *Shorea macroptera* (*meranti melantai*), *Shorea laevis* (*Selangan batu)* and *Shorea quadrinervis* (*meranti sudu*). Among the non-dipterocarps, *Dacryodes rostrata* (*kemayau*) has 8 individuals and *Calophyllum biflorum* (*bintangor*) has 6 individuals.

Table 1 Species and number of individuals in ulu Engkari genebank

DIPTEROCARPS			
Species	**No. of trees**	**Species**	**No. of trees**
Anisoptera laevis	7	*Shorea quadrinervis* (RM)	42
Hopea beccariana	11	*Vatica odorata*	106
Hopea dyeri	13	*Vatica granulata*	12
Hopea vesquei	5	*Vatica* spp.	5
Shorea beccariana (RM)	40		
Shorea mujongensis(SB)	4	Keys :	
Shorea domatiosa(SB)	35		
Shorea laevis(SB)	53	SB = *Selangan Batu*	
Shorea macroptera(RM)	83	RM = *Red Meranti*	
Shorea parvifolia(RM)	123	YM = *Yellow Meranti*	
NON-DIPTEROCARPS AND WILD FRUIT TREES*			
Species	**No. of trees**	**Species**	**No. of trees**
*Artocarpus lanceifolius**	2	*Madhuca markleeana*	2
*Artocarpus odoratissimus**	2	*Madhuca* sp.	1
Calophyllum biflorum	6	*Mangifera rufocostata**	1
Calophyllum canum	2	*Mangifera griffithii**	2
Calophyllum gracilipes	1	*Nephelium cuspidatum**	1
Calophyllum soulattri	4	*Palaquium gutta*	1
Calophyllum sp.	2	*Palaquium leiocarpum*	5
Dacryodes incurvata	4	*Palaquium rigidum*	1
Dacryodes macrocarpa	1	*Palaquium* sp.	1
*Dacryodes rostrata**	8	*Pentace curtisii*	1
Dialium indum var. *laurinum**	1	*Santiria griffithii*	1
*Dialium platysepalum**	1	*Santiria megaphylla*	1
Dialium sp.*	4	*Santiria mollis*	1
Koompassia malaccensis	5	*Sindora irpicina*	1

Source : Pearce K. and Julaihi, 1999

5.2 Ulu Mujok Genebank

Sixty two species from 643 individuals were enumerated in the 6.20 ha plot. A total of 44 species of dipterocarps and 18 non-dipterocarps including 6 wild fruit trees were recorded. *Dipterocarpus caudiferus* (*keruing putih*) with 69 trees is the species with the highest number of individuals recorded. This is followed by *Shorea collaris* (*lun kelabu*), *Shorea quadrinervis*, *Shorea havilandii* (*selangan batu*) and *Vatica oblongifolia* (*resak membangan*). Common non-dipterocarps include *Koompassia malaccensis* (*menggris*), *Cratoxylum arborescens* (*geronggang*), *Pentace truncata* (*baru*) and *Mangifera khoomengiana*. The species and number of individuals are shown in Table 2.

6.0 DISCUSSION

6.1 The Need for Genebanks in Sarawak

In 1998, Sarawak stated its intention of establishing one million ha. of forest plantations under a 15-year programme using indigenous species as well as exotics. Indigenous species previously identified by Sarawak Forest Department for reforestation include *Shorea macrophylla*, *Dryobalanops aromatica*, *Dyera costulata*, *Palaquium* spp. and *Calophyllum* spp. (Lottye *et al* 1992). A large amount of seeds of these and other species would be required. Futhermore, not all the species identified are suitable as planting sites can be highly variable. A wider range of species would enable closer species-site matching when species are selected for future plantation. The choice of species will also be determined by the end use.

6.2 The LEWS Genebanks

The two genebanks do not contain the same range of species. Some important timber species (notably *Dryobalanops* spp, many *Shorea* spp, *Anisoptera* spp, *Dipterocarpus* spp and useful non-dipterocarps) were not present in either genebank.

The genebanks contain many useful timber species as well as a range of wild fruit tree species. *Shorea* spp. (*selangan batu*), *Hopea* spp., *Dialium* spp. and Vatica spp. found in both the Ulu Engkari and the Ulu Mujok genebanks, are among the heavy hardwoods listed in the Manual of Sarawak Timber Species (Anon., 1987). Among the medium hardwoods, *Artocarpus* spp. occur in the Ulu Engkari genebanks while *Heritiera* sp., *Dipterocarpus* spp. and *Elateriospermum tapos* occur in the Ulu Mujok genebank. *Koompassia malaccensis* which is suitable for heavy construction, railway sleepers and parquet flooring is found in both sites. Of the light hardwoods mentioned in the Manual, *Anisoptera* spp., *Palaquium* spp., *Shorea* spp. and *Sindora* spp. occur in both genebanks, while *Calophyllum* spp., *Artocarpus* spp. and members of the Burseraceae were recorded in the Ulu Engkari genebank, and *Cratoxylum arborescens*, *Pentace* spp., *Durio* sp. in the Ulu Mujok genebank. Wild fruit tree species such as *Artocarpus* sp., *Dacryodes* sp., *Dialium* sp., *Durio* sp., and *Elateriospermum tapos* also produce useful timber.

Table 2 Species and number of individuals in ulu Mujuk genebank

Species	No. of trees	Species	No. of trees
DIPTEROCARPS			
Anisoptera costata	1	*Shorea macrophylla* (RM)	2
Dipterocarpus applanatus	3	*Shorea mecistopteryx* (RM)	6
Dipterocarpus caudiferus	69	*Shorea multiflora* (YM)	14
Dipterocarpus costulatus	11	*Shorea myrionerva* (RM)	2
Dipterocarpus crinitus	13	*Shorea obovoidea* (YM)	4
Dipterocarpus oblongifolius	6	*Shorea obscura* (SB)	8
Hopea beccariana	4	*Shorea ochracea* (WM)	1
Hopea wyattsmithii	13	*Shorea ovalis* (RM)	1
Shorea agami (WM)	4	*Shorea parvifolia* (RM)	15
Shorea beccariana (RM)	11	*Shorea quadrinervis* (RM)	37
Shorea brunnescens (SB)	11	*Shorea rubra* (RM)	12
Shorea collaris (YM)	67	*Shorea saggitata* (RM)	17
Shorea curtisii (RM)	1	*Shorea scaberrima* (RM)	20
Shorea dasyphylla (RM)	1	*Shorea scabrida* (RM)	16
Shorea exelliptica (SB)	19	*Sunaptera micrantha*	12
Shorea faguetiana (YM)	4	*Vatica dulitensis*	1
Shorea falciferoides (SB)	16	*Vatica nitens*	13
Shorea ferruginea (RM)	2	*Vatica oblongifolia*	28
Shorea flava (SB)	21	*Vatica sarawakensis*	4
Shorea havilandii (SB)	33		
Shorea hopeifolia (YM)	4	Key:	
Shorea johorensis (SB)	12	SB = *Selangan batu*	
Shorea leprosula (RM)	1	RM = Red *meranti*	
Shorea lunduensis (SB)	3	YM = Yellow *meranti*	
Shorea macrobalanos (YM)	1	WM = White *meranti*	
NON-DIPTEROCARP TIMBER TREES & WILD FRUIT TREES *			
Cratoxylum arborescens	9	*Mangifera lagenifera* *	3
*Dialium maingayi**	1	*Palaquium letocarpum*	4
*Durio lanceolatus**	2	*Palaquium* spp.	8
*Elateriospermum tapos**	4	*Payena obscura*	2
Heritiera aurea	5	*Pentace truncata*	9
Koompassia malaccensis	29	*Pentace laxiflora*	2
Madhuca spp.	4	*Pouteria malaccensis*	1
Madhuca utilis	5	*Sindora beccariana*	5
*Mangifera griffithii**	1		
Mangifera khoonmengiana	5		

Source : Pearce K. and Julaihi, 1999

The number of individuals included was large for many species (Tables 1 & 2) although some rarer species were present. Large numbers of individuals will allow for some loss of genebank trees (e.g. through wind-throw, as happened at the Ulu Engkari genebank during the period from April to August when 7 trees were lost).

6.3 Population Structure of the Genebank Species

Many tropical rainforest species have low population densities with less than one individual per hectare. Some of the species in LEWS genebanks are indeed represented by one or a few individuals which may not be enough for genetic variation. An understanding of the population structure would be essential in order that enough trees of each species are included to maintain the genetic diversity of the seeds produced. The distribution of species in the genebank reflects the actual species density of the forest. At present, it is difficult to determine whether to concentrate on the existing population or to increase the areas of the site because we do not know what species is important in the future.

6.4 Phenology

Plant phenology involves studies of seasonal phenomena such as leaf flushing, flowering and fruiting. The periodicity and duration of flowering, the occurrence of supra-annual flowering and gregarious fruiting and the stage at which fruit is sufficiently mature to be collected are all significant with respect to fruit production and collection. Dipterocarps often flower and fruit in different areas at different times. They also fruit gregariously and heavily but at irregular intervals of 3 to 5 years. As little phenological information is currently available for the species represented in the LEWS genebanks, regular monitoring for evidence of leaf-flush, which is very highly correlated with flowering is essential (Ng, 1981). More frequent monitoring is required during fruit development in order not to miss fruiting and to be able to collect fruits in optimal condition.

6.5 Fruit Production Capacity of Genebank Species

Size (dbh) was found to be the most convenient indicator of a genebank tree having reached sufficient maturity to produce fruit. A tree of 20 cm dbh is considered by the local community to be capable of fruit production. Sakai *et al* (1997). In Lambir National Park trees with 40 cm dbh are capable in producing fruit. While the average fruit production capacity of dipterocarps is known to be variable between species, little information is available.

6.6 Fruit Collection

Susceptibility to predation; fungi infestation and insect attack; susceptibility to dessication both before and after germination, and susceptibility to physical damage are factors relevant to genebank fruit collection and handling. In general the fruits have a short storage life and must be collected and transported as quickly as possible. Study at the seedbank in the Semengoh nursery shows that the fruits viability period in seedbank of *Neolarmarckia cadamba* is only six months. The methods of fruit collections and fruit transportation have to be studied.

6.7 Genebank Establishment in the Region

The Malaysian-German Forestry planting material Procurement Programme in Peninsular Malaysia which started in 1994, involves Forest Department of Peninsular Malaysia, FRIM and GTZ. Seed sources are determined, established, managed, conserved and phenological monitoring techniques developed in 10 seed production areas.

7.0 RECOMMENDATIONS

(i) The two genebanks established are the first two *in situ* genebanks in Sarawak. Both genebanks have a total of 1,245 trees in 10.71 hectares representing a very small fraction of potential species in the forest. In term of species selection, population structure and genetic variation, it is obviously not enough. In order to satisfy the need of future plantation forest in 10 to 15 years, more genebanks need to be established in other TPAs such as in Batang Ai, Bako, Gunung Gading, Lambir and Gunung Mulu national parks.

(ii) Species selected in these two genebanks are medium to slow growth of more than 25 years. In order to cater for the needs of large scale forest plantation, fast-growing species suitable for veneer, plywood, pulp and paper production need to be identified in future genebank establishment.

(iii) At present, exotic species such as *Acacia mangium* and *Gmelina arborea* are popular plantation species. However, there are also many indigenous species in our forests which are suitable for this purpose but have not been identified. More information needs to be gathered through field investigation and research. In order to cater for a wide range of plantation needs genebanks should also be established in the peat swamp forest and logged-over forest where many fast growing species occur as secondary pioneers.

(iv) This exercise is a long term study which requires continuity.. The Executing Agency would need to establish a unit of trained personnel in genebank management, phenology, seed collection and storage, nursery technique and breeding programme.

8.0 CONCLUSIONS

Establishment of genebanks meet the recommendations of ITTO Mission and the policy of the Sarawak Government on the sustainable use of plant resources in the Sanctuary. It is one example to show that conservation and economic development can be harmonised. It is premature at this stage to assess the potential of these genebanks because plantation forestry is still at its infancy stage. The extent to which resource from the genebanks can be used would be determined by the market situation and economic considerations.

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DISCUSSIONS

Dr. Efransjah

I notice that certain species in the genebank were represented by individual tree. Can you explain?

Julaihi

The two genebanks were established in 1999 for this project. These are the first two genebanks in Sarawak. Among the objectives were to identify criteria for development of genebank in other part of Sarawak. To overcome the problem of low density for certain species we need to increase the size of the genebanks or to set up the genebanks where these rare species occur.

Dr. Efransjah

Yes. You either increase the area of the genebank or replicate the genebank.

Dr. Haryadi

What is your priority, the exploration of genetic resources or just the collection and species identification?

Dr. Nengah Wirawan

To overcome your problem of low species density or rare species, I suggest that you have the whole of LEWS as genebank area. My second suggestion is that your study should base on forest types or habitats so that you can correlate the species to the habitats, then you will have replicates of species and gene existing in the area. Are the two genebanks having the similar habitat in terms of soil, geology and elevation?

Julaihi Abdullah

We did not carry out any genetic variation study in the genebanks. However the establishment of the genebanks involved the selection of suitable tree species. The selected trees are marked, mapped, identified, and measured for the diameters and heights. The form and condition of the tree are also recorded. We are now monitoring the phenology of the genebank trees.

The two genebanks were established at different altitudes. One is at Sungai Ensirieng at 230 to 250 m a.s.l. which is a lowland dipterocarp forest while the other at 600 to 700 m a.s.l. is in the transition of lowland dipterocarp forest to hill dipterocarp forest. That may explain only four species are common.

Dr. Efransjah

The point raised by Dr. Nengah is that as the whole of LEWS is almost undisturbed, the Sanctuary itself is a genebank. Are these the only two genebanks in Sarawak?

Julaihi

Yes.

Dr. Paul Chai

We still need more information on genebank establishment and method of survey so that we can include a good diversity of species and individuals. We also need guidelines on the monitoring of phenology, seed collection and storage procedures, and nursery techniques and breeding programmes. The establishment of these two genebanks is our first experience, and I welcome comments and suggestions on how we can improve in this particular field.

Dr. Efransjah

Although ITTO supports more than 200 projects this genebank establishment is the first one. How much does it cost to establish a genebank?

Dr. Paul Chai

The cost to establish a genebank is not very much. It takes 3 to 4 weeks to set up one genebank. However species identification will take a much longer time. The consultancy for establishing the two genebanks, including writing the report was six months. We would need expertise and trained personnel in genebank management.

Dr. Soepadmo

It may not be quite correct to say that the two plots you set up in LEWS are the first of its kind. In Sarawak and Peninsular Malaysia there are many research plots, including the 52 ha long-term ecological research plot in Lambir and the 50 ha plot in Pasoh. The only difference is that they are not called genebank plots. You can learn a lot from the 52 ha plot in Lambir, where all trees above 1.0 cm diameter are measured, labelled and mapped, the species distribution, the status of the species whether it is rare or common and so on. You can examine the Lambir data and identify the species particularly the fast growing species and medium-fast species that will be of future importance in forestry plantation. You can then focus your aim on the species for your future genebanks.

Julaihi

The objectives of genebanks are different from the objectives of research plots and the 52 ha plot in Lambir. The Lambir plot is a long-term growth and yield plot. If we add the objective of seed production to the Lambir plot, then it can be considered as a genebank plot.

Dr. Efransjah

Then you will have many genebank plots.

Julaihi Abdullah

In that sense, yes.

Dr. Efransjah

How would the fast growing indigenous species you have chosen for the genebank respond to the future market?

Julaihi Abdullah

In my opinion, instead of relying on the exotic species such as *Acacia mangium* which has not proved to be successful in Sarawak, we should choose our own forest growing indigenous species for the forest plantation. We have quite a number of fast growing species but we still need to study which species are more suitable.

Joseph Jawa

Will the genebank activity be extended to Phase III? I am of the opinion that the genebank activity should compliment the Planting Material Procurement Programme that has already identified 67 seed production areas in Sarawak.

Dr. Paul Chai

Yes. We will be looking at other habitats and species of potential use from these habitats when we establish the genebanks in Phase III. We will also be working closely with the Forest Department vis-a-vis the genebanks and seed production areas.

Dr. Lim Meng Tsai

Perhaps there should be a similar genebanks for non-timber, non-tree species of ethnobotanical values.

Tachrir Fathoni

Can your genebank study be extended to include tree improvement? In Indonesia, we collect the seeds from the trees that have been selected, develop an *ex situ* tree orchard and from these tree orchard we then develop the clonal seeds.

Dr. Paul Chai

The tree improvement can be linked to the planted forest programme in which two nurseries, one for exotic species and the other for indigenous species have been established. When seeds from the genebanks or other permanent plots are available, these seeds can be given to the nurseries for their study in the tree improvement programme. So there is a need to set up more genebanks and seed production areas. We know what species are preferred by the private sectors but we do not know exactly where these species are concentrated in the forests. This is one area we have to look into in the establishment of genebanks.

Ethnobotanical Survey in the Lanjak Entimau Wildlife Sanctuary

by

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Abstract

A survey on the uses of forest plants by the local communities was first carried out in conjunction with the ecological studies in Phase I in 1993 – 1995. In the present study more than 400 species with a wide variety of uses were recorded. The main uses included food, medicine and materials for construction, boat building, household items and handicrafts. Less well-known uses included dyes, shampoo, soap and perfume.

The local communities still have a good knowledge of the forest plants as a source of food and building materials but are much less familiar with those that possess healing properties due to increasing dependence on modern medicine. This is also generally true in other parts of Sarawak.

A changing international trend in recent years is the increase in recognition of the importance of biodiversity conservation in resource management and the central role of non-timber resources in sustainable forest management. In 1993, ITTO incorporated biological conservation in its guidelines on the sustainable management of tropical production forests. This trend is closely related to the various activities implemented in the LEWS project.

1.0 INTRODUCTION

There are 102 Iban longhouses scattered along the buffer zone of the Sanctuary with a total population of about 12,400 individuals (Jiram 1994). Many of the longhouses are provided with basic facilities such as electricity from generators, toilets, piped water from mountain streams, bathing and washing areas. Children begin their education in Government primary schools, then move to secondary schools located in nearby towns.

Although the number of longhouses and population are large, only residents from a few longhouses located immediately outside the Sanctuary's boundaries really have a little impact on the Totally Protected Area (TPA). They have been granted special priviledges by the Government to hunt and collect jungle produce in the Sanctuary for domestic use only. Three areas have been designated specifically for this purpose, but this does not restrict many of them from wandering into other parts of the Sanctuary.

Shifting agriculture is still very much a part of the Iban culture, though its practice is becoming increasingly confined among the older men and women folks. Out-migration among the younger generations is increasing in momentum, mainly for the purpose of employment and education. Knowledge on useful plants from the forests on which the local communities have depended for many generations in the past for food, medicine and construction materials largely remains with the older people. The younger generations have generally shown little interest in acquiring this knowledge from their elders. In particular, knowledge on medicinal plants is disappearing fast. The rural communities are able to seek medical help in many areas where Government clinics are already available. A wide variety of both Chinese and Western medicines for common ailments such as headache, fever, pain, stomach complaints and rheumatism are easily obtainable from village shops or shops in the nearby towns. In most cases patients are reluctant to seek alternative medicine even when modern medicines are not available. Many patients seem to prefer to suffer in silence and let nature take its course. In most of the longhouses visited, there is no medicine man or *manang* to provide traditional healing services.

Ethnobotanical surveys during Phase I of the project covered the areas in the Ulu Mujok and Ulu Engkari in the north-west and south-west regions of the Sanctuary respectively. The surveys investigated the uses among indigenous plant species for medicine, food and other purposes by the local Iban communities. In addition, medicine men from the Kedayan and Lun Bawan communities were brought in from northern Sarawak to assist in the surveys. These two communities revealed a different group of plants for a variety of uses.

Findings from Phase I included:-

(i) 157 species of plants containing medicinal properties;
(ii) 36 varieties of wild vegetables;
(iii) 114 varieties of wild fruits

The surveys concentrated on resources in the Sanctuary but also covered plants in the secondary forest and wasteland in the buffer zone. The secondary vegetation is an important source for numerous plant species. The medicinal uses of many species are more familiar to many longhouse residents and than those in the primary forest.

The fruits are not only consumed by humans but also by animals. During the primate survey 62 species were identified as important diet for the orangutans and five other species of primates, wild boar, deers and birds (Blouch,1993).

2.0 METHODOLOGY

Phase II surveys adopted a similar approach as in the previous phase but covered new areas in the Ulu Kanowit and Ulu Skrang regions. In each longhouse information was gathered through interviews and dialogues with the residents. Informants with good knowledge were employed for field work. Ethnobotanical information included plants with medicinal properties, wild vegetables and fruits, materials for house construction, boat building, poles, tools, handicrafts, as well as plants used in rituals and ceremonies.

For the purpose of keeping a permanent herbarium record, the following data were noted and recorded in the Sarawak Forest Department Herbarium collecting books:-

(i) Botanical and vernacular names of the plants;
(ii) Locality and habitat;
(iii) Habit of each plant (whether trees, shrubs, climbers or herbs, etc.)
(iv) Uses of each plant, the parts used, and method of preparation and administration in the case of medicinal plants.

Voucher specimens for common and well-known species were not collected. All voucher specimens collected were deposited in the Sarawak Forest Department Herbarium as permanent record.

Eight longhouses visited in the Ulu Sg Kanowit area included two that were surveyed during Phase I.

(i) Rumah Jarau, Rantau Limau;
(ii) Rumah Mauwa, Nanga Mesit;
(iii) Rumah Ansat, Nanga Mesit;
(iv) Rumah Lait, Nanga Selapong;
(v) Rumah Nyaiyang, ulu Sg Ensirieng (surveyed during Phase I);
(vi) Rumah Jayang, Nanga Ensirieng;
(vii) Rumah Unjang, Nanga Ensirieng; and
(viii) Rumah Gerasi, Nanga Ju, Mujok (surveyed during Phase I);

Of the people interviewed, Mr. Rangga from Rumah Lait was the most knowledgeable. Rumah Jarau was the last longhouse in the upper reaches of the Kanowit River with 54 doors or families.

The other study area covered six longhouses in the Ulu Skrang.

(i) Rumah Rantai;
(ii) Rumah Minggat;
(iii) Rumah Abon;
(iv) Rumah Chaong;
(v) Rumah Dau; and
(vi) Rumah Bau

These Iban communities still practise traditional shifting agriculture but have also ventured to small-scale pepper and rubber planting. Their daily needs are supplemented by hunting and gathering of jungle produce from the nearby forests.

3.0 FINDINGS

The information was classified into a number of categories based on uses. Food and medicine were the most popular categories. Out of the total 245 species or varieties recorded from Ulu Kanowit, 176 or 72% were found to have edible parts including oil from fruits, while 57 species or about 23% possessed medicinal properties. In the Ulu Skrang area, species with edible parts amounted to 113 species or 49% out of the total 233 plants while medicinal properties comprised 61 species or 26% (Table 1). All collections are listed in Appendices 1a – 1h.

3.1 Wild Vegetables

The Iban farmers in the buffer zone generally do not grow enough vegetables to meet their daily needs. Vegetable growing may be regarded as an activity normally associated with rice planting which falls annually between June and August. Tapioca leaves are one of the very few vegetables that are available all year round and are consumed regularly. This perennial crop is grown beside rice farms and longhouse compounds. Wild vegetables are readily consumed when planted vegetables are not available.

The number of wild vegetables from Ulu Kanowit and Ulu Skrang total 102 (see Appendix 1a). These are classified into young leaves and cabbages and young stems. Species that produce edible young leaves are trees, shrubs and treelets in the undergrowth. Cabbages and young stems are mostly obtained from palms including many rattans. The majority of the plants are known only to the local people.

Table 1 Plants and their uses in ulu Kanowit and ulu Skrang

Uses	Number of species	
	Ulu Kanowit	Ulu Skrang
Vegetables Young leaves cabbages (young shoots)	 35 44	 17 16
Flavouring (leaves, fruits)	3	9
Fruits	89	70
Oil	5	1
Medicine	57	61
Mats and other household items, fish traps	4	18
Fish poison	1	4
Shampoo/soap	1	1
Construction (Boats and thatching)	-	5
Dye	1	5
Bark	-	7
Latex Knife handle Anti-adhesive	 - -	 1 1
Pepper post	-	2
Leaves for wrapping	-	3
For polishing	-	1
Decorative	-	1
Betle leaves	-	1
Perfume	1	3
Strainer	-	1
Heat insulator	-	1
Cigarette wrapper	-	1
Protection again evil spirits	4	3
Total	245	233

3.1.1 Young leaves or *Kantok*

Wild vegetables are made up of young leaves and cabbages in nearly equal proportions. The young leaves or *kantok* in the Iban language are obtained from a wide variety of trees, shrubs, herbs and climbers. The most popular among these are the ferns *Diplezium esculentum (paku)* and *Stenochlaena palustris (midin)*. These ferns are also much sought after by the urban consumers. One reason for this is that as wild plants they are free from pesticides.

Kantok are also obtained from *Gnetum gnemon (daun sabong)* and *Pangium edule (kepayang)*, respectively a treelet and tree growing near inland river banks. These are sold in many jungle produce stalls in town but are not as popular as the ferns. *Kantok* from *Mangifera pajang (mawang)* and *Elateriospermum tapos (kelampai)* are less well-known. All four species also produce edible fruits. The fruits of *Pangium edule* contain a hydrogen cyanide compound and must be boiled in water for many hours before they can be eaten. Victor and Surik (1985) reported an additional use of the seeds for perfume and soap. The fruits are dried thoroughly to remove the poison, ground into fine powder and applied as a perfume. The dried seeds are used as soap.

Jiram (1994) found that the most popular vegetables were *Gnetum gnemon*, *Stenochlaena palustris* and *Diplezium esculentum*. They were consumed by up to 97% of the households in Ulu Kanowit and Ulu Ngemah but were less popular in the Ulu Katibas. The other popular vegetables were *Pangium edule* and wild mushrooms *(kulat)* Chin (1998). Thirty seven species of edible mushrooms were recorded from the Sanctuary.

Daun sabong (*Gnetum gnemon*) and jungle mushrooms are beginning to gain popularity among the urban dwellers for the same reason as *midin* and *paku. Daun sabong* is traditionally eaten as a salad or added to meat and fish but is also good as a vegetable when fried with garlic or prawn paste.

3.1.2 Cabbages and Young Stems

Thirty seven species of palms, 4 species of gingers and 3 species of bananas are known to produce edible parts including cabbages, undeveloped leaves and young pseudo-stems. Of the 37 species of palms, 27 are rattans. The cabbages and undeveloped leaves are normally cooked but many of the palm cabbages can also be eaten raw. The young stems of gingers are strongly aromatic and are used for flavouring meat and fish dishes.

Palms have a wide distribution in a variety of habitats and are most common in the lowland mixed dipterocarp forest. Their habits range from the climbing rattan to the tall woody-stemmed *Eugeissona (pantu)* and *Oncosperma (nibong)* spp. up to a height of over 25 m, and the smaller *Licuala (palas, biruk)* and *Salacca (ridan)* of the undergrowth. The edible rattans belong mainly to species of *Calamus, Daemonorops, Korthalsia* and *Plectocomiopsis*. They constitute an important diet among the local hunters and forest produce gatherers, and are also sought after by forestry officers and surveyors who may run out of food before the end of their trips.

There is very little documentation about the properties and food value of the palm cabbages and young leaves. However, there are isolated reports that lethargy, weak joints or rheumatism may result if too much is consumed on a regular basis. The stem apex of the rattan *Plectocomiopsis geminiflora* is believed to be very good for preventing or relieving diabetes and has a very bitter taste.

The gingers and bananas are associated with secondary vegetation as they colonise shifting cultivation sites, forest gaps and clearings, and are common in logged-over forests. The gingers grow best in shady environment and many have a clustering habit. The bananas are more widespread and may colonise an entire hillside after the rice is harvested.

The parts of the ginger and banana plants that are eaten are the young pseudostems and undeveloped leaves and meristems. These are obtained by peeling off the outer fibrous layers of leaf sheaths. They may be eaten as a vegetable after cooking or boiling in water, or added to meat and fish dishes. The strongly aromatic gingers, in particular the *Hornstedtia magnifica* (*kecala)* and *Etlingera fimbriobracteata (tepus)*, constitute a very important ingredient in local cooking. Its young inflorescences are also used. The ripe fruits can be eaten raw and have a sweet and sour taste.

3.1.3 Plants used for Flavouring

The rural communities cook simple but tasty food. Although aji-no-moto is widely used nowadays, natural food flavouring agents from the forest still remain a favourite among many ethnic tribes (see Appendix 1c).

Apart from the popular gingers *Etlingera fimbriobracteata* (*tepus*) and *Hornstedtia magnifica* (*kecala*), nine other species have been recorded. These consist of seven trees, two climbers and one herb. The more well-known species among the trees are *Eugenia cephalanthum* (*bungkang*), *Pangium edule* (*kepayang*), *Garcinia forbesii* (*kundong*) and *Garcinia parvifolia* (*chirei*). The young leaves are cooked with fish or meat to produce an acidic or sour taste. The *Garcinia* fruits are similarly used. The fresh fruit walls of *Garcinia forbesii* may be dried and kept for later use. The leaves of *Pangium edule* serves an additional function of preserving meat when making *kasam,* a meat dish preserved in salt in bamboo containers. The leaves are finely cut and mixed thoroughly with the fresh meat before putting them in bamboo containers. The leaves keep houseflies out and prevent their eggs or larvae from hatching or growing on the meat.

Scorodocarpus borneensis is aptly called *bawang hutan* in the local language, meaning forest garlic. The fresh bark, leaves and fruits emit a very strong garlic smell. It is not a favourite flavouring agent because many find the smell too pungent and repulsive.

The climbers with leaves used for flavouring are *Embelia ribes (akar kencham)* (Myrsinaceae) and *Pycnarrhena borneensis (daun tubu)* (Menispermaceae). The leaves of the *Begonia* spp. are similarly used although this herb is better known for its ornamental value.

3.2 Wild Fruits

Fruit trees constitute an important food chain of the forest ecosystems. The majority of them are confined to the lowland habitats from alluvial forest to mixed dipterocarp forest. They are relatively rare in the secondary forest except for members of some families such as the Moraceae (e.g. *Artocarpus* spp.) and Leguminosae (e.g. *Pithecellobium jiringa*). The 1994 primate survey found a high concentration of fruit trees in the southern region of the Sanctuary covering Mabau, Lelap and Batang Ai. This region is the stronghold of the orangutan (Blouch, 1994).

Between 70 and 89 species were recorded in the Ulu Skrang and Ulu Kanowit respectively, with the total number amounting to 127 species (Appendix 1b). The major fruit producing families are the Moraceae (19 species), Sapindaceae (15 species), Euphorbiaceae (9 species), Palmae (12 species), Fagaceae (7 species), Anacardiaceae and Zingiberaceae (7 species each), and Bombacaceae (5 species) and Dipterocarpaceae (4 species). Popular species with potential economic value have been cultivated. Chief among these are *Canarium odontophyllum* (*dabai*; family Burseraceae), *Artocarpus* spp. (*pingan, pedalai, cempedak*, etc, family Moraceae), *Nephelium* and *Dimorcarpus* spp. (*sibau, engkilili, serait,* etc, family Sapindaceae), and *Mangifera* spp. (*embang, raba,* etc, family Anacardiaceae). Many of these fruits are available at the local markets during the fruiting seasons.

In view of the increasing popularity of local fruits and the many varieties available, there is great opportunity for selection and propagation of high quality and high yielding species. The Sarawak Department of Agriculture has carried out selection and propagation of a number of species including *Canarium odontophyllum* (*dabai*), *Dimocarpus longan* (*isau*) and *Durio* spp. (*durian*), and studied the nutritional status of other species. As yet, none of the species has been developed on a commercial scale.

The forest fruits not only provide nutrition to humans but are also a major food source for numerous species of primates and birds. At least 62 species are eaten by *orangutan* and other primates. The genera that are especially important and are preferred by *orangutan* are *Durio, Baccaurea, Castanopsis, Lithocarpus, Garcinia, Artocarpus, Ficus* and *Nephelium* (Blouch, 1994). Figs (*Ficus* spp.) are a prime food source for the birds especially the eight protected species of hornbills. All forest species of *Ficus* are protected in Sarawak.

3.2.1 Edible Oil

For generations, the Iban people have extracted *minyak engkabang* or illepe nut oil from the fruits or nuts of the *engkabang* trees. The Iban communities in the LEWS buffer zone extract the oil from five species of *Shorea* in the family Dipterocarpaceae. These are *Shorea beccariana* (*engkabang langgai*), *Shorea macrophylla* (*engkabang jantong*), *Shorea seminis* (*engkabang terendak*), *Shorea smithiana* (*engkabang rambai*) and *Shorea splendida* (*engkabang bintang*) (Appendix 1c). All *engkabangs* species are protected in Sarawak.

With the exception of *Shorea beccariana* which occurs on ridges on clay soil, the other species are found on clay alluvial and lower slopes of clay hillsides. The favourite among these is *Shorea macrophylla* which produces the largest nuts with the highest oil content. Many trees have been planted near river banks for the fruits, while older trees are ocassionally cut down for boat building and construction. Flowering is infrequent and a bumper crop is expected only at three to five-year intervals. When the fruits are about to fall, nets or simple wooden barriers are erected across rivers and streams to trap the fallen fruits.

To extract the oil, the fruit walls are removed and the kernel dried under the sun. The dried kernel is pounded thoroughly and fried in a *kuali* until the oil begins to appear. The warm kernel is put in a small bamboo container and pressed between two pieces of wood to squeeze out the oil, which is collected in a bamboo container. This pressing process is repeated two to three times until all the oil is extracted. The kernel is fried before each subsequent pressing. The oil cools into a yellow solid inside the bamboo container.

The fragrant oil adds a delicious flavour and taste to cooked rice and enhances one's appetite. The solidified oil melts quickly when its end is dipped into a plate of steaming hot rice. It is occasionally used to prepare fried rice.

Commercial use of the engkabang oil is for the manufacture of chocolates and cosmetics such as lipsticks and face cream. During the bumper crops in 1982, 1987, 1990 and 1995, between 12,746 and 23,444 tons of the nuts, valued at 13 to 17 million Malaysian ringgit were exported from Sarawak. (Chai & Dick, 1995). The problem with introducing the crop into large scale cultivation for nut production is the long and irregular flowering and fruiting periods. Nevertheless, *Shorea macrophylla* has been selected as a potential plantation species due to its medium-fast growth rate and fine quality timber.

3.3 Traditional Medicine

The practice of traditional medicine among the Iban people has an equally long history as the use of wild plants for food and construction materials. In the olden days herbal remedies provided the only relief when modern medicine was not available. The medicine was usually administered through *bomohs* or *manangs* (medicine men). Depending on the ailments, the healing process would often involve some kind of rituals during which spirits would be called upon to help, through prayers and chanting of verses. Today, whatever knowledge on traditional medicine and healing that remains is confined within a small group of elderly people. Much information has been lost with the death of *bomohs* or *manangs* who were the most knowledgeable on the subject.

In Sarawak, ethnobotanical surveys among the different ethnic groups began in the late 1970s. The first report mainly on medicinal uses of 285 species was compiled in 1989 (Chai *et al*). This number has since been increased by more than three-fold with more information collected by the Sarawak Forest Department. The records from the major ethnic groups are shown below:-

Iban	234 species
Bidayuh	216 species
Malay & Melanau	164 species
Orang Ulu	387 species
Chinese	57 species

Included in the Orang Ulu group are the Kelabit, Kayan, Kenyah, Penan and a number of other minor communities such as Kedayan, Kiput and Bisayah. Over 90% of the uses are for medicinal purposes. While the surveys concentrated on the indigenous people, some information was also collected from the Chinese community. Two other studies that contained information on medicinal uses were by Victor and Surik (1985) from the Iban communities in the Pantu sub-District in Sri Aman Division, and Christensen H. (1995) from the Iban communities in the upper Batang Ai and Sungai Delok area and the Kelabit communities in the Kelabit Highlands.

In the present survey, 101 species of wild plants were reported to possess medicinal properties (Appendix 1d). They occur in a variety of habitats in primary and secondary forests. They have been grouped into eight categories according to their functions to treat different ailments (Table 2). The most popular categories are treatment of various types of skin diseases, body pains and swellings, fever, malaria and cholera, snake and insect bites, and stomach ache, gastric, diarrhoea and vomiting. A full description of the uses are given in Apendix 1c.

Table 2 Uses of medicinal plant from Skrang and Kanowit

Uses	Ulu Skrang	Ulu Kanowit
Skin diseases including itichiness, herpes, ulcers	12	7
Body pain & swellings	11	1
Fever, malaria, cholera	9	3
Snake & insect bites	7	5
Stomach ache, gastritis, diarrhoea, cough, vomiting	10	6
Eye infection	-	5
Cuts & wounds	4	6
Recovery after birth	-	5

Minor uses includes small pox, goitre and sore eyes were recorded from Ulu Skrang, and bone fracture, birth control, breast cancer, etc. from Ulu Kanowit

Remedies for other ailments are less well known, such as *Grammatophyllum speciosum*, a giant orchid, for jaundice in newborn babies, *Torenia polyonoides* (Scruphulariaceae) for goitre, a *Massaenda* spp. (Rubiaceae) for birth control, and *Adenostemma lavenia* (Compositae) for breast cancer.

The informants prescribed remedies to treat diseases based on the symptoms although the actual cause of the problem might not be known. Fever, headache and stomach ache can be due to a number of different causes.

In many instances, information about the nature of a disease was detected based on the informants' description of the symptoms. Thus *"sakit kuning"* (yellow sickness) in newborn babies is recorded as jaundice, swollen neck is linked to goitre, *sakit pinggang* or lower back pain not caused by physical injuries may be associated with kidney problems.

In most of the treatments, the herbal preparations are administered orally. The amount of materials is difficult to ascertain. The recommended dosage is normally a handful of leaves or a few pieces of roots or bark. For small herbs, the whole plant or a few plants may be used. The recommended dosage is usually once or twice daily until the patient is cured.

Although much information on the uses of jungle herbs is still available, in practice very little of them is used as most patients prefer to go for modern medicine instead. The local communities are generally more familiar with the many herbs from the young secondary jungles and farms close to their longhouses, while knowledge of the primary forest species is usually limited to few older people.

The wealth of indigenous knowledge on the medicinal properties of forest plants contributes an important database for use in research and discovery of new products or remedies to satisfy man's needs. In order to widen the resource base, continuing effort should be made to establish more TPAs in the State's remaining pristine forests for the preservation of more genetic materials from a variety of forest ecosystems.

3.4 Firewood

Firewood or fuelwood is an essential item for cooking in longhouses and farms and while travelling and camping in the forest. The local communities can easily identify fuelwood that can be used not only when dry but also when it is still fresh and wet. Regular jungle travellers such as Government officers on field duties and hunters and gatherers from the local communities will appreciate the knowledge of what freshly cut wood can be used when they have to quickly set up camp and start a fire during or after a heavy rainstorm when everything in the forest is wet. Dead stem or branches are not as popular either because they do not burn readily or burn too quickly. In the latter situation more wood would have to be collected. Dry branches that burn well are often used as splinters to start a fire.

The Iban classify firewood generally into three groups depending on the ability of the wood to burn. The first group refers to wood that burns easily when fresh. This includes all species of *Lophopetalum* *(perupok)* (family Celastraceae), *Agathis* (*bindang)* *(*Araucariaceae) and a few species of *Mallotus* in the Euphorbiaceae especially *Mallotus penangensis* (*ensarai*) and *Mallotus muticus* (*belati*).

The second group of fuelwood burns easily as soon as some moisture from the freshly cut wood is removed by placing it beside or above a fire place. Examples are all species of *Parastemon (ngilas)* (Rosaceae), many species of *Lithocarpus* (*empili)* (Fagaceae) and *Diospyros* *(kayu malam)* (Ebenaceae), hill species of *Eugenia syzygium* (*ubah)* and *Tristaniopsis* (*selunsor)* (Myrtaceae), *Knema* and *Myristica* (*kumpang)* (Myristicaceae) and *Elateriospernum tapos (kelampai)* (Eurphorbiaceae). Although *Horsfieldia* belongs in the same family as *Knema* and *Myristica*, its wood does not burn as easily and is referred to as *kumpang lusu* or "lazy *kumpang*" by the Iban.

The third group includes wood which must be sufficiently dried before it can be used. Included here are species of *Baccaurea* (Euphorbiaceae), in particular *Baccaurea lanceolata (limpaong)* and *Baccaurea angulata (uchong)*. *Horsfieldia* spp. (*kumpang lusu*) also belongs in this category. The fresh wood is cut, split and brought back to the kitchen and dried above the fire place.

In recent years, the local communities in the buffer zone have gradually switched from firewood to the use of gas. Gas tanks are purchased from nearby towns and brought to the longhouses in longboats. Nevertheless, wood fire is still preferred during communal cooking when large quantities of food need to be cooked.

3.5 Construction Materials

The forest provides ample materials for the construction of longhouses, farm huts and longboats. Selection of timber for house construction is based on end use. Strong and durable timber such as *belian (Eusideroxylon zwageri)* and *selangan batu (Shorea* spp.) are used for main support. Most other less durable and often decorative species are selected for a variety of uses such as general structuring or framing, walling, flooring and boat building.

Many species used in house construction are also good for boat building. As longhouses are traditionally built along the rivers, longboats provide an essential means of communication and transportation of farm products and materials.

Sources of construction and building materials come from 29 families of forest trees of which the Dipterocarpaceae is the most important (Appendix 1e). The majority of the species belong to *Shorea*, a genus that includes the *meranti* and *selangan batu*. Species of *Dipterocapus (keruing), Dryobalanops (keladan, kapur), Upuna borneensis (penyau)* and *Vatica (resak)* are much less commonly used, although *Upuna borneensis* is one of the favourite species for boat building whenever it is available.

In the olden days, *belian* shingles were widely used for roofing materials for longhouses. Each shingle was skillfully split by axe from blocks of solid wood. In recent years, due to the steady decline in supply and high cost of the timber, *belian* shingles have been replaced by metal sheets.

Materials for farm and jungle huts do not need to be durable as these huts are usually built for temporary use. While the main structures are built of timber, the walls and roofs are normally made from the leaves of palms, gingers, ferns and a few species of trees with large foliage, such as *Campnosperma (terentang)* and *Artocarpus (pingan)*. The bark of *Artocarpus* also makes good walling material but this is rarely used nowadays.

3.6 Mats and Baskets

Mats and baskets are regarded as valuable assets by the local communities. Every household, no matter how poor, will own at least a few of them. They are made for a number of uses. The best mats are kept exclusively for rituals and ceremonies. They are called *bidai* (Rajang Iban) or *idas* (Saratok Iban). A more common name is *tikai limpit.* They are made from long strips of good quality rattan held together by the inner bark of *tekalong (Artocarpus elasticus).* The best quality rattans are *wi letik* from the species *Calamus caesius* and *wi sega* from *Calamus optimus* (see Appendix 1f).

Mats are also used for sleeping, for entertaining guests and for drying of padi, corn, pepper and other farm products. The materials used are *rattan, bemban (Donax canniformis), kerupok* or *nas (Pandanus* spp.), *sengang (Hornstedtia* and *Etlingera* spp.) and bamboo.

Good mats are reserved for entertaining guests and for sleeping. *Bemban* mats are especially good for sleeping during warm weather because they are very cooling. Mats for drying purposes are normally made from materials of poorer quality.

The majority of the rattan belong to the species of *Calamus.* Species of *Daemonorops* and *Korthalsia* produce a number of well-known rattans called *wi lepa* and *wi tut (Daemonorops sabut, D. semoi),* and *wi danau (Korthalsia jala),* used to produce mats of medium quality.

The same materials are used to make a wide variety of baskets and containers. The largest of these baskets, called *lanji* are up to 1.5 m tall and 30 cm in diameter, and are used for carrying padi from the farm back to the longhouse. Due to the large size, big rattan canes are used to make a frame for support and to provide strength to the *lanji.* Padi containers may also be made from the bark of *Prunus arborea* (*enteli*) in the Rosaceae.

Ajat or *badok* are medium-sized baskets usually up to 60 cm high and do not have a frame. *Raga* are smaller than *ajat* and are usually carried as a backpack. Back straps for these baskets are made from the inner bark of *tekalong (Artocarpus elasticus*). In the olden days, this bark was also used to make clothing. *Selok* are worn as a waist pouch and are used for carrying pepper berries or padi during harvest. *Chapan* is a shallow spade-shaped container used for winnowing rice and for carrying and drying of small items. *Lupong* is a sacred item used only by the *manang* or medicine men to keep their medicine and other items for healing. It is a tabboo for anyone to step over a *lupang.*

3.7 Other uses

The forest plants have many other uses besides the ones already described. They produce a number of interesting products that are rarely known outside the local communities. In the olden days, when the rural communities were completely cut off from the outside world, they could only rely on the plants to provide them with such products as fibre, dyes, perfume, shampoo and soap. Today, these natural products are rarely used, but the knowledge that has been handed down would form the basis for research into the development of natural plant products and provide an opportunity for study on the sustainable exploitation of the rich plant resources to benefit mankind.

A list of the plants with less well known uses is given in Appendix 1g. Some of the more interesting uses are described below.

(a) Fibres

The most popular and useful fibres are produced from the bark of *Artocarpus elasticus* (*tekalong*). Uses include construction of walls and partitions, ropes, straps for baskets and containers, and belts.

Fibres from the bark of *Prunus arborea* (*enteli*) and leaves of *Curculigo latifolia* (*lemba*) (Hypoxidaceae) are used to make blankets (*pua kembu)* and clothing *(kain*). The fibres of *Curculigo* are from the long, lanceolate leaves. They are obtained by scrapping the upper and lower epidermis of the wetted leaves in water with split bamboo. The warp threads used to make *pua* and *kain* are first dyed. The parts of the threads where dyeing is not required are tied with the fibre.

The dry fibres of the climbers *Friesodielsia glauca* (*randau rarak*) (Annonaceae) and *Spatholobus* spp. (*penduk*) (Leguminosae) are used as fuses to start a fire. Fish lines are made from *Gnetum raya* (*akar tegang*). This is a climber of the primitive family Gnetaceae. The soft stems of the *resam* fern *Gleichenia linearis* (Gleicheniaceae) are used for making ornaments such as head bands and bangles and for decorating *parang* sheaths or scabboards after the hard outer covers are removed.

(b) Dyes

The two main colours of *pua kembu* are black and red. Black dyes are obtained from the leaves of *Rourea mimosoides* (*kayu kemarang*), *Symplocos fasciculata (jirak)* and *Morinda citrifolia (mengkudu),* and the tubers of *Tetrastigma pedunculare (buah tanah*). The last two species also produce red dyes. Other sources for red dyes are *Psychotria elmeri (engkerabai)* and the fruits of *Morinda citrifolia*. The dyes are extracted either from the fresh leaves, fruits or tubers.

(c) Perfumes

Many forest plants are strongly aromatic and fragrant. They have been used to produce substances such as spices *(Cinnamomum* spp.), incense (*Aquilaria* spp.) (Simaroubaceae) and oil (*Myristica fragrans*) (Myristicaceae). Recorded sources for perfumes are the fruits of *Lindera pipericarpa (medang serai)* and *Urophyllum hirsutum (duin*), and the stems and leaves of *Vandellia* spp. (*bunga penit*). *Lindera* is related to *Cinnamomum* (Lauraceae) while *Urophyllum* belongs to the same family as coffee in the Rubiaceae. *Vandellia* is a herb in the Scrophulariaceae.

(d) Shampoo and soap

The best known species for shampoo is *langir* or *Xanthophyllum amoenum*, a tree of the family Polygalaceae. It was popular also among other ethnic communities who lived in the more remote areas and is still occasionally available in jungle produce stalls and shops.

The ripe fruits are edible. The fruit skins are collected and dried. A few pieces of the dried fruit walls are boiled in a pot of water. A warm solution for hair wash is ready after adding cold water to get to a suitable temperature. The cleansing power of this product is so effective that the hair becomes "squeaky' clean and shiny after the wash.

Another species which is used both as a shampoo and a soap is the secondary forest shrub *Ilex cissoidea (aras)* of the Aquifoliaceae. When the fresh leaves are agitated or crushed in water, they produce a white lathery substance. This is used to rub on the body or hair. Soap is also similarly produced from the leaves of the small fleshy herb *rumput pupok (Salomonia cantoniensis)* also of the Polygalaceae. Sap from its fresh leaves is also used externally to treat snake bites.

(e) Insecticide

The people from Rumah Dau in Ng Entalau in the Sri Aman Division reported the use of the herb *Pogostemon articularis* (Labiatae) to kill bed bugs. Mats and mosquito nets infested with the bugs are soaked in a solution obtained from boiling the plant in water.

3.8 Rituals and ceremonies

It is the long tradition of the Iban people to appease the spirits of heaven, water and earth and to thank them for a bountiful rice harvest and good luck. A number of *Gawai* or festivals are performed each year for specific purposes, such as *Gawai Hantu* (festival of the ghosts), *Gawai Kenyalang* (festival of the hornbills) and *Gawai Dayak* which is the grandest and most important festival held to celebrate a good rice harvest. It is also the Dayak New Year which falls officially on 1 June each year.

During each festival, *miring* is performed. This is a ceremony to offer sacrifice to the spirits. The ritual or ceremony cannot be performed without a number of plants which are considered as sacred to the Iban people. These include the herbs *Cordyline terminalis (sabong)* (Agavaceae), *Costus glabra* and *Costus speciosus (letik* or *tepung buluh)* (Zingiberaceae).

Among the many uses, the most popular ones are to keep off malevolent spirits. The variety of plants used include the shrubs *Vernonia arborea (entupong)* (Compositae) and *Fagraea crassipes (sukong)* (Loganiaceae), and the herb *Homalomena sagittifolia (belingau)*. *Belingau* (Araceae) is also carried by hunters for good luck during hunting trips.

Although only 19 species were collected from the present study (see Appendix 1 h), the number used for rituals and ceremonies is much more. Recent studies have mentioned the uses of many other species (e.g. Victor and Surik 1985, Christensen 1995). Most of the plants from secondary forest are easily obtainable as they are near the longhouses. Others are available only from the more remote primary forest may require one or two days of travel to obtain. The local people usually have a good knowledge of where exactly a particular species may be found. A number of herbaceous species have been brought into cultivation such as *Cordyline, Homalomena* and *Costus* spp. *Cordyline* is also an ornamental plant.

4.0 DISCUSSION AND CONCLUSION

Many people are familiar with the tropical rainforest as a source of commercial timber and a limited number of non-timber products such as rattan and fruits. To the rural community the forest is much more than these. They have for many generations been dependant on the forest for protection, shelter, materials, food, medicine and recreation. Traditional shifting agriculture satisfies only a part of their need; most other necessities are derived from the forest.

Lanjak Entimau Wildlife Sanctuary is the only TPA in Sarawak where sustainable ethnobotanical survey has been carried out. The Sanctuary has contributed significantly to the livelihood of the Iban communities since they moved to the vicinity about 300 years ago. Although their dependence on herbal remedies has shown a significant decline particularly in recent years, they continue to rely on the forest for their daily subsistence and to supplement their cash income from limited farm products. It is for this reason that the people are granted special priviledges to hunt and collect jungle produce in certain designated areas of the Sanctuary. Commercial exploitation is however, not allowed.

A new perception of the local communities is the realisation that with the TPA come a healthy environment of clean air and water, and an abundance of plant products, game animals and fish. This is in great contrast to the condition experienced by people in areas affected by the logging industry. The LEWS project has also brought employment, training and assistance in community-oriented development in the buffer zone.

The Forest Department, under the Special Wildlife Committee, will ensure the sustainable development of the Sanctuary's resources through active local participation, while continuing surveys to build up a complete database on the non-timber resource and to explore other potential uses. One example is the development and commercialization of numerous species of ornamental plants in the forest. The development of local handicraft is also to be encouraged, particularly in the promotion of culture and eco-tourism in the Batang Ai National Park area adjacent to the Sanctuary. Materials for handicraft-making have been identified. These can be brought into cultivation through community-based development programme in the buffer zones.

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Appendix 1a Wild vegetables from Ulu Skrang and Ulu Kanowit

Family	Scientific Name	Vernacular Name	Parts used
Agavaceae	*Dracaena gracilis*	Sabong kura	Young leaves for vegetables
Anacardiaceae	*Mangifera pajang*	Daun mawang/embang	Young leaves, fruits
Anacardiaceae	*Swintonia acuta*	Daun pitoh ai	Young leaves
Araceae	*Colocasia esculentum*	Keladi	Tubers, leaves including petioles
Araceae	*Scindapsus perakensis*	Daun akar gemalong	Young leaves
Aspleniaceae	*Asplenium nidus*	Daun rajang	Young leaves
Athyriaceae	*Athyrium esculentum*	Paku kerjaie	Young leaves
Begoniaceae	*Begonia* spp.	Daun riang	Young leaves
Blechnaceae	*Blechnum orientale*	Paku/daun kelindang	Young leaves
Blechnaceae	*Stenochlaena palustris*	Midin	Young leaves
Celastraceae	*Lophopetalum* sp. 1	Daun kerupok/perupok	Young leaves
Clusiaceae	*Garcinia* spp.	Daun kandis	Young leaves
Convolvulaceae	*Ipomoea gracilis*	Daun akar kemibit	Young leaves
Cyatheaceae	*Cyathea polypoda*	Paku mungut	Young leaves
Dennstaedtiaceae	*Pteridium aquilinum*	Paku bedegak/resam	Young leaves
Dilleniaceae	*Dillenia beccariana*	Daun buan	Young leaves
Dioscoreaceae	*Discorea alata*	Ubi	Tuber
Elaeocarpaceae	*Elaeocarpus glaber*	Minggur	Young leaves
Euphorbiaceae	*Claoxylon longifolium*	Daun sepang/kesepang	Young leaves
Euphorbiaceae	*Elateriospermum tapos*	Daun kelampai	Young leaves, fruits
Euphorbiaceae	*Euphorbiaceae*	Daun mendai	Young leaves
Euphorbiaceae	*Manihot esculenta*	Daun pasak	Young leaves
Euphorbiaceae	*Trigonopleura malayana*	Daun kayu sedi	Young leaves
Gnetaceae	*Gnetum gnemon*	Daun sabong	Young leaves & shoots, fruits
Gnetaceae	*Gnetum raya*	Daun tengang	Young leaves
Lauraceae	*Litsea garciae*	Daun engkala	Young leaves, fruits
Leguminosae	*Derris malaccensis*	Tubai padi	Young leaves
Leguminosae	*Parkia speciosa*	Petai	Beans
Leguminosae	*Saraca declinata*	Daun babai ai	Young leaves, fruits
Leguminosae	*Spatholobus ferrugineus*	Akar kemedu	Young leaves
Liliaceae	*Smilax borneensis*	Kuntum meludang	Young shoots
Liliaceae	*Smilax odoratissima*	Randau meludang	Young shoots
Moraceae	*Artocarpus nitidus*	Daun selanking	Young leaves
Moraceae	*Ficus grossularioides*	Daun lengkan	Young leaves, fruits
Moraceae	*Ficus* sp.	Daun ros/keros	Young leaves
Moraceae	*Ficus stolonifera*	Daun jengkong/ entimau	Young leaves, fruits
Musaceae	*Musa acuminata*	Lingki	Young pseudostem
Musaceae	*Musa* sp. 1	Gritum	Young pseudostem, flower buds

Family	Scientific Name	Vernacular Name	Parts used
Musaceae	*Musa* sp. 2	Pisang	Young pseudostem
Musaceae	*Musa* sp. 3	Enteranjok	Young pseudostem
Musaceae	*Musa* sp. 4	Ranjuwai	Young pseudostem
Myrsinaceae	*Embelia ribes*	Daun akar kecham	Young leaves
Myrtaceae	*Eugenia cephalanthum*	Daun bungkang	Young leaves
Olacaceae	*Scorodocarpus borneensis*	Kesindu/bawang hutan	Young leaves, fruits (garlic)
Ophioglossaceae	*Helminthostachys zeylanica*	Paku tunjuk langit/ paku manis	Young leaves
Palmae	*Arenga brevipes*	Ridan/aping	Cabbage
Palmae	*Arenga undulatifolia*	Bo'	Cabbage
Palmae	*Calamus axillaris*	Wi tulang	Undeveloped leaves and meristem
Palmae	*Calamus conirostris*	Wi jernang	Undeveloped leaves and meristem
Palmae	*Calamus convallium*	Wi seru	Undeveloped leaves and meristem
Palmae	*Calamus flabellatus*	Wi takong	Undeveloped leaves and meristem
Palmae	*Calamus marginatus*	Wi matahari	Undeveloped leaves and meristem
Palmae	*Calamus optimus*	Wi sega	Undeveloped leaves and meristem
Palmae	*Calamus ornatus*	Wi jelayan	Cabbage, fruits
Palmae	*Calamus paspalanthus*	Wi tingkow	Undeveloped leaves and meristem
Palmae	*Calamus pseudoulur*	Rotan lembah	Undeveloped leaves and meristem
Palmae	*Calamus scipionum*	Wi marau/semambu	Undeveloped leaves and meristem
Palmae	*Calamus semoi*	Wi tut	Undeveloped leaves and meristem
Palmae	*Calamus* sp.	Wi lia	Undeveloped leaves and meristem
Palmae	*Caryota mitis*	Mudor	Cabbage
Palmae	*Ceratolobus subangulatus*	Wi janggut	Undeveloped leaves and meristem
Palmae	*Daemonorops fissa*	Wi rua ai	Undeveloped leaves and meristem
Palmae	*Daemonorops ingens*	Wi darum	Undeveloped leaves and meristem
Palmae	*Daemonorops microstachys*	Wi empunok	Undeveloped leaves and meristem
Palmae	*Daemonorops oxycarpa*	Wi tunggal	Undeveloped leaves and meristem
Palmae	*Daemonorops periacantha*	Wi empunok	Undeveloped leaves and meristem

Family	Scientific Name	Vernacular Name	Parts used
Palmae	*Daemonorops* spp.	Wi dudok	Undeveloped leaves and meristem
Palmae	*Daemonorops* spp.	Wi empunok	Undeveloped leaves and meristem
Palmae	*Elaeis guineensis*	Kelapa sawit	Cabbage
Palmae	*Eugeissona utilis*	Pantu	Cabbage
Palmae	*Iguanura curvata*	Tudong-pelandok	Undeveloped leaves and meristem
Palmae	*Korthalsia jala*	Wi dahanan	Undeveloped leaves and meristem
Palmae	*Korthalsia* sp.	Wi semut	Undeveloped leaves and meristem
Palmae	*Licuala* spp.	Geranis	Undeveloped leaves and meristem
Palmae	*Oncosperma horrida*	Nibong	Cabbage, fruits
Palmae	*Palmae*	Wi angsang keli	Undeveloped leaves and meristem
Palmae	*Palmae*	Wi bukop	Undeveloped leaves and meristem
Palmae	*Palmae*	Wi kelakup	Undeveloped leaves and meristem
Palmae	*Palmae*	Wi tekoyong	Undeveloped leaves and meristem
Palmae	*Palmae*	Wi terong	Undeveloped leaves and meristem
Palmae	*Pinanga crassipes*	Pinang mureng	Cabbage
Palmae	*Plectocomia mulleri*	Wi tibu	Undeveloped leaves and meristem
Palmae	*Plectocomiopsis geminiflora*	Laris/lalieh	Undeveloped leaves and meristem
Palmae	*Salacca affinis*	Ridan	Cabbage, fruits
Palmae	*Salacca vermicularis*	Lemayong	Cabbage, fruits
Rubiaceae	*Psychotria* sp.	Daun sugi raong	Young leaves
Rubiaceae	*Uncaria gambir*	Daun akar kelait/ gambir	Young leaves
Saurauiaceae	*Saurauia subcordata*	Daun migol/igol-igol	Young leaves
Sterculiaceae	*Pangium edule*	Kepayang	Young leaves, fruits preserved
Theaceae	*Ploiarium alternifolium*	Jinggau	Young leaves
Urticaceae	*Poilkilospermum cordifolium*	Entaban	Young leaves
Urticaceae	*Poikilospermum* sp. 1	Daun entaban	Young leaves
Violaceae	*Rinorea anguifera*	Daun siku ensluai	Young leaves
Woodsiaceae	*Cyclopettis presliana*	Paku ikan	Young leaves
Zingiberaceae	*Etlingera fimbriobracteata*	Tepus	Young pseudostem, fruits
Zingiberaceae	*Etlingera littoralis*	Sengang	Young pseudostem
Zingiberaceae	*Hornstedtia havilandii*	Panyun	Undeveloped leaves and meristem, fruits

Family	Scientific Name	Vernacular Name	Parts used
Zingiberaceae	*Hornstedtia magnifica*	Kecala	Undeveloped leaves and meristem, fruits
Zingiberaceae	*Hornstedtia reticulata*	Senggang	Undeveloped leaves and meristem, fruits
Zingiberaceae	*Plagiostachys strobilifera*	Banjang	Undeveloped leaves and meristem
Zingiberaceae	*Plagiostachys* sp.	Batak	Undeveloped leaves and meristem

Appendix 1b Wild Fruits from Ulu Skrang and Ulu Kanowit

Family	Scientific Name	Vernacular Name
Anacardiaceae	*Mangifera caesia*	Binjai
Anacardiaceae	*Mangifera foetida*	Buah kemantan
Anacardiaceae	*Mangifera indica*	Mempelam
Anacardiaceae	*Mangifera laurina*	Mempelam
Anacardiaceae	*Mangifera pajang*	Asam embang
Anacardiaceae	*Mangifera* spp.	Buah raba
Anacardiaceae	*Pentaspadon motleyi*	Buah pelajau
Apocynaceae	*Willughbeia sarawakensis*	Tabau/kubal
Apocynaceae	*Willughbeia* spp.	Buah kubal
Bombacaceae	*Durio graveolens*	Buah isu
Bombacaceae	*Durio oblongus*	Buah nyekak
Bombacaceae	*Durio* sp. 1	Buah tai anak
Bombacaceae	*Durio* sp. 2	Buah tutong
Bombacaceae	*Durio zibethinus*	Rian/durian nika
Burseraceae	*Canarium caudatum*	Merambang
Burseraceae	*Canarium odontophyllum*	Dabai
Burseraceae	*Dacryodes rostrata*	Kemayau/langain
Clusiaceae	*Garcinia forbesii*	Kundong
Clusiaceae	*Garcinia mangostana*	Manggis
Clusiaceae	*Garcinia* spp.	Kandis
Dipterocarpaceae	*Dipterocarpus apterus*	Buah ran/keruing letik
Dipterocarpaceae	*Dipterocarpus oblongifolius*	Buah ensurai
Dipterocarpaceae	*Shorea faguetiodes*	Buah barek
Dipterocarpaceae	*Shorea* sp.	Buah pelapok
Elaeocarpaceae	*Elaeocarpus floribundus*	Maboh
Elaeocarpaceae	*Elaeocarpus glaber*	Minggur
Elaeocarpaceae	*Elaeocarpus griffithii*	Perdu
Elaeocarpaceae	*Elaeocarpus nitidus*	Buah pabom
Elaeocarpaceae	*Elaeocarpus sphaeroblastus*	Buah tamang
Elaeocarpaceae	*Elaeocarpus stipularis*	Buah pensi
Elaeocarpaceae	*Elaeocarpus* spp.	Buah empedu
Euphorbiaceae	*Baccaurea angulata*	Ucong
Euphorbiaceae	*Baccaurea costulata*	Buah telo kejira
Euphorbiaceae	*Baccaurea edulis*	Buah penyal nyumboh
Euphorbiaceae	*Baccaurea hookeri*	Jelantik
Euphorbiaceae	*Baccaurea lanceolata*	Lempaong
Euphorbiaceae	*Baccaurea latifolia*	Buah pekang
Euphorbiaceae	*Baccaurea macrocarpa*	Puak
Euphorbiaceae	*Baccaurea macrophyllum*	Tampoi
Euphorbiaceae	*Baccaurea motleyana*	Rambai
Euphorbiaceae	*Baccaurea pyriformis*	Buah telur engjirak
Fagaceae	*Castanopsis clemensii*	Buah berangan bu’
Fagaceae	*Castanopsis oviformis*	Berangan pipit

Family	Scientific Name	Vernacular Name
Fagaceae	*Castanopsis psilophylla*	Buah berangan entadu
Fagaceae	*Castanopsis* sp. 1	Buah berangan kukut
Fagaceae	*Castanopsis* sp. 2	Berangan
Fagaceae	*Lithocarpus* sp. 1	Buah tangsang genok
Fagaceae	*Lithocarpus* sp. 2	Buah nankuk
Flacourtiaceae	*Pangium edule*	Buah kepayang
Gnetaceae	*Gnetum gnemon*	Buah sabong
Gnetaceae	*Gnetum raya*	Buah tengang
Guttiferae	*Calophyllum soulattri*	Bangkit
Guttiferae	*Garcinia beccarii*	Buah kendong
Lauraceae	*Litsea garciae*	Engkala
Leguminosae	*Dialium laurinum*	Engkeranji
Leguminosae	*Dialium* spp.	Buah keranji
Leguminosae	*Parkia speciosa*	Buah petai
Leguminosae	*Saraca declinata*	Buah babai ai
Melastomataceae	*Dissochaeta rubiginosa*	Randau kemunting burong
Melastomataceae	*Pternandra* sp.	Puloh
Meliaceae	*Lansium domesticum*	Langsat
Meliaceae	*Sandoricum borneense*	Buah kelampu
Moraceae	*Artocarpus anisophyllus*	Bintawak
Moraceae	*Artocarpus communis*	Pulor
Moraceae	*Artocarpus dadah*	Dadah
Moraceae	*Artocarpus elasticus*	Tekalong
Moraceae	*Artocarpus heterophyllus*	Nangka
Moraceae	*Artocarpus integer*	Cempedak
Moraceae	*Artocarpus kemando*	Pudau
Moraceae	*Artocarpus nitidus*	Selangking/pala tupai
Moraceae	*Artocarpus obtusus*	Pala tupai
Moraceae	*Artocarpus odoratissimus*	Buah pingan/lumok
Moraceae	*Artocarpus peltatus*	Buah dadak
Moraceae	*Artocarpus rigidus*	Pala musoh
Moraceae	*Artocarpus sarawakensis*	Pingan/Pedalai
Moraceae	*Artocarpus sericicarpus*	Pedalai
Moraceae	*Artocarpus tamaran*	Kakang
Moraceae	*Ficus cereicarpa*	Buah sampadai
Moraceae	*Ficus grossulariodes*	Lengkan
Moraceae	*Ficus stolonifera*	Buah jengkong/entimau
Moraceae	*Ficus uncinata*	Entimau
Musaceae	*Musa acuminata*	Lingki
Myrtaceae	*Eugenia polyantha*	Ubah bunkang
Palmae	*Calamus flabellatus*	Buah wi tekong
Palmae	*Calamus ornatus*	Buah wi jelayan
Palmae	*Calamus scipionum*	Wi marau
Palmae	*Calamus* spp.	Buah wi tunggal
Palmae	*Daemonorops* spp.	Wi empunok
Palmae	*Eugeissona utilis*	Buah pantu
Palmae	*Oncosperma horridum*	Buah nibong
Palmae	*Pinanga* sp.	Ayet

Family	Scientific Name	Vernacular Name
Palmae	*Plectocomiopsis geminiflora*	Laris/wi lalieh
Palmae	*Salacca affinis*	Ridan
Palmae	*Salacca sarawakensis*	Salak
Palmae	*Salacca vermicularis*	Buah lemayong
Passifloraceae	*Passiflora foetida*	Buah letop
Polygalaceae	*Xanthophyllum amoenum*	Langgir/mangok
Polygalaceae	*Xanthophyllum stipitatum*	Buah langir
Proteaceae	*Helicia* sp.	Palis
Rosaceae	*Rubus alpestris*	Buah emperingat
Sapindaceae	*Allophyllus cobbe*	Daun ising/mata kucing
Sapindaceae	*Dimocarpus fumatus*	Daun melikiang/kakus
Sapindaceae	*Dimocarpus* sp.	Buah dujong
Sapindaceae	*Guioa bijuga*	Maruniau
Sapindaceae	*Lepisanthes alata*	Engkilili
Sapindaceae	*Lepisanthes amoena*	Engkilili
Sapindaceae	*Nephelium cuspidatum*	Sibau
Sapindaceae.	*Nephelium lappaceum*	Karangan/sibau
Sapindaceae	*Nephelium maingayi*	Mujau/serait/sibau raras
Sapindaceae	*Nephelium mutabile*	Buah mak/kakus
Sapindaceae	*Nephelium mutabile*	Daun onak/mak
Sapindaceae	*Nephelium rambotan-ake*	Mak
Sapindaceae	*Nephelium uncinatum*	Melanjan
Sapindaceae	*Nephelium* sp. 1	Buah melakat
Sapindaceae	*Nephelium* sp. 2	Buah perapait
Sapindaceae	*Nephelium* sp. 3	Buah pari
Sapindaceae	*Pometia pinnata*	Buah kasai
Sapindaceae	*Xerospermum noronhianum*	Buah ilat/tudun biawak
Saurauiaceae	*Saurauia subcordata*	Buah migol/igol-igol
Solanaceae	*Solanum surathensis*	Terung asam
Tiliaceae	*Grewia* spp.	Buah bunsi
Zingiberaceae	*Etlingera fimbriobracteata*	Tepus
Zingiberaceae	*Etlingera littoralis*	Senggang
Zingiberaceae	*Hornstedtia havilandii*	Buah panyun
Zingiberaceae	*Hornstedtia magnifica*	Buah kecala
Zingiberaceae	*Hornstedtia reticulata*	Senggang
Zingiberaceae	*Plagiostachys strobilifera*	Banjang

Appendix 1c Plants used for flavouring and edible oil

(a) Flavouring agent (from Ulu Skrang)

Family	Scientific Name	Vernacular Name
Begoniaceae	*Begonia asperula*	Riang kura
Begoniaceae	*Begonia* sp.	Riang
Clusiaceae	*Garcinia forbesii*	Kundong
Clusiaceae	*Garcinia parvifolia*	Chirei
Menispermaceae	*Pycnarrhena borneensis*	Daun tubu
Myrsinaceae	*Ardisia patula*	Randau kacam
Myrtaceae	*Eugenia cephalanthum*	Daun bunkang
Violaceae	*Rinorea anguifera*	Siku ensluai

(b) Edible oil

Family	Scientific Name	Vernacular Name
Dipterocarpaceae	*Shorea beccariana*	Engkabang langgai
Dipterocarpaceae	*Shorea macrophylla*	Engkabang jantong
Dipterocarpaceae	*Shorea seminis*	Tergelam
Dipterocarpaceae	*Shorea smithiana*	Engkabang rambai
Dipterocarpaceae	*Shorea splendida*	Engkabang bintang

Appendix 1d A list of medicinal plants from Ulu Kanowit and Ulu Skrang (Lanjak Entimau Wildlife Sanctuary)

1. ACANTHACEAE

1.1. *Gendarussa vulgaris* Nees. (S.77063)
Daun penyapal abi (Ib)

Herb up to 1 m tall frequently planted around longhouse compound.

Leaves used for treating minor cuts. Pounded fresh leaves are used as a poultice.

2. AMARYLLIDACEAE

2.1. *Crinum asiaticum* Linn. (S.77055)
Jukal (Ib)

Succulent herb. Cultivated as an ornamental.

To aid recovery in mothers after giving birth. Boil plant in water to make a warm solution for bathing.

3. ANACARDIACEAE

3.1. *Pentaspadon motleyi* Hook. f. (S.77076)
Empelanyau/Pelangau/Pelajau (Ib)

A medium-sized tree of the inland riparian vegetation, with spreading crown and pinkish young leaves. Fruits are edible, either raw or cooked.

Bare footed walkers often develop cracks at the soles due sometimes to infection. These are cured by warming the fresh bark over a fire and rubbing the black exudate from the bark on the wounds. The bark and leaves are sometimes burnt to keep malevolent spirits away (Christensen, 1995).

4. ANNONACEAE

4.1. *Friesodielsia biglandulosa* (Bl.) Scheff. (S.77071)
Akar rarak (Ib)

Common woody climber of the lowland primary forest.

As an antidote for taking poisonous fungi. The outer bark is scraped off, mixed with the roots of *Arenga brevipes* (Palmae) and roots of *Dillenia beccariana* (Dilleniaceae). Boil mixture in water to make a tea.

4.2. *Goniothalamus macrophyllus* (Bl.) Hk. f. & Th. (S.78603, S. 78757)
Lukai kampong/Selukai (Ib)

Shrub with a wide distribution in mixed dipterocarp forest and submontane forest.

a. For fever and malaria. Fresh stem and leaves from this species are mixed with those from *Goniothalamus velutinus* and pounded together. Boil the mixture in water to make a tea.

b. For fever in babies. Burn bark to ashes. Use ashes to massage on the body.

4.3. *Goniothalamus velutinus* A. Shaw (S.78602)
Hujan panas (Ib)

Treelet in primary forest on sandy soils.

This species has the same uses as *Goniothalamus macrophyllus* described above. This little unbranched tree with a prominent tap root is believed to possess magical powers. It is used as a protection against evil forces.
To protect their homes and properties, the Penan will plant a stick at each corner of their houses. The spell is broken when a stone is thrown over the roof. The bark is also burnt to keep off bad spirits and as a mosquito repellent.

4.4. *Polyalthia cauliflora* Hk. f. et. Th. (S.77054)
Semukau (Ib)

Small tree frequent in mixed dipterocarp forest on clayey soils.

For treatment of sore eyes. Young leaves are wrapped in another leaf and warmed over a fire. Sap from the warm leaves is squeezed into the eye.

4.5. *Trivalvaria* cf. *macrophylla* (Bl.) Miq. (S.77059)
Semukau, Karai (Ib)

Small tree with a rather rare occurrence in mixed dipterocarp forest on clay soils.

This plant has similar use as *Polyalthia cauliflora* in treating sore eyes.

5. APOCYNACEAE

5.1. *Alstonia scholaris* R. Br. (S.77095, S.78733)
Pelai lilin (Ib)

Common tree in primary and secondary forests on fertile clay and alluvial soils.

To treat shingles (*kayap*), a painful viral infection of the skin. The milky latex is applied on the affected part.

5.2. *Willughbeia sarawakensis* (Pierre) K. Schum.
Akar kubal (Ib)

Climber in lowland primary forest.

To treat shingles (kayap) and other skin diseases. The white latex from the fresh plant is applied externally.

6. ARACEAE

6.1. *Alocasia beccarii* Engl. (S.78798)
Keladi kampong (Ib)

Common aroid with a localised distribution.

As an antidote for centipede bites. Squeeze sap from cut leaf stalk onto the wound.

7. ARISTOLOCHIACEAE

7.1. *Thottea rhizantha* Becc. (S.78715)
Suntik babi (Ib)

Small semi-woody herb up to 1 m tall in primary forest. Dark brownish-red flowers are borne on stem near the ground.

For fever. An infusion of the roots is taken. A related species, *Thottea macrophylla* Becc. is used to relieve gastric pain (Chai *et al*, 1989).

8. ASCLEPIADACEAE

8.1. *Dischidia bengalensis* Colebr. (S.78784)
Tipang kura (Ib)

Slender climber in primary forest. Fresh parts contain milky sap.

To treat body pain and inflammation of the liver. Thoroughly pound the fresh leaves, add some cooking oil and use the preparation to massage the body.

9. BLECHNACEAE

9.1. *Nephrolepis biserrata* (Sw.) Schott. (S.77093)
Paku kubok, Paku keru (Ib)

Fern with a widespread distribution in open areas with clayey soils.

To relieve pain and itchiness caused by shingles or herpes zoster and bites by certain species of ants. Rub the fresh young leaves on the affected part.

10. CLUSIACEAE

10.1. *Garcinia mangostana* L. (S.76176, S.77097)
Sikop (Ib)

Cultivated mangosteen.

a. For stomach ache. Boil the bark in water to make a drink.

b. To prevent rice-wine (*tuak*) from turning sour. The outer bark is pounded thoroughly and added to the *tuak*.

10.2. *Garcinia* sp. (S.78702)
Kayu manis (Ib)

Tree in primary forest.

For fever and malaria. Boil 20 leaves in two cups of water (equivalent to 800 ml). Slow boil to 300 – 400 ml. Drink the tea when still warm.

11. COMPOSITAE

11.1. *Adenostemma lavenia* (L.) O. K. (S.77080)
Sempulut babi (Ib)

Small herb in young shifting cultivation areas.

For treating breast cancer. A fresh leaf is wrapped in another leaf and warmed over fire. Remove leaf from the wrapper and paste it on the breast while still warm. Repeat several times.

11.2. *Ageratum conyzoides* L. (S.78746)
Rumput temayai (Ib)

A common herb of the waste land. Has a strong aromatic smell. Flowers light lilac in colour.

To treat swollen knees and ankles due to physical injuries. Pound leaves thoroughly with some salt and use as a poultice.

11.3. *Blumea balsamifera* Ham. (S.78752)
Mambong (Ib)

Common herb that appears soon after a shifting cultivation plot is abandoned. Grows up to 1.5 m tall, flowers white.

When long illness is suspected to be caused by malevolent spirits, the leaves are burnt near the house. The smoke with a strongly aromatic smell will drive the malevolent spirits away. This herb is also used to reduce fever and help mothers to regain energy after birth (Chai *et al*, 1989).

12. CONNARACEAE

12.1. *Agelaea borneensis* (Hook. f.) Merr. (S.78772)
Akar malam (Ib)

Climber in mixed dipterocarp forest.

Used on babies who cry non-stop, locally referred to as *sakit sawan*. To stop the crying, place a piece of the plant on the large leaf of *Artocarpus odoratissimus* (Moraceae) near the baby's bed.

12.2. *Rourea mimosoides* (Vahl.) Planch. (S.78750)
Randau plis (Ib)

Small tree on ridges in mixed dipterocarp forest.

To relieve general body pain. The fresh leaves are used to rub on the body.

13. CUCURBITACEAE

13.1. *Alsomitra macrocarpa* (Bl.) M. J. Roemer. (S.78729)
Akar empekak/Randau emperkak (Ib)

Light-demanding climber in lowland primary forest.

To kill worms in wounds of pigs and chickens and to heal wounds. Sap from cut fresh stem is used as an antiseptic.

14. CYPERACEAE

14.1. *Scleria purpurescens* Steud (S.77094)
Rumput kejuru (Ib)

Common sedge with sharp triangular stems in damp or marshy secondary habitats.

To kill parasitic worms in dogs. The young leaves are fed to the dogs.
Chai *et al*, (1989) reported the use of this species by the Selakau community to treat diarrhoea while Yii (pers. comm. 1999) said that a tea made from the dryland variety had been used to treat asthma.

15. DILLENIACEAE

15.1. *Dillenia excelsa* (Jack) Galg. (S.76170)
Beringin (Ib)

Medium-sized tree in mixed dipterocarp forest.

To stop diarrhoea. Boil the bark in water to make a tea for drinking. The Penan also use this plant for a similar purpose (Chai *et al*, 1989).

15.2. *Dillenia suffruticosa* (Griff.) Mast. (S.76171)
Buan (Ib), Simpor gajah (Mal)

Shrub with large leaves and conspicuous yellow flowers in open secondary forest with abundant sunlight.

To neutralise the poison caused by accidentally swallowing poisonous butterflies. Pound the young roots thoroughly, squeeze out the juice for drinking.

15.3. *Tetracera arborescens* Jack. (S. 76183)
Tetracera akara (Burm. f.) Merr. (S. 76182)
Tetracera macrophylla Wall. ex Hk. f. et. Th. (S.78708, S.78775)
Akar mempelas (Ib.)

Semi-woody climbers common in lowland dipterocarp forest. Much water is stored in the fresh stems.

To relieve persistent cough. Water from the freshly-cut stems is taken.
Residents of Rumah Chaong and Rumah Minggat in Ulu Kanowit also use the roots of *Tetracera macrophylla* to stop vomitting and diarrhoea. Its roots are boiled with those of *rumput unjam* (unidentified) to make a tea.

16. DIPTEROCARPACEAE

16.1. *Shorea macrophylla* (de Vr.) Ashton (S.77061)
Engkabang jantong (Ib)

This tree of the emergent canopy is an important component of inland riparian vegetation and is commonly cultivated for its illepe nuts and timber.

For fever and chill. Boil leaves of *Engkabang* with the fruits in a big pot of water. The patient is asked to stand above the pot to allow the steam to heat the body to produce a sweat. A large blanket is used to cover the patient to prevent the heat from escaping.

16.2. *Shorea obscura* Meijer (S.77077)
Pelapak ai (Ib)

Large tree in mixed dipterocarp forest.

For treating jaundice in babies, called *sakit empak rambul* or *sakit kuning* in Iban. Boil bark in water. Use the solution to bathe the baby twice a day.

17. EBENACEAE

17.1. *Diospyros mindanaensis* Merr. (S.78763)
Tubai buah (Ib)

Tree in primary forest.

For skin diseases. The endosperm is pounded and rubbed gently on the affected part. It is also used to stupefy fish in streams.

17.2. *Diospyros puncticulosa* Bakh. (S.78725)
Kayu malam balik (Ib)

Tree in primary forest.

For yellow fever. The bark is pounded and mixed with some water. The solution is used to wash the body.

18. EUPHORBIACEAE

18.1. *Croton ensifolius* Merr. (S.78767)
Penampal labi (Ib)

Small shrub in secondary forest.

For minor cuts. The leaves are pounded into a paste and used as a poultice. Also stops bleeding.

18.2. *Homalanthus populneus* (Geisel.) Pax. (S.78764)
Tapang lalat (Ib)

Shrub in old secondary forest.

For treatment of shingles or *kayap*. 5 to 10 young shoots are wrapped in some big leaves and heated over a fire until half cooked. Squeeze juice on affected part. Continue treatment for 2 to 3 days.

18.3. *Macaranga gigantea* Muell.-Arg. (S.77053)
Merkubong (Ib)

Common tree in secondary forest on sandy soils.

For ulcer in the mouth. Apply the brownish-red sap from fresh young stem on the ulcer.

18.4. *Phyllanthus urinaria* L. (S.77092, S.78755, S.78786)
Rumput blis, Engcerengak belut (Ib)

Small semi-woody herb common in wasteland and house gardens.

a. For treating jaundice (*sakit kuning*) in babies. Equal proportion of this plant and *Melastoma malabathricum* (Melastomataceae) are boiled together in water to make a bath.

b. To treat minor cuts. The fresh plant is pounded into a paste for poultice.

18.5. *Trigonopleura malayana* Hook. f. (S.77056, S.78716)
Sedik padi, Kayu sedi (Ib)

Medium-sized tree in primary forest.

a. For fever. Some fresh leaves and twigs together with equal proportion of *Lycopodium cernuum* (Lycopodiaceae) are boiled to make a solution for bathing.

b. To treat minor cuts. Fresh young leaves are wrapped in some bigger leaves and warmed over a fire until soft. Squeeze juice from warm leaves onto the wound.

c. To make poison for blowpipe darts. The leaves are thoroughly crushed to squeeze out the sap. This sap is mixed with the latex from *Antiaris toxicaria* (Moraceae). The mixture is applied to the tips of the darts.

19. FLACOURTIACEAE

19.1. *Pangium edule* Reinw. (S.77084, S.78742)
Kepayang (Ib)

An inland riverbank tree with straight trunk, dark green heart-shaped leaves and big oblong brown fruits. The seeds are edible after sufficient cooking.

a. Skin infection. The young leaves are rubbed on the skin to stop itchiness.

b. Kill worms on wounds of chicken and house pets. Sap from fresh bark is squeezed onto the wounds.

20. GLEICHENIACEAE

20.1. *Dicranopteris linearis* (Burm.) Hend.
Resam (Ib)

A common fern that quickly colonises degraded land with very poor soils.

For treatment of sore-eyes. The juice from fresh young shoots is squeezed into the eyes.

21. GRAMINEAE

21.1. *Imperata cylindrica* Beauv. (S.78786)
Lalang (Ib, Mal)

A common weed species on degraded soils.

For small pox. A drink is prepared by boiling the young roots in water.

21.2. *Lophatherum gracile* Brogn. (S.78710, S.78776)
Rumput jung/Rumput unjam/Rumput ruding mawang (Ib), Udu buloh (L. Bawang)

A common grass in open wasteland.

a. For relief of stomach ache and gastric pain. Pound roots to obtain juice. Mix with water to make a drink.

b. For treatment of cholera and malaria. The roots are boiled together with the stem of *Tetracera* sp. (Dilleniaceae) to make a drink.

21.3. *Paspalum conjugatum* Berg. (S.78714)
Rumput kumpai (Ib)

Grass in open wasteland.

To stop bleeding. The juice from fresh leaves is applied on the wound.

21.4. *Saccharum* sp. (S.76215)
Tebu enda pesalah (Ib)

Wild sugar cane with slender stems.

To relieve pain and reduce swelling resulting from sprains. The stem is pounded into a paste and used as a poultice.

21.5. *Saccharum* sp. (S.76216)
Tebu enda benta (Ib)

Wild sugar cane.

To treat weak joints and general body pain (*sakit benta*) in mothers after delivery. The fresh juice is taken.

22. HEMIONITIDACEAE

22.1. *Syngramma wallichi* (Hook.) Bedd. (S.78748)
Paku (Ib)

A fern in secondary forest.

To reduce swollen legs in mothers after delivery. Pounded leaves are used to massage on the swollen parts.

23. HYPERICACEAE

23.1. *Cratoxylum glaucum* (Vahl.) Blume (S.78736)
Geronggang/Temau (Ib)

Shrub in secondary forest.

To treat skin diseases. Reddish-brown latex from the fresh plant is applied on the affected part.

24. LAURACEAE

24.1. *Lindera pipericarpa* Boerl. (S.78724)
Medang serai, Kayu wangi (Ib)

Shrub in primary mixed dipterocarp forest. Fresh leaves are slightly fragrant when crushed in between the fingers.

To treat kidney problem and reduce fever. Three pieces of the roots, each about 20 cm long, are boiled to make a drink.

24.2. *Litsea garciae* Vidal (S.76194)
Engkala (Ib)

A common tree of inland river banks. Often cultivated near longhouse for its fruits.

For treatment of boils. It is used together with the shoot of the rattan *Calamus scipionum*. The leaves of *Litsea garciae* (wrapped in another leaf) and the rattan shoots are heated over a fire. They are then pounded thoroughly together and mixed with lime juice. The mixture is applied over the boil.

24.3. *Litsea paludosa* Kosterm. (S.77066)
Balong lawang/Medang bulu (Ib)

Tree in primary mixed dipterocarp forest.

For speedy recovery after giving birth. Boil bark of this tree with the roots of *Labisia pumila* (S.77064) in water to make a drink.

25. LEEACEAE

25.1. *Leea gigantea* Kurz (S.76199)
Ubat betu, Kemali (Ib)

Shrublet in secondary and riparian forest.

To treat burns by scalding. Pound leaves into paste and apply on the affected part.

26. LEGUMINOSAE

26.1. *Bauhinia simibifida* Roxb. (S.76195)
Akar tangkop-bedaup (Ib)

Climber in open place at edge of forest.

For treating hypertension. Boil roots in water to make a drink to be taken regularly.

26.2. *Cassia alata* L. (S.78761)
Serungan/Daun rugin (Ib)

Small tree or shrub in open place usually along rivers. The conspicuous bright yellow flowers are borne on erect spikes.

Commonly used in the treatment of white spots or of dhobi itch. Pounded fresh leaves are used to rub on the affected part. For better effect, ash from firewood may be added.

26.3. *Dalbergia parvifolia* Roxb. (S.78766)
Randau menggris (Ib)

Climber in primary forest.

Used specifically to relieve gastric pain. A drink is made from boiling the pounded roots.

26.4. *Fordia gibbsiae* Dunn. et. Baker RT. (S.76200)
Kergantong (Ib)

Shrub in lowland primary forest.

To stop vomitting and diarrhoea. Pound the bark together with the roots of the wild ginger, *Etlingera littoralis* (S.77049). Extract juice from the mixture and drink.

26.5. *Saraca declinata* (Jack) Miq. (S.76172)
Babai (Ib)

Common tree along fast-flowing rivers or streams.

For treating diarrhoea. A drink is prepared from boiling the bark in water.

26.6. *Spatholobus ferrugineus* (Zoll & Mor) Benth. (S.77057, S.77068, S.78706)
Akar kemedu, kemedu darah (Ib)

Climber in primary forest.

a. To treat ulcers of the mouth. Apply the red sap from the fresh plant on the affected part. Also used to treat white spots in baby's mouth. Apply sap once only.

b. To stop diarrhoea. Boil the bark in water to make a drink.

27. LILIACEAE

27.1. *Dianella ensata* (Thunb.) Hend. (S.78794)
Jerangau padi (Ib)

Herb in primary or secondary forest.

As an antidote for snake-bite and bee sting. The fruits are pounded into a paste and applied on the wound.

27.2. *Smilax leucophylla* Bl. (S.78795)
Randau tipang nyebayai (Ib)

Climber in primary forest.

As an antidote for centipede bite and bee sting. Sap from the fresh stem is applied.

28. MALVACEAE

28.1. *Sida rhombifolia* L. (S.77091)
Rumput tamawai (Ib)

Common shrublet in longhouse compound.

To reduce high fever. Boil roots in water to make a drink.

29. MELASTOMATACEAE

29.1. *Driessenia dispar* (Cogn.) C. Hansen (S.78790)
Kemunting umang (Ib)

Herb in cool areas in primary forest.

To treat fungal infection of the foot. Pound fresh leaves to make a poultice.

29.2. *Melastoma malabathricum* L. (S.77096)
Kemunting (Ib)

Shrublet in secondary forest and wasteland.

a. For treating jaundice in babies (anak mit sakit kuning). A bath is prepared by boiling the leaves with *Phyllanthus urinaria* plant (S.77092) in water.

b. To stop diarrhoea. 3 to 5 pieces of fresh young twigs are eaten raw.

30. MENISPERMACEAE

30.1. *Fibrauea chloroleuca* Miers. (S.76198)
Akar tipang (Ib)

Climber in primary forest.

a. As an antidote for snake bites. Sap from freshly cut stem is applied on the wound.

30.2. *Tinospora tuberculata* Beumee. (S.77079)
Akar hidu (Ib)

Climber in primary forest.

a. As an antidote for blowpipe poison. Apply sap from fresh stem on the wound.

b. For hypertension and malaria. Boil stem in water to make a drink.

31. MORACEAE

31.1. *Antiaris toxicaria* (Pers.) Lesch. (S.78783)
Ipoh (Ib)

Tree in lowland primary forest with alluvial soils.

For blowpipe poison. The white latex is tapped, mixed with the leaves of *Trigonopleura malayana* Hook. f. (Euphorbiaceae) and warmed over a fire. To apply the poison, dip the tips of the dart into the mixture.

31.2. *Artocarpus kemando* Miq. (S.78771)
Pudau (Ib)

Tree in lowland primary forest, sometimes cultivated for its fruits.

For stomach ache. The young shoots are boiled together with the roots of *Areca catechu* (Palmae) and *Imperata cylindrica* (Gramineae) in water to make a drink.

31.3. *Ficus callicarpa* Corner. (S.78768)
Gemalong (Ib)

Tree in lowland primary forest.

a. As an antidote for poisonous caterpillar stings. Burn leaves to ashes, mix with cooking oil and applied on affected part.

b. For centipede bite. White latex from the stem is applied on the wound.

31.4. *Ficus grossularioides* Burm. f. (S.77058, S.78773)
Lengkan (Ib)

Tree in lowland primary and secondary forests.

As an antidote for centipede bite. The white latex is applied on the wound.

32. MYRSINACEAE

32.1. *Labisia pumila* (Bl.) Benth. ex Hk. f. (S.77064, S.78604, S.78774)
Sabang kampong/Sakang ribut/Daun sangkoh (Ib), Kacip fatimah (Mal)

Herb in lowland primary forest.

a. To contract and tighten the uterus after giving birth. Prepare a drink by boiling the roots with the bark of *Litsea paludosa* Kosterm. (S.77066) in water.

b. As an antidote for taking poisonous mushroom. Eat plant raw or boil to make a drink.

c. For skin diseases. Pound fruits and apply as poultice.

33. MYRTACEAE

33.1. *Psidium guajava* L. (S.78737)
Jambu labas (Ib)

Cultivated fruit tree.

To stop diarrhoea. Young shoots are eaten raw.

34. NEPHROLEPIDACEAE

34.1. *Nephrolepis biserrata* (Sw.) Schott.
Paku kubok (Ib)

Secondary forest in open place.

To relieve muscular pain. Young leaves are rubbed on the aching muscles.

35. ORCHIDACEAE

35.1. *Grammatophyllum speciosum* Bl. (S.76197)
Tebu musang (Ib)

A giant orchid in primary forest.

For treating jaundice in newborn babies. (*Anak mit sakit kuning or sakit gamalus*). Boil pieces of the stem in water to make a solution for bathing.

36. PALMAE

36.1. *Arenga brevipes* Becc. (S.76165)
Aping (Ib)

Stemless palm in primary forest.

To neutralise poison caused by *sawat* or *buyah* (butterflies). The palm cabbage is eaten.

36.2. *Calamus scipionum* L. (S.76193)
Wi marau (Ib)

Rattan in lowland primary forest.

To treat boils. See under *Litsea garciae* (Lauraceae) for preparation and use.

37. PIPERACEAE

37.1. *Piper caninum* Bl. (S. 76191)
Sireh pala (Ib)

Herb in secondary forest.

a. To reduce swelling caused by minor physical injury. Warm the leaves over a fire and cover warm leaves on the affected part.

b. To reduce fever. Boil the stem in water to make a drink.

38. POLYGALACEAE

38.1. *Salomonia cantoniensis* Lour. (S.77086)
Tipang ular (Ib)

Small herb in lowland primary forest.

As an antidote for snake bites. Pound leaves into a paste and apply.

39. RHAMNACEAE

39.1. *Zizyphus borneensis* Merr. (S.76192)
Akar kuku menaul (Ib)

Thorny woody climber in lowland mixed dipterocarp forest.

For ulcers of the mouth. Drink the water from freshly cut stem.

40. RUBIACEAE

40.1. *Borreiria repens* (L.) R. Br. (S.78754)
Rumput mas (Ib)

Herb in lowland primary forest.

For general body pain. Boil whole plant to make a tea.

40.2. *Hedyotis costata* (Roxb.) Kurz (S.76186, S.78756, S.78782)
Akar perut manok/Rumput mas (Ib)

Herb in lowland primary forest.

a. For fever and chill. Boil the whole plant in water to make a warm bath to get the patient to sweat.

b. For body pain. Boil plants in water to make a tea. Use 4 to 5 plants each time.

40.3. *Mussaenda* sp. (S.77087)
Jernang kukut (Ib)

Woody shrub/climber in open place.

For birth control. Boil the roots in water to make a tea.

40.4. *Psychotria elmeri* Merr. (S. 76185, S.77073)
Engkerabai (Ib)

Small shrub in primary forest.

a. For treating diarrhoea and blood in stool. A tea is made from boiling the leaves in water.

b. For cuts. Boil leaves in water and use solution to clean the wound.

40.5. *Psychotria* sp. (S.76184)
Sugi raong (Ib)

Shrublet in lowland primary forest.

a. To treat sore eyes and cough. Swallow the fresh ripe fruits.

41. SAPINDACEAE

41.1. *Lepisanthes amoena* (Hassk.) Leenh. (S.78800)
Ribu (Ib)

Tree in primary forest.

As antidote for snake-bite. Sap from the fresh inner bark is rubbed on the wound.

41.2. *Nephelium mutabile* Bl. (S.76212)
Mak (Ib)

Cultivated fruit tree.

For treating septic wound (*telih murok*). Wrap the young leaves in another leaf and warm over a fire. Pound the warm leaves into a paste and poultice.

41.3. *Pometia pinnata* Forst. (S.77074)
Kasai (Ib)

Common tree in riparian forest on alluvial soils. Fruits edible.

For minor cuts. Wrap the young leaves in another leaf and warm over a fire. Squeeze juice from the warm leaves onto the wound.

42. SCHIZAEACEAE

42.1. *Lygodium microphyllum* (Cav.) R. Br.
Remat kikat (Ib)

Creeping fern in open areas.

To relieve breast pain after giving birth. Wrap the fern in another leaf and warm over a fire. Place the warm plant over the breasts and secure with a bandage.

42.2. *Lygopodium scandens* (L.) Sw. (S.78760)
Remat (Ib)

Fine creeping fern in open areas.

To stop diarrhoea. Boil young shoots and leaves in water to make a tea.

43. SCROPHULARIACEAE

43.1. *Brookea tomentosa* Benth. (S.77078)
Merjemu (Ib)

Tall herb colonising shifting cultivation sites after rice harvest.

To prevent sore eyes. It is believed that eye infection can be prevented if the fruits are swallowed.

43.2. *Scoparia dulcis* L. (S.78731)
Rumput tahi babi (Ib)

Herb in waste land.

For itchy skin and skin diseases. Boil plant in water. Use the solution to wash the affected part.

43.3. *Torenia polyonoides* Benth. (S.78797)
Rumput pupok (Ib)

Herb in secondary forest.

For treatment of goitre. Boil 5 plants each time to make a tea.

44. SIMAROUBACEAE

44.1. *Eurycoma longifolia* Jack
Sengkayap (Ib)

Treelet in primary forest on sandy soils.

This plant is used to treat a number of ailments including high fever, kidney problem, back pain, headache and stomach ache and to regain body strength after a sickness or due to alcohol intoxification, and has been promoted as an aphrodisiac. Boil the plant or roots in water to make a tea.

45. THELYPTERIDACEAE

45.1. *Pronehrium hosei* (Bak.) Holttum (S.78779)
Daun kejai (Ib)

Fern in lowland forest.

To relieve body pain. Use fresh leaves to rub on the affected part.

46. URTICACEAE

46.1. *Elatostema linear* Stapf. (S.78799)
Rubai (Ib)

Succulent herb in cool shaded areas in primary forest.

For tooth ache. A small piece of the stem with the outer skin removed is inserted into the cavity. If there is no cavity, a paste prepared from the stem is used to cover over the aching tooth.

47. VERBENACEAE

47.1. *Clerodendrum adenophyllum* Hall. f. (S.78601, S.78739)
Kelampahit/Bunga pepanggil (Ib)

Shrub in lowland forest.

a. For itchy skin. A paste prepared from the leaves is rubbed on the affected part.

b. To remove leech from inside nasal cavity. Obtain juice by pounding the fresh leaves. Drop juice into the nose.

c. For muscular pain. Crushed leaves are mixed with coconut oil. The mixture is rubbed on the muscles.

48. VITIDACEAE

48.1. *Ampelocissus imperialis* (Miq.) Planch. (S.78744)
Daun kelimpak pinggai (Ib)

Climber in primary forest.

For cough and diarrhoea. Boil leaves, stem and roots together to make a tea.

48.2. *Cissus* sp. (S.76211)
Riang bot (Ib)

Climber in primary forest.

For treatment of septic wounds. Warm the leaves over a fire. Pound warm leaves into a paste and use as a poultice.

49. ZINGIBERACEAE

49.1. *Alpinia ligulata* K. Schum. (S. 76173)
Timbang (Ib)

Wild ginger in lowland primary forest.

For stomach ache. Chew the young shoot to relieve pain.

49.2. *Curcuma zedoaria* (Berg.) Rosc. (S.77062, S.77048)
Entemut indai abang (Ib)

Wild ginger in lowland primary forest.

a. For healing of fractured bone. Pound the rhizomes into a soft mass and poultice on the fracture.

b. For eye infection. Juice from the rhizomes is used as an eye drop.

49.3. *Etlingera littoralis* (Konig) Giseke. (S.67343, S.77049)
Tepus kenyeli, Senggang (Ib)

Wild ginger in secondary forest.

To stop vomitting and diarrhoea. Pound the roots of this plant together with the bark of *Fordia gibbsiae* (Leguminosae) into a paste. Squeeze juice from the mixture, add some water and drink.

b. For mat making. Cut stem and leave to dry. Peel off sheath covering stem for further drying. Then split into 1 cm strips for use. Fruits edible.

49.4. *Etlingera* sp. (S.78707)
Tepus kenyali (Ib)

Wild ginger in secondary forest.

a. For cholera. Up to three young shoots each time are eaten raw.

b. As an antidote for snake bites. The young shoots are pounded together with some roots from a Vitidaceae (unidentified). Use mixture to cover on the wounds.

49.5. *Globba* sp. (S.78745)
Sakang batuk rangkai (Ib)

Wild ginger in lowland secondary forest.

For dry cough and yellow fever. The rhizomes are eaten raw.

49.6. *Plagiostachys* sp.
Batak (Ib)

Wild ginger in secondary forest.

For treating fungal infection on dogs. Pound fruits thoroughly and rub on the affected part.

Appendix 1e Building and construction materials from Ulu Skrang

Family	Scientific Name	Vernacular Name	Uses
Anacardiaceae	*Campnosperma coriacea*	Terentang	Leaves-roofing for huts
Blechnaceae	*Blechnum orientale*	Paku kijang	Leaves-roofing for huts
Bombacaceae	*Durio zibethinus*	Rian	Building, boat
Clusiaceae	*Calophyllum soulattri*	Bangkit	Boat building
Clusiaceae	*Calophyllum* spp.	Bintangor	House construction, boat
Cryteroniaceae	*Crypteronia cumminggi*	Ubah semut	House construction
Dipterocarpaceae	*Dipterocarpus oblongifolius*	Ensurai	House construction
Dipterocarpaceae	*Dipterocarpus* spp.	Keruing	General
Dipterocarpaceae	*Dryobalanops* spp.	Keladan	House construction
Dipterocarpaceae	*Shorea macrophylla*	Engkabang	General construction
Dipterocarpaceae	*Shorea materialis*	Tekam	Poles, building, pepper post,boat building
Dipterocarpaceae	*Shorea ochracea*	Raruk	General
Dipterocarpaceae	*Shorea* spp.	Perawan	General construction
Dipterocarpaceae	*Shorea* spp.	Tengelam	Poles
Dipterocarpaceae	*Shorea* spp. (Selangan batu group)	Tengelam	House construction
Dipterocarpaceae	*Shorea* spp.	Tengelam batu	Building, boat
Dipterocarpaceae	*Shorea* spp.	Meranti	General construction
Dipterocarpaceae	*Shorea* spp.	Selangan batu	Poles, house construction
Dipterocarpaceae	*Shorea* spp.	Merawan	House construction, boat building
Dipterocarpaceae	*Shorea* spp.	Raruk udang	House construction
Dipterocarpaceae	*Shorea* spp. (Yellow meranti group)	Lop	House construction
Dipterocarpaceae	*Upuna borneensis*	Penyau	Poles, house construction
Dipterocarpaceae	*Vatica* spp.	Resak	General
Fagaceae	*Castanopsis* spp.	Berangan	House construction
Hypericaceae	*Cratoxylum glacum*	Temau	Building, boat, poles
Lauraceae	*Eusideroxylon zwageri*	Belian	Poles, house construction
Loganiaceae	*Fragraea crassipes*	Tembusu/Sukong	Poles
Moraceae	*Artocarpus nitidus*	Selangking	Poles, house construction
Moraceae	*Artocarpus sericicarpus*	Pingan	Leaves-roof, bark-walls
Musaceae	*Musa* spp.	Gritum	Leaves
Myrtaceae	*Eugenia* spp.	Ubah	Building, house construction
Palmae	*Eugeissonia utilis*	Pantu	Leaves-roofing
Sapotaceae	*Palaquium* spp.	Nyatoh	House construction
Theaceae	*Ploriaum alternifolium*	Jinggau	House construction
Zingiberaceae	*Etlingera littoralis*	Tepus	Leaves-roofing for huts

Appendix 1f Materials for mats, basketry & other household items (from Ulu Skrang and Ulu Kanowit)

Family	Scientific Name	Vernacular Name	Uses
Gramineae	*Bamboo* (many species)	Buluh timiang and engkalat	Baskets
Marantaceae	*Donax canniformis*	Bemban	Mats
Marantaceae	*Donax grandis*	Bemban batu	Baskets, fish traps
Moraceae	*Artocarpus elasticus*	Tekalong	Mats with wi tunggal, rope
Palmae	*Calamus caesius*	Wi letik	Mats
Palmae	*Calamus convallium*	Wi seru	Mats, 'ajat', 'selabit' and 'laji'
Palmae	*Calamus flabellatus*	Wi takong	Mats
Palmae	*Calamus javensis*	Wi batu	Baskets, mats
Palmae	*Calamus nematospadix*	Wi rengut	Mats
Palmae	*Calamus optimus*	Wi sega	Baskets, mats
Palmae	*Calamus ornatus*	Wi jelayan	Baskets, mats
Palmae	*Calamus pseudoulur*	Wi lembak	Mats
Palmae	*Calamus scipionum*	Wi marau	Baskets, petioles for 'chapan'
Palmae	*Calamus semoi*	Wi tut	Mats
Palmae	*Calamus* sp.	Wi bukop	Mats, 'ajat', 'selabit' and 'laji'
Palmae	*Calamus* sp.	Wi tunggal	Mats, 'ajat', 'selabit' and 'laji'
Palmae	*Calamus spectabilis*	Wi matahari	Baskets, mats
Palmae	*Daemonorops atra*	Wi leku	Mats
Palmae	*Daemonorops sabut*	Wi lepo	Mats, 'ajat', 'selabit' and 'laji'
Palmae	*Eugeissonia utilis*	Pantu	Petioles for baskets
Palmae	*Korthalsia jala*	Wi danau	Baskets, fish traps
Palmae	*Licuala petiolulata*	Geranis	Mats, petioles for 'chapan'
Palmae	*Plectocomiopsis geminiflorus*	Wi lalih	Baskets
Palmae	*Plectocomiopsis mira*	Wi matar	Baskets
Pandanaceae	*Pandanus kamii*	Kerupok	Mats
Pandanaceae	*Pandanus* sp.	Nas	Mats
Pandanaceae	*Pandanus vinaceus*	Akas	Mats
Zingiberaceae	*Etlingera littoralis*	Sengang	Stems for mats
Zingiberaceae	*Hornstedtia reticulata*	Sengang	Baskets

Appendix 1g Other uses (from Ulu Skrang and Ulu Kanowit)

Family	Scientific Name	Vernacular Name	Uses	Herbarium No.
Anacardiaceae	*Campnosperma squamatum*	Terentang	Bark to make 'padi' container	
Annonaceae	*Friesodielsia glauca*	Randau rarak	Wood-fibre for lighting fire	
Annonaceae	*Spatholobus* sp.	Penduk	Fibre	
Apocynaceae	*Tabernaemontana macrocarpa*	Tara manang	Prevent insect attacking padi farm. Burn the leaves. Perform rites 3 times.	S.76177
Apocynaceae	*Willughbeia sarawakensis*	Akar kubal	Latex for fixing knife handle	
Aquifoliaceae	*Ilex cissoidea*	Aras	Shampoo or soap. Rub crushed leaves on hair or body.	S.76214
Cornaraceae	*Rourea mimosoides*	Kayu kenarang	Black dye	
Cyatheaceae	*Cyathea laurifolia*	Paku kijang	Stem for pepper post	
Dilleniaceae	*Dillenia suffruiticosa*	Buan	Leaves for food wrapping Stem for pepper post	
Ebenaceae	*Diospyros mindanaensis*	Tubai buah	Fish poison - fruits	
Euphorbiaceae	*Baccaurea lanceolata*	Lempaong	Polishing silver, brass wares, rub fruit on	
Euphorbiaceae	*Macaranga kingii*	Purang	Shavings for decoration	
Euphorbiaceae	*Macaranga kingii* var. *platyphylla*	Purang	Leaves for wrapping food	
Euphorbiaceae	*Trigonopleura malayana*	Sedik padi	Leaves for eating with betle nuts	
Gleicheniaceae	*Dicranopteris linearis*	Resam	Stem fibre for tying of knife sheath (scabbard)	
Gnetaceae	*Gnetum raya*	Akar tegang	Fibre for fishing line, nets	
Hypoxidaceae	*Curculigo latifolia*	Lemba babi	Leaf fibre for cloth making. Kill leeches, put crushed leaves in water.	
Labiatae	*Pogostemon auricularis*	Rumput gentut uduh	Used to kill bed bugs	
Lauraceae	*Lindera pipericarpa*	Medang serai	Fruits dried and crushed for perfume	
Lecythidaceae	*Barringtonia pendula*	Langkong/Putat	Bark as fish poison	
Leguminosae	*Derris elliptica*	Akar tuba	Roots as fish poison	
Leguminosae	*Derris malaccensis*	Tubai empadi/ Randau tubai	Tuber as fish poison	
Lycopodiaceae	*Lycopodium cervuum*	Selap padi	Leaves as a strainer for rubber latex	
Melastomataceae	*Pternandra multiflora*	Puluh	Wood good for insulation while making knives or metal tools	
Moraceae	*Artocarpus elasticus*	Tekalong	Bark for clothing, containers	
Moraceae	*Artocarpus kemando*	Pudau	Bark for making containers	

Family	Scientific Name	Vernacular Name	Uses	Herbarium No.
Musaceae	*Musa acuminata*	Gritum	Young leaves as tobacco wrapper	
Palmae	*Licuala petiolulata*	Biris	Leaves for wrapping food	
Polygalaceae	*Salomonia cantoniensis*	Rumput pupok	Crushed leaves used as soap	
Rosaceae	*Prunus arborea*	Enteli	Bark for clothing, 'padi' containers	
Rubiaceae	*Morinda citrifolia*	Mengkudu	Leaves for black/red dye, roots for red dye	
Rubiaceae	*Psychotria elmeri*	Engkerebai	Pound leaves to get red dye	
Rubiaceae	*Urophyllum hirsutum*	Duin	Fruits to make necklace and for perfume	
Sapindaceae	*Xerospermum laevigatum*	Ilat	Boil leaves in water to obtain bluish dye	S.77067
Scrophulariaceae	*Vandellia* sp.	Bunga penit	Leaves or stem for perfume	
Symplocaceae	*Symplocus fasciculata*	Jirak	Leaves for black dye	
Taccaceae	*Tacca borneensis*	Beting	Leaves for wrapping	S.77075
Verbenaceae	*Gmelina unifolia*	Selui ular	Leaf sap used to prevent latex from sticking to container	
Vitaceae	*Tetrastigma pedunculare*	Buah tanah	Crush tuber to obtain red/ black dye	

Appendix 1h Plants used in rituals and ceremonies (from Ulu Skrang and Ulu Kanowit)

Family	Scientific Name	Vernacular Name	Uses	Herbarium No.
Agavaceae	*Cordyline fruticosa*	Daun sabang	Gawai	
Agavaceae	*Cordyline terminalis*	Sabong	Gawai	
Annonaceae	*Goniothalamus malayanus*	Selukai	To keep away evil spirits. Burn dried bark.	S.77050
Araceae	*Homalomena sagittifolia*	Belingau/ Kemuyang bukit	For good luck during hunting, keep away evil spirits. Burn stem.	S.77065, S.78713
Clusiaceae	*Garcinia andersonii*	Sikop	Padi planting	
Compositae	*Vernonia arborea*	Entepong	Keep away evil spirits	
Euphorbiaceae	*Glochidion* sp.	Menyan	Burn damar to keep away spirits	
Euphorbiaceae	*Macaranga* sp.	Merkubong	To hide from enemies	
Loganiaceae	*Fragraea crassipes*	Sukong	To keep away evil spirits	
Lycopodiaceae	*Lycopodium cervuum*	Kumbai selap padi	Ceremony	
Myrsinaceae	*Ardisia colorata*	Kayu merjemah	To keep away evil spirits	
Ochnaceae	*Labisia pumila*	Sakang ribut	To prevent strong winds	
Orchidaceae	*Bromheadia borneensis*	Rotan buntak	Padi planting	
Palmae	*Licuala* spp.	Geranis	Gawai	
Piperaceae	*Piper betle*	Sirih	Ritual	
Polygalaceae	*Xanthophyllum amoenum*	Langir	To keep away evil spirits. Burn dried fruit walls.	S.77072
Verbeneaceae	*Vitex pubescens*	Kepapa/Leban	To keep away evil spirits. Rub the pounded young leaves with pineapple leaves on affected body parts.	S.77082
Zingiberaceae	*Costus glabra*	Letik	Ritual	
Zingiberaceae	*Costus speciosus*	Tepung buluh/ Letik	For good harvest and during padi planting	

DISCUSSIONS

Dr. Nengah Wirawan

Did you relate the Intellectual Property Right of the local communities to your ethnobotanical study?

Dr. Efransjah

What is the Sarawak Government's policy on this matter?

Dr. Paul Chai

The State policy is to conserve and protect whatever biological resources we have for the pharmaceutical and bio-technological developments. In this respect the State Government has set up the Sarawak Biodiversity Centre to regulate the collection, management and utilization of the State biodiversity, including policies and guidelines for scientific research, experiments, pharmaceutical, medicinal and other purposes. On the question of Intellectual Property Right, it has not been developed at this stage and I believe this will come in time under the purview of the Sarawak Biodiversity Centre.

Ernest Chai

What are the most popular species of the medicinal plants used by the local communities in Ulu Kanowit and Ulu Skrang? How often do they use these plants? Is there any plan to carry out chemical analysis of these medicinal plants?

Dr. Paul Chai

The purpose of the ethnobotanical study is to document what are available in our natural resources, the plants used by the local communities and the uses of these plants. The more common types of medicinal plants used by the local communities in Ulu Kanowit and Ulu Skrang are for treatments of external injuries, wounds, stomachache and diarrhoea. We do not have information on how often they use these medicinal plants as modern medicine is easily available now, even in the village shops. Again ITTO has no plan to carry out chemical analysis of medicinal plants. Bio-prospecting and pharmaceutical studies are expensive and time consuming. As I said earlier this ethnobotanical study is to document what is already known before this information is lost.

Jayl Langub

What are the Iban's harvesting strategies on the various plant resources, e.g. in the harvesting of rattan?

Dr. Paul Chai

The Iban community also practices the principle of conservation when they harvest the rattan and other food plants such as *Eugeissona*. As these plants produce multiple stems, they only harvest the mature stems and allow the young ones to grow. A lot of rattan is lost not because of over exploitation but due to the destruction of the habitats. Our major concern is the fish fauna. Because some of these fish command very high market values and are very popular among the consumers, there is a likelihood that these species may be over exploited. The prospect of rearing of high value indigenous fish is being studied.

Jiram Sidu

The Iban community has a good conservation strategy. They would leave a buffer zone along the river bank to preserve the fruit trees as a source of food for the fish or reserve a forested area in the Nature Customary Right Land as a source of forest produce. I feel that this project should look into the socio-economic needs of the communities.

Penguang Manggil

I think we should patent the Traditional Forestry Related Knowledge of the local communities and the medicinal value of our plant resources to protect the Intellectual Property Right for the interests of the local communities and the Government.

Dr. Efransjah

According to Dr. Dayanandan, the *dabai* trees have a good prospect. You did not seem to have highlighted on this. Could you elaborate?

Dr. Paul Chai

Dabai, scientifically know as *Canarium odontophyllum* is recognised for its fruits. The timber is quite soft and is not being used at the moment. I have briefly mentioned the *dabai* fruits and the trees during the slide presentation. When Dr. Dayanandan came to Kuching we mentioned to him of the importance of this species as a crop tree for Phase II. *Dabai* is a species with male or female trees and they are not distinguishable at the seedling stage. He was saying about developing genetic markers for early sex identification, preferably at the seedling stage so that more female trees can be selected for planting to maximise the fruit crops.

Dr. Efransjah

You mentioned that *kantok* or young leaves of *Gnetum gnemon* are used as vegetables. Do the local communities use the fruits for making *emping*.

Dr. Paul Chai

The *Gnetum* has two habits. It's either a climber or a treelet. The Sarawak species is a treelet, but it does not produce enough fruits to make *emping* as in Java, Indonesia. The local communities eat the young leaves as vegetables. Whenever it is found the local communities will protect and preserve the plant. The *kantok* of *Gnetum gnemon* has the potential to be introduced as vegetables among the urban consumers because it tastes delicious besides being free of pesticide.

Dr. Lim Meng Tsai

The list of ethnobotanical plants shows that many of these useful plants are from disturbed/secondary forests. To maintain the diversity of these plant communities in the disturbed forests does it not conflict with the TPA status of LEWS.

Dr. Paul Chai

Before the area was made the Sanctuary there were already people living inside the boundaries and cultivated the crops there. When LEWS was constituted the local communities living in the periphery were granted rights and privileges to collect the forest produce and used the resources within the designated areas. At the moment there are only a few areas in the TPA where the local communities continue to farm. One such area is at Ulu Katibas.

The local communities use quite a high proportion of ethnobotanical plants that are collected from the disturbed and secondary forests, hence the long list. A good thing is, many species of the ethnobotanical plants are actually there, and they appear readily after the land is abandoned. From the point of view of conservation of the secondary forests or the disturbed areas it is not critical because what we do now is to discourage them from farming in the TPA or we acquire their land so that we can take over the areas and conserve the resources.

Fungi and Lichens in the Lanjak Entimau Wildlife Sanctuary

by
Chin Fook Hon
Mycologist, formerly with ITTO

Abstract

A survey of the fungi and lichens was carried out. The objectives were to investigate the population, properties, uses and economic importance of forest fungi and lichens and to gain an understanding on the importance of the Sanctuary as a habitat for these groups of flora.

Field inventory was confined to the tributaries of Sungai Katibas, Sg Bloh and Bukit Plandok. At Ulu Engkari, sampling was done in the periphery of Bukit Lanjak (400 m a.s.l.), the riparian, alluvial, mixed dipterocarp, old secondary, submontane and montane forests.

A total of 521 fungi species belonging to 71 genera of 39 families were collected. These fungi species constitute about 11.0% of the known forest fungi in Sarawak. A very large percentage of the macrofungi (larger fungi) were collected in mixed dipterocarp and alluvial forests but were less abundant in other forest types. All findings sampled from various ecosystems in the Sanctuary are classified accordingly to their biological characteristics and uses.

42 lichen species on plant leaf and trunk were encountered in alluvial and mixed dipterocarp forests.

Market survey of edible fungi were made on the species of mushrooms consumed by the local people from various areas in Sarawak. Among the 11 edible fungus species, 4 are recommended for pilot cultivation.

1.0 INTRODUCTION

Although macrofungi (larger fungi) grow abundantly in the tropics and provide an excellent opportunity for study, to-date no comprehensive plan has been made to document the flora in the forests of Sarawak.

The study on fungi began in 1976 following the establilshment of Forest Pathology Unit in Sarawak Forest Department. To-date, about 4,600 species from different areas and forest types have been collected. Information on the fungi and lichen flora of Lanjak Entimau Wildlife Sanctuary (LEWS) is still lacking.

The present study represented the first mycology inventory in LEWS. Micro-fungi are extremely specific in their growth association. Edible fungi have been an important source of food among the local people. It is therefore necessary to study the biology, nature and habitats of these fungi in the Sanctuary.

The Sanctuary is located in an area with a 'humid tropical' type of climate. This is a continuously wet, tropical rainforest climate that has an annual rainfall exceeding 3,000 mm with a weak peak of rainfall in October to January up to about 300 to 350 mm per month. July and August are the driest months (about 200 mm) (Anon. 1996).

Temperatures are moderate, rarely exceeding 27°C or falling below 21°C at the Tintieng Gerongang subcamp (300 m a.s.l.), and relative humidity is high ranging from 92 to 100 %

2.0 OBJECTIVES

The present activity is undertaken for the aims of:-

(a) conducting a general survey of the non-vascular plants (fungi and other lower plants) of the sanctuary;

(b) to document the edible, inedible, poisonous and some medicinal species of fungi collected in various eco-systems;

(c) to investigate the economic importance of fungi among the local people and to gain an understanding of the importance of the Sanctuary as a habitat for forest fungi;

(d) to correlate species richness and distribution with different forest types and identify the edible species.

3.0 METHODOLOGY

For fungal samples collection, the following procedures are adopted:-

(a) Collections are carried out in different types of forest. In each type, examining different habitats such as rotten woods, roots, tree trunks and soil for fungal species;

(b) Depending on the fruit bodies available, 1 to 4 specimens of each species are collected. The day's collection are then sorted out, described, numbered and labelled for herbarium record; for unknown species , a spore-print is obtained;

(c) All collection are either smoke-dry or preserved in $ZnSO_4$ solution, the dried specimens are placed in sealed plastic bags or mounted on herbarium sheets.

(d) All notes, photographs and microscopic preparations relevant to particular collections were either kept with the collections in the herbarium or retained in a series of loose-leaf folders.

Besides the permanent record and dried reference samples, living cultures maintenance were maintained in the laboratory for further investigation.

4.0 FINDINGS

More than 500 fungi species belonging to 71 genera of 39 families were collected from various ecotypes. The number of fungi species made up some 11.0% of the known forest fungi species in Sarawak (about 4,600 species). A very large percentage of macrofungi in the Sanctuary were recorded in mixed dipterocarp forest (63.0%) and riparian/alluvial forest (32.0%) while less abundant in other forest types. The Polyporaceae (11 genera) and Tricholomataceae (8 genera) are the most dominant families in the studied areas. Collections by forest types are described below:-

4.1 Alluvial Forest

Most fungi were found on a wide variety of substrate, growing on rotten tree trunks, dead branches or fallen twigs, leaf litter, soil and other forms of organic matter.

Two poisonous, eight edible and ten medicinal species were found here. Some edible species, e.g. *Pleurotus ostreatus* (Oyster mushroom), *Auricularia auricula-judae* (*kulat bibir*), *Lentinus sajor-caju* (*kulat jelutong)*, and *Calostoma* sp. (*kulat mata babi)* are commonly sold as food at local markets.

4.2 Old Secondary Forest

Although the result is not much encouraging, some fungi species probably formed mycorrhizal association with forest trees. Species of *Thelephora, Boletus, Russula* and *Tricholoma* were found locally on the forest floor.

4.3 Lowland Dipterocarp Forest

The most number of collection were made in the lowland dipterocarp forest (LDF) at Ulu Engkari. Some parasitic bracket fungi species such as *Fomes* sp. (Polyporaceae) on living *meranti majau* (*Shorea leptoclados*) and *Phellinus* sp. (Hymenochaetaceae) on living *kumpang pali* (Myristicaceae) were encountered.

Fungi of socio-economic importance are plentiful in this forest type e.g. *Xylaria polymorpha* (*kulat tusu babi*), *Amauroderma* sp. (*kulat menaul)*, *Ganoderma lucidum* (*kulat lang)*, *G. applanatum* (*kulat lang*), *Lentinellus cochleatus* (*kulat burak*) and *Pycnoporus sanguineus* (*kulat bungkang).* They are commonly used as food or medicine by the Iban people.

Species of *Boletus, Amanita, Thelephora, Cortinarius*, and *Tricholoma* are common. Many of them may form mycorrhizal roots with forest trees.

4.4 Hill Dipterocarp Forest

Collection localities included forests area around camp site on Ubah Ribu ridge about 700 m a.s.l. Many species occur in diverse habitats including soils and rotten wood. They were simple saprophytes and a number of parasitic species.

4.5 Submontane and Montane Forest

Sampling in submontane mossy and montane mossy forests was undertaken at Bukit Lanjak (with a height of 1,285 m. a.s.l.). The occurrence of macrofungi in these vegetation types indicates a decrease in species or quantities. The fungi possess small to medium-sized fruit bodies which are tough, leathery or even corky.

The fungi species sampled from various ecosystems are summarised in Table 1.

Table 1. Occurrence of Macrofungi in Relation to Vegetation in LEWS

Forest Types	Types of Nutrition	Food Source	Longevity	Texture of Fruit body	No. of Species
Alluvial /riparian forest (60 - 120 m a.s.l.)	Saprophytic	Feeding off dead materials or on soil	Short-lived to annual	fleshy, fragile, gelatinous to leathery.	170
Old secondary forest (400 - 550 m a.s.l.)	Saprophytic and symbiotic.	On soil, humus and roots	Short -lived	fleshy and leathery.	15
Lowland dipterocarp forest (600 - 700 m a.s.l.)	Saprophytic, parasitic and symbiotic.	Feeding off dead materials or on living organisms.	Short-lived, annual, biennial to perennial.	fleshy, leathery, corky to woody.	265
Hill dipterocarp forest (800 -900 m a.s.l.)	Saprophytic and a few parasitic.	On soil, humus and rotten wood.	short-lived to annual.	fleshy, leathery to corky.	62
Submontane mossy forest (1,150 m a.s.l.)	Saprophytic	On soil and dead branch.	short-lived to annual.	fleshy, gelatinous and corky.	6
Montane mossy forest (1,250 m a.s.l.).	Saprophytic	On dead wood	Annual	leathery to corky.	3

5.0 THE IMPORTANCE OF LEWS AS A HABITAT FOR FOREST FUNGI

5.1 Important habitats for fungi

The Polyporaceae (11 genera) and Tricholomataceae (8 genera) are the most dominant families. Special importance of the former family lies in their ability to bring about wood decay on standing trees, e.g. *Fomes* spp. and *Polyporus* spp. They cause heart rots on the living trees of *belian* (*Eusideroxylon zwageri*) and *meranti majau* (*Shorea leptoclados*).

The Tricholomataceae is a large family of mostly fleshy species. Most of the species are harmless and a few are among the best edible kinds e.g. *Pleurocybella porrigens* (*kulat ikan)*, *Oudemansiella canarii* (*kulat minyak*), *Marasmius* sp. (*kulat upa)* and *Clitocybe fragrans* (*kulat perut manok*). They are commonly sold as food at local markets.

Another group of typical woody, bracket fungi belong to the Ganodermataceae. They are the destructive parasites in lowland dipterocarp forest, e.g. *Amauroderma* sp. found on living Resak (*Cotylelobium* spp.), *Ganoderma* spp. on *menggris* (*Koompassia malaccensis*) and *kapur* (*Dryobalanops* sp.). These fungi are not only well known to our foresters as wood-destroying pathogens, some species also possess medicinal value to the longhouse communities, especially in the Ulu Katibas area. About 6 of the 16 species for medicinal and other uses belong to this family.

Analysis of field data indicates that more than half of the edible fungi and medicinal species occur in the lowland dipterocarp forest and more rarely in the alluvial forest. Very few edible fungi occur in the hill dipterocarp forest.

The distribution and occurrence of fungi in submontane mossy forest and montane mossy forest are comparatively fewer than in other vegetation types. Most species found in these forests are short-lived with a small to medium-sized fruit body that are tough, leathery or even corky.

5.2 Occurrence of the LEWS forest fungi in Relation to Seasons, Ecotypes and rainfall

Most species will grow between 15^{o} - 35^{o} C and the optimum temperature lies in the range of 20^{o} - 30^{o}C.

Light is essential only for producing spores. They are more common and abundant during warm, rainy seasons. The main growing season begins from late October or early November to February, with the peak period between December and February (Chin 1981). During the dry season, only the wood inhabiting species are found growing well.

Due to their dependence on organic materials for food, most of them may appear whenever such materials are available. Some species are extremely specific in their grow associations, being found only on dung or associated with roots of certain trees.

Generally, macrofungi can flourish very well in alluvial/riparian and mixed dipterocarp forests.

Alluvial/riparian forest occurs in lowlying flood plains. Alluvial material ranges in texture from fine clay to large rocks and even to boulders. Fine sediments are washed into the drainage valleys from the watershed surface. These deposits are poorly drained, but, where drainage is provided, they constitute important crop-producing areas. Flood plains in general rich in plant nutrients and comparatively high in organic-matter content for more forest fungi to grow.

In LEWS, almost all swidden land and potential swidden land fall roughly into the lowland dipterocarp forest zone. The richest flora (and fauna) are found in this vegetation type. The Euphorbiaceae and Dipterocarpaceae are the two dominant groups. These rainforest trees occupy several canopy layers among the eight vegetation formations in the Sanctuary (Chai, 1994). The dense vegetation prevents drought, minimise moisture evaporation and protects forest foils from direct exposure to the sun.

At the same time, a large number of organic material decomposed from dead plant parts and animal products provide the necessary habitats for forest fungi.

In submontane mossy and montane mossy forests above 1,100 m a.s.l., damp mosses grow over tree trunks and branches and form a layer of cushion making it difficult for the fungi to penetrate.. The small trees are enveloped in dense growths of moss. Cool weather coupled with peaty, acidic soils and the presence of many exposed areas that are totally bare of tree growth are factors that discourage fungi development.

6.0 THE LICHENS RECORDED IN LEWS

Lichens are abundant and widely distributed in riparian/alluvial and lowland dipterocarp forests. The fundamental part of lichen is called the *thallus* which is composed of a fungus and an alga. Basically, three main kinds of lichens can be distinguished by their habit of growth and the manner of attachment to the object on which they grow (the substratum) : -

(i) Crustose lichens: - the crust-like thallus tightly appressed to the substrate. Most lichen species in LEWS belonging to this class, e.g. *Graphis* sp, and *Opegrapha* sp.

(ii) Fruticose lichens: - thallus erect and rising from the substrate. They may be entirely unattached or may arise from a disk or holdfast. No specimen was collected in the Sanctuary area.

(iii) Foliose lichens: they are leaflike and prostrate but not so firmly attached to the substratum. *Collema* sp. and *Parmelia* sp. are the typical foliose lichens collected in LEWS.

During the study, 42 lichen species were collected. Lowland dipterocarp forest had the highest lichen species diversity than other forest types. The most common species found here are the "Crustose lichens": Pyrenulaceae (*Pyrenula* sp.) on *bilat* (*Parashorea macrophylla*), and Graphidaceae (*Graphis* sp.) on *empili* (*Lithocarpus* spp.) and *kumpang seluai* (*Knema* sp.). Some unidentified species are recorded on living trees of the Myristicaceae, Myrtaceae (*Eugenia* spp.) and Leguminosae (*Koompassia malaccensis*)

"Foliose lichens" are also common in occurrence. The Parmeliaceae (*Parmelia* sp.) was found on Sapotaceae (*Nyatoh* sp.), while Physciaceae (*Physcia* sp.) was collected from an unidentified small tree.

In general, the riparian/alluvial forest is richer in crustose lichen species than the lowland dipterocarp forest. They occur on the leaves of Dipterocarpaceae (*Vatica* sp.), Palmae, Euphorbiaceae (*Cleistanthus* sp.), Leguminosae, Myrtaceae (*Eugenia* sp.) and Zingiberaceae. Many species were also observed on the stem (or bark) of Myrtaceae, Annonaceae, Polygalaceae, Euphorbiaceae and Dipterocarpaceae. In the riparian forest they occur on exposed rocks. Their growth on bare rocks initiates the weathering away of such rocks.

Lichens are less common in hill dipterocarp forest and sometimes thoroughly disappear in submontane and montane forests.

Some lichen species occurrence and distribution in Ulu Kartibas and Ulu Engkari are given in Table 2.

Table 2 Lichen diversity and habitats in LEWS : -

Forms of Lichen Plant	Genus / Family	Habitats
(A). Crustose lichens	*Graphis* sp., Graphidaceae	On living *kawi* (*Whitiodendron* sp.) (Myrtaceae) in alluvial forest.
	Opegrapha sp., Opegraphaceae	Found on rock surface in riparian forest.
	Pyrenula sp., Pyrenulaceae	On climber bark – akar kayas (Annonaceae) and *kawi* (Myrtaceae) in alluvial forest; and on *bilat* (*Parashorea macrophylla*) at 500 m. a. s. l. in LDF.
	Tomasellia sp., Arthopyreniaceae	On *nyalin* (*Xanthophyllum* spp.) in alluvial forest.
	Graphis sp., Graphidaceae	On *empili* (*Lithocarpus* spp.) in LDF.
	Unknown	On living Myristicaceae in LDF
	Unknown	On living *bintangor (Calophyllum* spp.) at 700 m a.s.l. in HDF
	Unknown	On living *ubah (Eugenia* spp.) at 600 m a.s.l. in LDF

Forms of Lichen Plant	Genus / Family	Habitats
	Graphis sp., (?) Graphidaceae	On living *kumpang seluai (Knema* sp.) at 500m.a.s.l. in LDF.
	Unknown	On living small tree (unidentified) at 500 m. a.s.l. in LDF.
	Pertusaria sp., Pertusariaceae	On the bark of *mataik* tree (Euphorbiaceae), in alluvial forest.
	Unknown	On *entak empuluh* (Euphorbiaceae) in alluvial forest.
	Unknown	On *luis* (*Hopea* spp.) in alluvial forest.
	Unknown	On *menggris* (*Koompassia malaccensis*), in LDF.(Bkt. Plandok).
	Unknown	On *ubah* tree (*Eugenia* spp.) in alluvial forest.
	Lecanoraceae	On the leaf of *Vatica* sp. (Dipterocarpaceae) and Palmae, in alluvial forest; on leaf of Leguminosae in LDF (Bkt. Plandok).
	Unknown	On the foliage of *pala beriak* (*Cleistanthus* sp.) in alluvial forest.
	Lecanora sp., Lecanoraceae	On the leaf of Zingiberaceae in riparian forest.
	Unknown	On the leaf of Palmae in riparian forest
	Unknown	On leaf of Palmae and *ubah* (*Eugenia* spp.) in riparian forest.
(B). Foliose lichens	*Collema* sp., Collemataceae	On the root of *pingan* tree (*Artocarpus* sp.) (Moraceae), in alluvial forest.
	Parmelia sp., Parmeliaceae	On *nyatoh* (Sapotaceae) at 700 m.a.s.l. in HDF.
	Parmelia sp., Parmeliaceae	On rotten wood at 600 m. a.s.l. in LDF.
	Physcia sp., Physciaceae	On a small tree (unidentified), in LDF.
	Parmelia sp., Parmeliaceae	On fallen bark in LDF (Ubah Ribu).
	Unknown .	On a small tree (unidentified), in LDF.
(C). Fruticose lichens	Nil	

7.0 ROLES OF THE FUNGI AND LICHENS IN THE FOREST ECOSYSTEM

During warmer seasons, the majority of the floor population, particularly the fungi (and bacteria) are engaged in feeding the forest debris to gradually decompose and free their component chemicals. These fungi play an important role in the cycle of nature, by putting back into circulation all the materials required by autotrophic organisms such as green plants. Undoubtedly, fungi are both destructive and beneficial to human. On one hand, they are responsible for millions of dollars worth of damage to forest crops by causing plant diseases, while on the other they increase the fertility of the soil by inducing various changes which eventually result in the release of plant nutrients in a form available to green plants. Without the decay produced by fungi (and bacteria), dead bodies of plants and animals would pile up indefinitely.

Some fungi live in close association with the roots of forest trees. Together, the tree roots and the root-like hyphae of the fungi form absorbing structures known as mycorrhizae. These structures are more efficient than the normal rootlets for the absorption of water and chemical nutrients, particularly nitrogen.

Compared with forest fungi, lichens do not occupy a prominent situation in most ecosystems but in some special circumstances may be important. The best known role of lichens is colonisation of bare rock surfaces. Lichens are among the very few organisms that can survive on bare rocks. They weather the rocks by penetrating its structure physically with rhizines (root-like structures) and hyphae, and they chemically erode the rocks with the various acids they produce.

The lichen thallus also traps wind-blown dust and plant material thus building up a substrate for mosses and small herbs.

In arid areas lichens colonise stable soil surfaces. Once covered with lichens the soil is protected from wind, and to a large extent from water erosion.

8.0 CLASSIFICATION OF FOREST FUNGI ACCORDING TO THEIR BIOLOGICAL CHARACTERISTICS AND USES

Since the study relies heavily on the knowledge of local traditional culture in the supply of information, especially on medicinal fungi, short stays at the longhouses were arranged. According to the biological characteristic and uses, the collections were classified as below : -

8.1 Mushrooms

Thirty seven edible species in 17 families (Table 3) were found in various ecosystems mainly in alluvial and lowland dipterocarp forests. For the longhouse communities, 12 species are regularly consumed, 14 species are seasonally consumed while others are obtained during the course of work, such as gardening, travelling to and from farm sites, or while collecting wild fruits. It is a common fare only when the fungi are especially abundant during the rainy season and the early stages of farming, particularly when the swidden cultivators are staying temporarily near their farmland.

Table 3 Edible fungi species sampled in LEWS

NO.	LOCAL NAME	SPECIES	FAMILY
1.	Kulat banyak menantu	*Lentinellus cochleatus*	Lentinellaceae
2.	Kulat kerang	*Schizophyllum commune* *	Schizophyllaceae
3.	Kulat aping	*Crepidotus* sp.	Crepidotaceae
4.	Kulat ikan/K. isek	*Pleurocybella porrigens*	Tricholomataceae
5.	Kulat bintang/Kulat mata babi	*Calostoma* sp.	Calostomataceae
6.	Kulat buah	*Hygrophorus* sp.	Hygrophoraceae
7.	Kulat resak	*Lentinus* sp.	Lentinellaceae
8.	Kulat minyak	*Oudemansiella canarii*	Tricholomataceae
9.	Kulat kemarau	*Crepidotus* sp	Crepidotaceae
10.	Kulat bulu	*Lentinus strigosus*	Lentinellaceae
11.	Kulat tusu babi	*Xylaria polymorpha*	Xylariaceae
12.	Kulat mangkok	*Cookeina sulcipes*	Sarcoscyphaceae
13.	Kulat upa	*Marasmius* sp.	Tricholomataceae
14.	Kulat engkabang	*Amanita* sp.	Amanitaceae
15.	Kulat jelutong/Kulat gelang	*Lentinus sajor-caju* *	Lentinellaceae
16.	Kulat taun	*Hygrophorus puniceus*	Hygrophoraceae
17.	Kulat kerop	*Auricularia delicata*	Auriculariaceae
18.	Kulat bibir/Kulat lepik	*Auricularia auricula-judae* *	Auriculariaceae
19.	Kulat mangkok	*Cookeina tricholoma*	Sarcoscyphaceae
20.	-	*Tremella fuciformis*	Tremellaceae
21.	Kulatbuluh	*Camarophyllus* sp.	Hygrophoraceae
22.	Kulat perut manok	*Clitocybe fragrans* *	Tricholomataceae
23.	-	*Amanita vaginata*	Amanitaceae
24.	-	*Hydnum repandum*	Hydnaceae
25.	Kulat jerami	*Cyathus striatus*	Nidulariaceae
26.	-	*Pleurotus ostreatus*	Pleurotaceae
27.	Kulat tapak labi	*Polyporus pes-caprae*	Polyporaceae
28.	-	*Tremella mesenterica*	Tremellaceae
29.	Kulat kasut	*Amanita* sp.	Amanitaceae
30.	Kulat abus	*Hygrocybe* sp.	Hygrophoraceae
31.	-	*Dictyophora* sp.	Phallaceae
32.	Kulat kerop	*Auricularia mesenterica*	Auriculariaceae
33.	Kulat tegalan /Kulat amau	*Neurospora* sp.	Sordariaceae
34.	Kulat rian }		
35.	Kulat repek }	(Unidentified)	
36.	Kulat raung }		
37.	Kulat kaki sengayan }		

* Most popular species.

8.2 Poisonous/Hallucinogenic Fungi

Eight poisonous fungi were encountered. The toxic effects of *kulat tenggar* (*Gymnopilus* sp., Cortinariaceae) had been described by Sather (1978) in his study on Iban Folk Mycology. *Xerula radicata* (Syn. *Oudemansiella radicata*) is believed to have cancerostatic properties (Singer, 1986). The most highly toxic species comes from *kulat ipoh* (*Russula* sp., Russulaceae). This fungus takes its name from its association with the poisonous latex of the *ipoh* tree, *Antiaris toxicaria* (Moraceae). Other species such as *kulat dilah kendawang* (*Pycnoporus sanguineus*, Polyporaceae) are able to disperse pimples and other skin infections (Burkill, 1935).

8.3 Luminescent Fungi

The luminosity of wood may be due to the fungal hyphae, which penetrates inside the wood cells. On other occasions it is the fruit body itself that is luminous. Ramsbottom (1965) reported 20 fungi species which are known to "phosphoresce". Some best-known species are *Polyporus sulphureus*, *Fomes annosus*, *Collybia* spp., *Panus* sp., and *Corticium* sp.

At temperatures between 4°C and 39°C, the gills of some *Pleurotus* sp. will emit a white light in the presence of oxygen.

Armillaria mellea is well-known worldwide as a destructive pathogen. Its young rhizomorph covered with active mycelia which are luminous. As the rhizomorph becomes old and cuticularised it loses this property

Two types of *kulat malam* (*Mycena* sp. and *Nothopanus* sp.) were reported by Sather (1978) to exhibit brillian blue-white or greenish-white luminescence at night. A number of *Mycena* sp. were reported by Lim (1972) to emit bio-luminescence in the dark. In all cases, however, the light appears to have little biological significance.

8.4 The mycorrhizal fungi

The fungal mycelium may form an encircling mantle around the rootlets or it may be largely internal in the cortex of the root. Such infested rootlets are much enlarged and usually show an abnormal amount of branching. The mycorrhizal habit increases the surface area of the root system thereby facilitating the selective absorbtion of nutrients and ions. It also protects roots from pathogenic micro-organisms and toxic chemicals. Such trees are also more drought resistant. The fungi concerned in all such associations are the Basidiomycetes: species of *Boletus, Cortinarius, Russula* etc. Forty-one Malaysian dipterocarp species have been reported to form mycorrhizae (Norani, 1996).

At LEWS, one *Tricholoma* sp. (Tricholomataceae) was found to form a fairy ring surrounding a *Shorea* and a *Hopea* tree in the mixed dipterocarp forest, a phenomenon of mycorrhizal formation. The same fungus species also occurs on another *Shorea* sp. in hill dipterocarp forest at 700 m a.s.l.

8.5 Macrofungi for Medicinal Purposes and Other Uses

Sather (1978) has described the particular uses of *kulat mata hari* (*Poromycena manipularis*, syn. *Filoboletus manipularis*) and *k. ipoh* (*Russula* sp.) in his mycological study on the Paku tributary of Batang Saribas, Sri Aman Division. Singer (1986) stated that the poisonous fungus, *kulat bengang (Flammulina velutipes)* contains an antibiotic substance Flammulin which has anti-tumor activity. However, an extensive investigation on medicinal uses of fungi was made by Burkill in 1935. At least 17 species applied to different ailments in Peninsula Malaya, Java, Moluccas and India were recorded. Ramsbottom (1965) also reported several medicinal species being used in Japan, West Sussex, China, New Zealand and Australia. The information collected in LEWS is shown in Table 4.

Table 4 Some macrofungi for medicinal and other uses

No	Local Name	Botanical Name	uses
1.	*Kulat mata hari*	*Poromycena manipularis* Tricholomataceae	Treatment of headache caused by heat of the sun. Wrap the fungus in leaves and warm on fire. When hot, rub on the forehead.
2.	*Kulat dilah kendawang*	*Pycnoporus sanguineus* Polyporaceae	For 'red-eye' Dry and burn the fruit body, to smoke the infected eye(s).
3	*Kulat ipoh*	*Russula* sp. Russulaceae	Dry and burn the fruit body. Its smoke is believed to provide magical defence against rats and insect pests in rice fields. Also used by the Iban as poison in blowpipe darts.
4.	*Kulat lang*	*Ganoderma lucidum* Ganodermataceae	To release air from stomach. Dry and burn the fruit body. Mix the ashes with white lime and betel leaves. Then crush together and smear on stomach.
5.	*Kulat keringit*	*Cymatoderma* sp. Podoscyhaceae	As insect repellent. Dry and burn the fungus to produce smoke from the burning fruit body against sand-fly and mosquito.
6.	*Kulat lang*	*Ganoderma applanatum* Ganodermataceae	- do -
7.	*Kulat tangkal*	*Amauroderma* sp. Ganodermataceae	- do -
8.	*Kulat menaul (eagle fungus)*	*Amauroderma* sp. Ganodermataceae	To release air from stomach. Dry and burn the fungus. Mix the ashes with white lime and betel leaves. Crush and smear on the stomach.
9.	*Kulat tangkal*	*Amauroderma* sp. Ganodermataceae	Cut the stem into short sections and used for Talisman to chase away evil spirits.
10.	*Kulat bengang*	*Flammulina velutipes* Tricholomataceae	Possesses anti-tumor activity. Flammulin - an anti-tumor antibiotic substance is found in this species..
11.	-	*Amauroderma* sp. Ganodermataceae	Dry samples are used as table ornaments after polishing with varnish and lacquered (Lim, 1972).
12.	*Kulat burak*	*Lentinellus cochleatus* Lentinellaceae	Regarded as a 'cold food', traditional Iban curers will not allow patients suffering from chronic rheumatism and asthma or other recurrent illness to eat it in order to prevent a relapse of symptoms

13.	*Kulat mangkok*	*Cookeina tricholoma* Sarcoscyphaceae.	For 'red-eye' treatment. Add water into the 'cup' shake for a while, then cover on the affected eye(s)
14.	*Kulat lipik / kulat bibir / kulat kepik*	*Auricularia auricula - judae,* Auriculariaceae	Fresh fruit body may slightly neutralise the toxin from poisonous fungi when taken.
15.	-	*Tremella fuciformis* Tremellaceae	As a cold drink to reduce heat.
16.	*Kulat bintang / Kulat mata babi*	*Calostoma* sp. Calostomataceae	As a drink to lower body temperature.

8.6 Inedible fungi

The majority of the collection fall in this group. About 456 species in more than 40 families occur in various forest types. The number of fungi species constitutes some 10% of the known forest fungi in Sarawak (Table 5). A large percentage of the inedible species in the Sanctuary are Polyporaceae (16%) and Tricholomataceae (14%). Others are Clavariaceae (8%) and Hygrophoraceae (4%) which produce their fruit bodies on soil or humus.

Table 5 A comparison of macrofungi species diversity sampled in LEWS and Sarawak

CLASSIFICATION	LEWS	SARAWAK
(a) Edible mushrooms	37	75
(b) Poisonous/Hallucinogenic Fungi	8	21
(c) Inedible Fungi	456	4,500
(d) Luminescent Fungi	6	6
(e). Mycorrhizal Fungi	1	2
(f) Fungi for Medicinal and Other uses	16	14

9.0 SPECIES FOR SOCIO-ECONOMIC IMPORTANCE AND THEIR POTENTIAL FOR CULTIVATION

9.1 Food (values) and medicine

The food value of fungi is in fact not great, approximately the same as that of green vegetables.

Fungi contains many useful substances, although they are 80 to 90% water. The most important structural substances is mycocellulose (a special type of cellulose) and fungal chitin. Besides the usual organic components (sugars, proteins and fat), all sorts of mineral matter are present. As reported by Tosco (1973), the fresh mushrooms provide energies of up to 30 to 85 calories/100gm; while the dried products yield 300 to 360 calories/100 gm. Many vitamins, especially vitamins D and C, are present in mushrooms.

Compared to other forms of flora, fungi contributes very little to Iban diet and are of only minor importance in Iban pharmacology. Some village medicine might be considered home-remedy medicine, since someone in every household is expected to know the treatment for common ailments, such as headache, common cold etc. Traditional medicine is still very much a part of the culture among some Iban communities in Sarawak.

Approximately 14 different kinds of macrofungi for treating a variety of internal and external ailments were described from Lanjak Entimau by traditional medical practitioners from the Iban communities (Table 4).

9.2 Market survey of edible mushrooms

This survey was made based on the species of mushrooms consumed by the local people from various areas of Sarawak. The results of market investigation are shown in Tables 6 & 7.

Locally, some *kulat* are the most frequently eaten. Among the edible mushrooms are *Schizophyllum commune, Auricularia auricula-judae, Lentinus sajor-caju* and *Clitocybe fragrans*. The Iban communities generally boiled the *kulat* as a vegetable sidedish. One of the Iban traditional methods of preparation is by steaming them inside green bamboo tube.

Most of the edible mushroom are collected in hill rice field while some species are found in peatswamp forest and rubber gardens close to their farmland. No fungi are gathered in the temuda area.

While out in their farms, the Iban women participate in gathering of mushrooms and other products. Such activity usually takes place in the newly made farms or in vegetation in the first couple of years of fallow. Most mushroom appear in response to rainy seasons during which more fruit bodies may be collected.

Kulat kerang (*Schizophyllum commune*) usually appears on logs 3 to 4 weeks after the burn and will be abundant for up to one month. This fungus is also available throughout the rest of the year in small quantities.

Another species, *kulat amau* (*Neurospora* sp.) appears on partially burnt or unburnt logs within one week after the burn.

The Iban women may sell their product twice per month during the early and the middle of every Muslim month. This is in accordance with the market demand besides the problem of transporting their product to the town.

9.3 The potential for mushroom cultivation on a pilot scale

The Iban exploit the forest environment for food by hunting, fishing and gathering. The more important gathered food items of *umbut* (the'heart' of various plants), *paku* (ferns) and *kulat* (mushrooms) may provide to 25% of the diet (by frequency of consumption).

The possibility obviously exists that many local species of fungi can be cultivated, particularly those that naturally live on a rich medium such as humus and rotten logs. Besides *Auricularia auricula-judae* and *Clitocybe fragrans*, possibilities include species of *Schizophyllum commune*, *Lentinus sajor-caju*, *Tremella fuciformis*, *Hygrophorus conica and Auricularia delicata.* Trial planting could be carried out on pilot scale among the Iban communities.

Compost materials such as maize, sawdust, rice straw and household refuse can be easily obtained from the longhouses. The compost will be piled in heaps outdoors, sterilised in a variety of ways and inoculating it with chosen 'spawn' (block of fungal mycelium) under the right conditions.

Usually it takes about one month for the inoculated bed to produce the very small, white buttons, and about 1½ to 2 months for the growing process to be completed. Mushrooms need the right humidity and temperature, together with the correct sort of compost.

Tremella fuciformis is a pure white, jelly fungus that commonly occurs on rotten tree trunk in riparian forest. This edible fungus is imported mainly from China, Japan and Korea in preserved form and is used extensively as cold food by the Chinese and a small number of Malay and Iban communities. It is highly recommended for the improvement of constipation, poor appetite, to get rid of toxin in stomach and intestines, as well as for menstrual irregularity. In the Chinese drug shop, the market price is roughly RM35.00 per kilogram. In one shop, the quantity sold daily is between 2.0 and 5.0 kg. Based on an average amount of 3.5 kg er day, it means that a wholesale value of about RM.44,700.00 (US$11,732.00) a year per shop. Each year the local consumers will spend about a million Malaysian ringgit or more on this particular species.

Thus, pilot scale cultivation among the swidden cultivators as an alternative source of cash income is feasible. The activity would also help to discourage them from exhausting the natural populations in the wild.

Table 6 Market investigation on edible mushrooms

EDIBLE SPECIES		Average Weight (in gm) / heap	COLLECTION AREA				Races of consumer	The more popular and welcome species
			Peatswamp Forest	Hill rice field	Temuda area	Others		
1.	*Schizophyllum commune* (Kulat kerang)	210	✓	✓		Rubber gardens	a) Malay b) Iban c) Chinese	✓
2.	*Auricularia auricula - judae* (Kulat bibir)	200	✓	✓		Rubber gardens	a) Malay b) Iban c) Chinese	✓
3.	*Lentinus sajor-caju* (Kulat jelutong)	175	✓	✓		-	a) Malay b) Iban	✓
4.	*Cookeina tricholoma & Cookeina sulcipes* (Kulat mangkok)	100		✓		Rubber gardens	a) Iban	
5.	*Calostoma* sp. (Kulat mata babi)	15-20 pcs/pack		✓		Lowland Forest	a) Iban	
6.	*Termitomyces* sp. (Kulat guntur)	200				Lowland Forest	-	
7.	*Auricularia delicata* (Kulat kerop)	230		✓		-	a) Iban b) Malay	
8.	*Clitocybe fragrans* (Kulat perut manok)	210		✓		Fruit gardens	a) Malay b) Iban c) Chinese	✓
9.	*Lentinellus cochleatus* (Kulat burak)	200	✓	✓		-	a) Malay b) Iban	
10.	*Hygrophorus conica*	>200		✓		-	a) Iban b) Malay	

Table 7 : Amount of individual species sold in local markets (Monthly record)

	Fungi Species	PASAR TAMU										Total Number of heap sold (Monthly)	Weight in Kg
		Serian	Sri Aman	Engkilili	Betong	Lubok Antu	Sarikei	Bintangor	Saratok	Sibu	Kapit		
1	*Schizophyllum commune*	23	8	-	16	-	6	-	-	5	12	70	14.7
2	*Auricularia auricula-judae*	13	9	-	2	-	-	-	-	105	16	145	29.0
3	*Auricularia delicata*	-	5	-	-	-	60	-	-	-	18	83	19.1
4	*Lentinus sajor-caju*	9	31	-	48	-	-	-	12	-	-	103	18.0
5	*Clitocybe fragrans*	9	23	-	2	-	-	-	10	-	30	76	16.0
6	*Calostoma* sp.	-	-	-	8 (Packs)	8 (packs)	-	-	10 (packs)	-	-	26 (packs)	468 (pc)
7	*Termitomyces* sp.	-	-	-	-	-	3	-	-	-	-	3	0.6
8	*Cookeina sulcipes*	-	1	-	-	-	-	-	-	-	-	1	0.1
9	*Lentinellus cochleatus*	-	1	-	-	-	-	-	-	-	-	1	0.2
10	*Hygrophorus conica*	4	4	-	-	-	-	-	-	-	-	8	1.6

Remarks : (1). Calostoma sp. sold in pack (about 18 pcs / pack).

10.0 DISCUSSION

A total of 521 fungi species belonging to 71 genera of 39 families were collected from the forests in LEWS. The number of fungi species made up some 11.0% of the known forest fungi species in Sarawak. A very large percentage of macrofungi were collected in mixed dipterocarp forest and alluvial forest.

Temperature and moisture are important determining factors on fungi growing. With little or no rainfall, very few fruit bodies may appear. The distribution of rainfall is also important for the timing of the burning of fields which usually takes place in the second half of July or in August. Some varieties of forest fungi are associated with hill rice agriculture. The appearance of certain fungi (Table 6) in newly fired fields is a sign of ideal conditions for planting of annual crops. Their occurrence also indicates an optimum rainfall for crop growth. Some short-lived fungi, e.g. *kulat amau* (*Neurospora* sp.) and *kulat buah* (*Hygrophorus* sp.) are indicators of soil fertility and the success of farmland fired.

Although the Iban inter-plant green vegetables in their rice fields and gardens around the longhouses, the collection of wild foodstuffs, fishing and hunting, are important field activities. Gathering edible mushrooms and other wild foodstuffs is one of the field activities of women. Usually the senior women have a good knowledge of fungi, especially those species of medicinal value.

A number of edible species are recommended for pilot scale cultivation. Rare species include the *kulat ipoh (Russula* sp.), and *kulat menaul* (*Amauroderma* sp.) (both for medicinal uses); *kulat ikan* (*Pleurocybella porrigens*), *kulat taun* (*Hygrophorus puniceus*) and *kulat teglan* (*Neurospora* sp.) (all edible species). Compared to other kinds of foodstuff, mushrooms are less important among the Iban diet and are of minor importance to their pharmacology.

Species of *Amanita* and *Boletus* were found locally on the forest floor in secondary and primary forests. Some probably form mycorrhizal relationship with forest trees. *Tricholoma* sp. from the mixed dipterocarp forest, is specifically associated with roots of *Hopea* sp. and *Shorea* sp.

In alluvial/riparian and lowland dipterocarp forests, crustose lichens and foliose lichens are abundant and are widely distributed on bare rock surfaces and tree bark. Although these organisms do not occupy a prominent position in most ecosystems, certain species have been used as food by human, in the preparation of dyes is litmus as an indicator in chemistry, as well as used in the treatment of diseases of the chest. *Peltigera canina* has traditionally been used in "rabies" (Smith, 1921).

11.0 RECOMMENDATIONS

Based on the results of the study, the following recommendations are given:

(a) Further inventory in the Sanctuary is needed to discover more species of socio-economic importance as well as to increase our knowledge on the fungal population and to establish their potential values not only to the communities living adjacent to the Sanctuary, but also to the people of Sarawak;

(b) Initiate a pilot project on mushroom cultivation to raise the living standard of the local residents while at the same time to gain their support for the sustainable management of the Sanctuary; e.g. to reduce their dependence on the forest and to promote biodiversity conservation;

(c) Biologically, LEWS is one of the richest natural areas in Sarawak. Its stable climate together with the wide range of topographical features and various ecotypes have given rise to a great diversity of flora and fauna. Study on the lichens and their potential in the pharmaceutical industry should be carried out.

(d) Most fungi collectors have had no knowledge of biology (especially mycology). They have simply gathered just the common edible species, trampling and destroying all other types. The consequence of this is obvious; the local fungi flora has suffered and this means less food for the local population in future. Appropriate training programmes ought to be developed further.

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APPENDIX I

CONSUMPTION OF FOOD ITEMS BY HOUSE-HOLD (LANJAK-ENTIMAU WILDLIFE SANCTUARY)

NO.	FOOD ITEMS	NUMBER OF MEAL TAKEN BY	
		Rumah Api / Rumah Enggong (Ulu Katibas)	**Rumah Lenggang, NangaTalong (Ulu Engkari)**
1.	Rice	daily (3 per day)	daily (3 per day)
2.	Vegetable-all kinds	daily (3 per day)	daily (3 per day)
3.	Fish	4 - 5 per month	3-4 / week to daily
4.	Hunting (of wildlife)	1-2 per month	1 - 2 per month
5.	Mushroom (edible fungi)	1 - 2 per month	1 per month

DISCUSSIONS

Dr. Soepadmo

Why are mycorrhizal fungi so rare in LEWS? Why many species of fungi, particularly the edible and poisonous fungi, are only identified to family and generic levels?

Chin Fook Hon

The study of mycorrhizal is very time consuming. The consultancy for mycology inventory was only six months and there wasn't enough time to fit the study of mycorrhizal fungi into the six-month work plan. Most of the mycorrhizal studies were carried out in the nurseries and plantations. I consider it not worthwhile to conduct mycorrhizal study in the natural forests.

Most species of edible fungi can be identified to species levels. We only found eight species of poisonous fungi of which three species were identified. We did not spend too much time trying to identify poisonous fungi because they were less important compared to the edible fungi.

Ernest Chai

What are the four species of fungi that you have recommended for pilot cultivation? Why only four out of eleven species were chosen? How are you going to carry out the pilot cultivation? You mentioned that *kulat mangkok* has medicinal values for treating red eyes, could you elaborate?

Chin Fook Hon

The four species of fungi recommended for pilot cultivation are: *kulat kerang* (*Schizophyllum commune*), *kulat bibir* (*Auricularia auricula-judae*), *kulat jelutong* (*Lentinus sajur-caju*), and *kulat perut manok* (*Clitocybe fragrans*). The four species are chosen because they are the most popular species and commonly sold in the markets. The consumers also prefer these four species. It is also for this reason that only four species are recommended for pilot cultivation. I have not looked into pilot cultivation of these fungi. On *kulat mangkok* for treating red eyes, the information was collected from the elderly ladies in the longhouses.

Chung Kueh Shin

You mentioned *kulat* or forest fungi will be getting less and less for the longhouse communities. What are the causes and how are you going to improve the situation? On pilot cultivation I would suggest that we should proceed towards development rather than concentrating on research, and to examine the feasibility for mass production. We may start with one out of the four selected species.

Chin Fook Hon

First you have to understand how the local communities go about collecting the forest fungi. From the collected fungi they will select the ones with perfect food body, throw away the over mature and rotten ones. They even collect the immature fungi. In this way they will reduce the fungi population in the forest. We need to train them in conservation education so that the forest fungi population can be sustained.

WORKSHOP SESSION II

FAUNA INVENTORY

CHAIRMAN	:	MR. PATRICK M. ANDAU
RAPPORTEURS	:	MR. MUHAMAD TAHA B. WAHAB MR. PASCAL AK. DAGANG

A Species Inventory of Small Mammals for the Development of Lanjak Entimau As A Totally Protected Area

by

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and

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Abstract

Sampling at five sites in Lanjak Entimau recorded 40 species of small mammals, including 13 bats and one potential tree shrew. Taking together the findings in this study and that of Kavanagh (1982), the number of small mammal species in Lanjak Entimau now stands at 48. The figure shows that the diversity of small mammal in Lanjak Entimau appears to be high, encompassing at least 36% of Sarawak's known species and 30% of Bornean endemics. No montane species were found in the study though.

Despite its status as one of the totally protected species in Sarawak the naked bat appears to be common in the Sanctuary while the geographic differentiation among the population of wrinkle-lipped bat and Prevost's squirrel appears to be substantial. For the Maxomys rats the elevational effect is found to be prominent.

At least 75 plant species representing 29 families of angiosperms in Lanjak Entimau are known to be visited and/or consumed by small mammals. At the same time small mammals play an important role in pollinating flowers, dispersing seeds, controlling insect populations, enhancing successful seed germination, and providing important source of nutrients to forest trees. Because pollination enhances the genetic diversity of plants via sexual reproduction, conservation of pollinators should be viewed as conservation of plant species. Thus the small mammals of Lanjak Entimau should be preserved and be included in long-termed research on tropical forest dynamics.

In view of the importance of small mammals in the Lanjak Entimau, a series of research activities have been recommended for prioritization. These are, (i) systematic and periodic field surveys, (ii) specimen collections, (iii) taxidermy, (iv) construction of electronic data base, (v) publications, and (vi) integration of study with parasitology and medical entomology.

It is also recommended that a research canopy walk for surveying arboreal species be installed in the Sanctuary.

1.0 BACKGROUND

Although Lanjak Entimau Wildlife Sanctuary (LEWS) has long been gazetted as a protected area as far back as 1983, a checklist of LEWS small mammals is yet to be available. Because small mammals are relatively more abundant in number, less attractive in coloration and often regarded as pests, it is therefore not surprising that research priority in previous LEWS surveys has been given to other more vulnerable animal groups such as primates, game mammals, birds and herpetofauna. In light of the high endemism and species richness of Borneo, a study of small mammals has thus been recommended for the development of LEWS as a totally protected area (TPA) Phase II (Stuebing, 1994). This recommendation is timely because inventory-taking is the first step towards studying biodiversity regardless of the level of diversity we are dealing with, whether they be different kinds of association and biota in ecology and biogeography or different kinds of species and higher taxa in taxonomy.

Indeed, the foundation on which description and inventory-taking lays form the basis on which further progress in forest and wildlife management depends. Protection strategies to monitor the uses of wildlife, both scientifically and non-scientifically as well as locally and internationally, cannot be efficiently implemented without a good knowledge of their distribution and their functional roles. This is particularly true for small mammals whose ecological roles in terms of pollination and fruit or seed dispersal are still poorly known. To a lesser extent, the same can also be said on the socio-economic importance of the small mammals in terms of medicinal uses, food sources, host-parasite association and vectors.

2.0 OBJECTIVES

Because small mammals are important in providing insight into understanding the changes of community structure in tropical forest, this study focuses on establishing an inventory for the small mammal group. Specifically, the objectives of this study are:

(i) to make a synoptic collection of the small mammals of LEWS;

(ii) to prepare a checklist of LEWS small Mammals;

(iii) to evaluate the ecological roles of the small mammals via identification of the fruit types consumed by these animals, which may provide a bearing to the establishment of seedbanks later, and

(iv) to assess the socio-economic importance of the small mammals.

3.0 GENERAL DESCRIPTION OF THE LANJAK ENTIMAU WILDLIFE SANCTUARY (LEWS)

Located between 111°51' E and 112°30' E, and 1°19' N and 1°51' N, Lanjak Entimau covers a total area of 168,758 ha. Bounded by the Betung Kerihun National Park

(Kalimantan) on the southeast and the Batang Ai National Park (Sarawak) on the south, Lanjak Entimau is drained by two of Sarawak major river systems, the Batang Lupar and Batang Rajang. The Batang Lupar river system is formed by a network of streams, which includes the rivers of Engkari, Lubang Baya, and Skrang in the south. In the north, rivers of Katibas, Bloh, Mujok, Ensirieng, Kanowit, and Ngemah flow into the Rajang. This network of streams appears to have acted as natural barriers to the spread of many of the small mammal populations.

The rugged topography of Lanjak Entimau supports a variety of tropical moist vegetation along its elevational profile with the highest peak on Bukit Lanjak (1,285 m). This wide diversity of climax vegetation includes secondary forest of 50 to more than 100 years old, alluvial forest, mixed lowland and hilly dipterocarp forest and submontane mossy forest, creating an array of interacting microhabitats that greatly enhance the animal diversity. Given that small mammals have been known to propagate rapidly in regenerating forest, Lanjak Entimau thus provides a suitable study site for comparing the community changes of small mammals in natural versus exploited forest and in low versus high elevations.

4.0 STUDY SITES AND METHODOLOGY

Sample collection was conducted in five sites (Ulu Engkari, Sungai Bloh-Joh of Ulu Katibas, Bukit Sengayoh of Ulu Katibas, Ulu Skrang, and Ulu Lubang Baya) (Figure I), covering both primary and secondary forests as well as low and high elevations to give an optimum habitat diversity. Each site comprised four transects which were demarcated either by the streams or the elevational contours.

The duration of visits to each site varied from 11 to 21 days and the sampling effort also varied considerably from site to site, mainly due to logistical restriction. Collection was done using as many methods as possible and at as many niches as possible so as to obtain the highest number of species. The non-volant mammals (rats, squirrels, tree shrews, porcupines) had been collected mainly using wire cage traps (20 x 20 x 48 cm) and snares although several specimens were hit with catapult or caught by hand by local people. In each site, the cage traps were placed along the transects at an interval of 25 m with odd-numbered cages set on the ground and even-numbered cages tied to tree branches, 2 to 3 m above the ground. Bananas and roasted coconut were the major bait types used. Other baits such as jack fruit, pineapple, *cempedak,* salted fish, and live insects were also tried out but discarded after a while because these baits either decomposed rapidly, or were chewed up rapidly by ants.

Snares were also set next to the cage traps where applicable with the use of a number of different fruit (liquid) essence as attractant to lure the animals.

Most bats were mist-netted although two cave species were knocked down or caught by hand. Another was found inside a length of bamboo. The mist nets, two to three in a site, were set across the streams and other available open area. The nets were checked and closed in the early morning at 7.30 a.m.

With the exception of several specimens of the totally protected and protected species which were released the majority of the specimens collected were preserved in 10%

formalin after being euthanized with chloroform, standard body measurements taken, and tagged. The remaining specimens were dry-preserved as skin vouchers.

Beside body measurements of the specimens, field data such as locality, altitudes, and reproductive condition were also recorded in field catalogue as well as in computer database. Both the wet and the dry-preserved specimens have been deposited with the Sarawak Forest department.

Identification of fruit types consumed by small mammals were done through the collection of fallen wild fruits on the forest ground where small mammals had been seen foraging.

5.0 RESULTS

Based on the present study, 45 mammal species (13 bats, 10 rats, 9 squirrels, 5 tree shrews, 3 porcupines, 1 mustelid, 3 viverrids, and 1 barking deer –Appendix I) have been recorded from Lanjak Entimau. Only 21.7% of the 60 Sarawak bat species are represented in the present study. No shrews (moon rat) were trapped or sighted.

At least another seven species were sighted but failed to be accurately identified to their species level. These include three bats, one mouse (*Mus* sp.), one tree mouse (*Chiropodomys* sp.), one field rat (probably *Rattus tiomanicus*) and one squirrel (*Sundasciurus tenuis*?). Several other small mammal species as reported by Kavanagh (1982) were also not caught in the present study. These include 2 horseshoe bats, 3 tree squirrels, the whiskered flying squirrel, the moon-rat (shrew), the pentail tree shrew and the lesser mouse deer. Other mammals species not found in this study but also reported by Kavanagh (1982) are the sambar deer, the yellow-throated marten, the western tarsier, and the pangolin (Appendix II).

Currently there are altogether 58 mammal species recorded from Lanjak Entimau, of which 48 are true small mammals, or approximately 36% of the known small mammals of Sarawak (Table 1). Among these 48 species of small mammals, 21% (10) are Bornean endemics. As seen for the herpetofauna (Stuebing, 1995), no true montane mammals were found, suggesting that Lanjak Entimau may have long been isolated from other mountain ranges of Sarawak in the past.

Among the non-volant mammals, one unusual tree shrew species caught in Ulu Engkari and Ulu Skrang at an elevation of 260 m and closely resembles the montane tree shrew, *Tupaia montana* has not been identified. Although found together with the common tree shrew (*Tupaia glis*) this unknown species is slightly smaller than the former. Preliminary examination suggests that this unknown tree shrew is likely to be a new species.

Table 1 The composition of various small mammal groups found in Borneo, Sarawak, and Lanjak Entimau Wildlife Sanctuary (LEWS)

Small Mammal	Borneo	Sarawak	Present Study in LEWS	Study by Kavanagh in LEWS-1982	% (LEWS/Sarawak)
Bats	92 + 1*	60	13	2	25.0
Rats	26	22	10	-	45.5
Squirrels	34	32	9	4	40.6
Porcupines	3	3	3	-	100
Tree Shrews	10 + 1**	9 + 1**	4 + 1**	1	60.0
Shrews	8	5	-	1	20.0
Total	175	132	40	8	36.4

+ 1* : *Cynopterus minutus* found in Brunei (Kofron, 1997)
+ 1** : the potential new *Tupaia* sp. found in the present study

Strangely, the widely distributed lesser tree shrew (*Tupaia minor*) was not represented in the present collection even though this species is known to occur sympatrically with *T. tana* and *T. glis* in Sabah (Han,1991). One possibility is that the absence of *T. minor* may be attributed to the principle of competitive exclusion from the terrestrial niche by this unknown species or by *T. glis* or by both. It is possible that *T. minor*, an arboreal species in most habitats studied thus far, may have been pushed to a higher canopy niche and failed to be caught.

The unexpected record of plaintain squirrel (*Callosciurus notatus*) in Ulu Engkari and Ulu Katibas may represent an extension of known range of this species. This is simply because *C. notatus* was thought to be found largely in the western part of Sarawak and absent from tall forest (Payne *et al* 1985). The recent range expansion of this species could be due to its high capability to propagate well in monoculture plantations such as oil palm and fruit orchards. This is particularly true in the last fifty years or so in which a large portion of the Sarawak lowland had been converted into agricultural land.

The rat collections are equally represented by *Maxomys surifer*, *M. rajah*, *Leopoldamys sabanus* and *Sundamys muelleri*. Both *M. surifer* and *M. rajah* are relatively abundant in the Sanctuary (Table 2).

The Lanjak Entimau Wildlife Sanctuary is also found to inhabit all the three Bornean porcupines in abundance (Table 1). A local man from Ulu Skrang, Anjan ak. Ngelambong confessed that he had killed as many as 100 porcupines, mainly the common *Hystrix brachyura*, in the past few years. The present study shows that this animal can be easily lured by using essence with fruit flavor, and hence snared. Incidentally, the short-tailed mongoose was also attracted to the essence.

Table 2 Number of rat specimens collected from different elevational levels in Lanjak Entimau.

Rat species	<300 m	<400 m	<500 m	>500 m	Total
Maxomys rajah	2	5	-	1	8
Maxomys surifer	1	1	1	7	10
Maxomys whiteheadii	2	2	1	2	7
Maxomys ochraceiventer	1	-	-	-	1
Sundamys muelleri	7	1	-	-	8
Leopoldamys sabanus	6	3	-	-	9
Rattus exulans	-	-	-	1	1
Niviventer cremoriventer	1	-	-	-	1
Niviventer rapit	2	1	-	-	3

6.0 DISCUSSION

In general, among the volant mammals, the composition of bat species netted was similar in all the selected study sites of Lanjak Entimau. However there seems to be a substantial amount of morphological variation among the geographic populations in different parts of the Sanctuary. This is evidenced in the wrinkle-lipped bat (*Tadarida plicata*), in which the specimen collected in Ulu Katibas is golden yellowish extended to the nape, while those of Ulu Skrang are entirely black. In term of conservation aspect, most bat species in Lanjak Entimau, including that of the totally protected status (naked bat: *Cheiromeles torquatus*) appear to be rather common. Its status as a totally protected species might create misconception among the Wildlife Licencing Unit and other relevant authority by introducing further administrative and bureaucratic complications for granting research permission to scientists who wish to collect it in their study. A somewhat similar argument can also be extended to other species such as the tree shrews which seems to be equally abundant.

Failing to find a particular small mammal species does not always necessarily mean that the species is endangered. Such failure is merely the result of a lack of specific knowledge on its ecology (e.g., the specific niche it occupies), behaviour (e.g., its seasonality), or even the sampling technique itself (e.g., bait choice or trap type). Simply enlisting them as 'totally protected' or 'protected' can further hinder field scientists from learning more about certain species since some advancing knowledge requires substantial field collections (e.g., studies involve the estimation of intraspecific gene flow). Unfortunately, specimen collection has been mistakenly deemed by some as one of the critical factors that drives local populations to extinction. However, no small mammals are known to have disappeared as a result of specimen collections in Sabah. What is certain is that some populations are wiped out by the total destruction of habitat, and conserving the habitat is fundamental to faunal conservation.

6.1 Ecological Roles of Small Mammals

At least 75 fruit species representing 29 families of angiosperms were known to be consumed by small mammals (Appendix III). The Euphorbiaceae appeared to be the plant families most frequently visited by small mammals. The ecological interactions between plants and their pollinators as well as seed dispersers are mutualistic. Animals gain a source of nutrients (nectar, pollen, fruit pulp, and seed) from plants, which in turn gain mobility for their pollen grains. Regal (1977) argued that the evolutionary interplay between vertebrate pollinators and seed dispersal was the crucial factor that allowed angiosperms to become the dominant plants in most terrestrial habitats. Pollinators such as fruit bats (Pteropodidae) help perpetuation of plants through making their sexual reproduction a success. Thus conservation of pollinators should therefore mean conservation of plant species. Fujita (1988) stated that at least 306 plant species are known to have evolved adaptive morphological structures for bat pollination. For example, flowers produce large amount of pollens and dilute nectar, the numerous stamens of Leguminosae and Myrtaceae, the large and sturdy blooms of Bombacaceae, and the nocturnal blooming of other plants (Fujita, 1988; Whitmore, 1990). Among the fruit bats, *Macroglossus minimus* has long been known to feed on nectar and pollen from various plants while the frugivorous-nectarivorous *Cynopterus* (the short-nosed fruit bat) and the flying fox (*Pteropus vampyrus*) are known to pollinate *durian* and *petai*.

Mammals are also known to disperse seeds from the fruiting trees. A small fruit bat , for instance is capable of dispersing seeds as far as 38 km over one night (Start and Marshall, 1976). They also play an important role in the colonization of disturbed habitats by pioneer plants. Many tree squirrels have been seen transporting fruits of various forms and sizes in Lanjak Entimau. The red spiny rats (*Maxomys surifer*) has been reported to store fallen fruits in its nest for the young while common porcupine (*Hystrix brachyura*) disperses the seeds of Borneo ironwood (Payne *et al,* 1985). Mammals are also known to disperse seeds through their faeces.

The insectivorous bats such as the naked bat (*Cheiromeles torquatus*), the free-tailed bat (*Tadarida mops*), the wrinkle-lipped bat (*Tadarida plicata*), and the Javan pipistrelle (*Pipistrellus javanicus*) are known to feed on insects. Hill and Smith (1984) estimated that a pipistrelle can eat around 30,000 mosquito-sized insects a night. The naked bat, the free-tailed bat, and the wrinkle-lipped bats which are at least twice larger in body size than that of the pipistrelle, certainly have a much greater contribution in regulating the population of insects. Apart from all the mentioned ecological contribution to the ecosystem, through their waste product small mammals can also form an important source of nutrients to many forest trees.

6.2 Socio-Economic Aspect of the Small mammals

Except for rats and tree shrews, local people in Lanjak Entimau eat most of the small mammals including the squirrels, tree shrews, porcupines, and even bats if they happen to catch them incidentally. Although no adult rats are ever eaten, new born rats with eyes still closed are occasionally swallowed alive, particularly by older people who believe that consuming the new born rats could render the ability to be immune from the charm of black magic and also to cure asthma.

The bezoar stone (bladder stone) of porcupines and primates may fetch a high commercial price because of its medicinal value. It is believed to have magical curing effect on various diseases including fever, diabetes and heart problems. A golf ball size of a single bezoar stone can easily fetch a price of RM 3,000.00. The local Ibans also believe that a preparation of the stomach of the porcupine (*Trichys fasciculata*) can also treat stomach pain.

7.0 RECOMMENDATION FOR MANAGEMENT AND DEVELOPMENT

The management of small mammals should be an integral part in the conservation of the biotic communities of Sarawak. As such among some of the activities recommended for the management and development of the LEWS small mammals are:

(i) Intergration of research on Lanjak Entimau's small mammals into the mainstream of small mammal research in the state. This research should emphasize on the following objectives:

- to identify the relevant research areas (topics) and techniques which are of conservation significance (e.g. study on the small mammal community structure, which reflects the habitat quality via diversity indices, the Simpson or Shannon-Weiner);

- to do specimen collection, systematic and periodic field surveys which require field trappings. Specimen collection, however should not be done on species which are rare or endangered;

- to identify the small mammal groups that require study, eg. species at risk or indicator species;

- to build a computer database for all the relevant information for ease of reference, cataloging, analysis, and finally publication;

- to outline some basic requirements for staff recruitment, training and education;

- to identify species and communities sensitive to limited habitat area, or genetic isolation;

- to identify which factors most influence long-term survival of endangered and other vulnerable species so as to minimize the probability of extinction;

- to integrate the study of small mammals with parasitology and medical entomology. This is to provide a databank for future retrieval in the event of disease outbreak that may be associated with small mammals so as to avoid being caught unprepared. Among others, Hafner and Nadler (1981), Nadler *et al* (1990) and Page (1991), in their reports have well documented the host-parasite relationships between arthropod parasites and small mammals.

(ii) Recruitment of more field scientists, training of research workers, and educating public and school children on the importance of conserving biodiversity such as small mammal;

(iii) Construction of a research canopy walk (e.g. 100 m high and 2 km long) for the study of arboreal small mammals. It was found that cage traps being set up 2 to 4 m above the ground have failed to catch several rat and squirrel species that can only be found at higher canopy level (Zubaid and Khairul, 1997);

(iv) Construction of facilities, equipment and better logistics such as science laboratory and hostel for researchers in LEWS. (These facilities are being progressively constructed at Nanga Bloh and Ulu Engkari).

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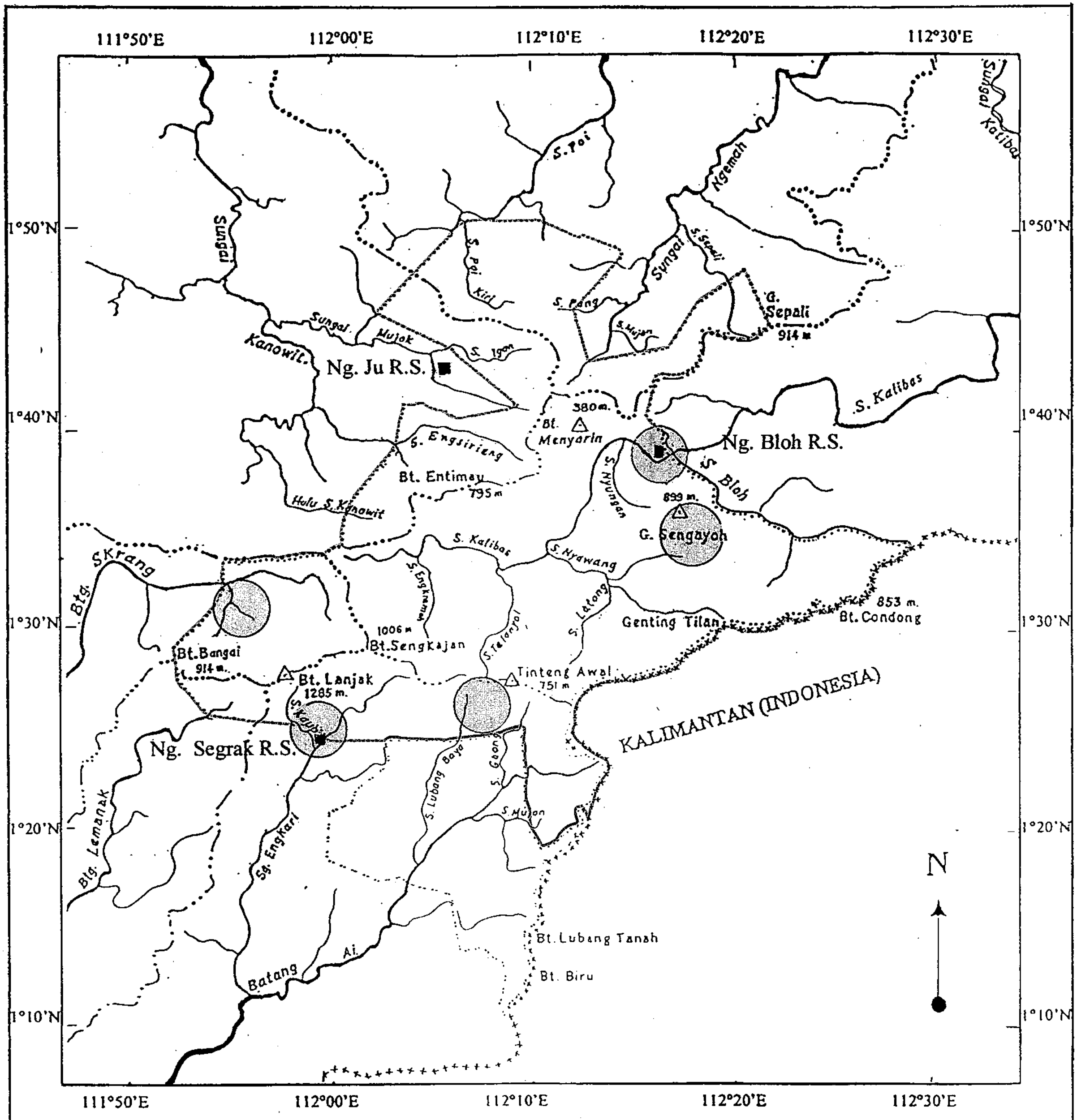

Figure 1 : THE COLLECTING SITES OF SMALL MAMMAL IN LANJAK ENTIMAU WILDLIFE SANCTUARY

0 20 KM

Scale 1 : 625,000

Legend

Lanjak Entimau Wildlife Sanctuary...

Batang Ai National Park................

International boundary ....

Collecting Site ....

Ranger Station..............................

Appendix I Small mammal species collected in the present study

	Scientific Names	Common Names	I	II	III	IV	V	Total
1.	*Balionycteris maculata*	spotted-winged fruit bat	-	-	1	2	-	3
2.	*Cheiromeles torquatus*	naked bat	-	4	*	*	-	4
3.	*Cynopterus brachyotis*	short-nosed fruit bat	38	-	1	5	-	44
4.	*Glischropus tylopus*	thick-thumbed pipistrelle	16	-	4	-	-	20
5.	*Hesperoptenus tomesi*	Tome's false serotine	-	-	-	-	1	1
6.	*Macroglossus minimus*	long-tongued nectar bat	13	-	-	1	-	14
7.	*Miniopterus magnater*	large bent-winged bat	2	-	-	-	-	2
8.	*Myotis macrotarsus*	pallide large-footed myotis	-	-	-	7	-	7
9.	*Penthetor lucasii*	dusky fruit bat	2	-	2	4	-	8
10.	*Pipistrellus javanicus*	Javan pipistrelle	1	-	-	-	-	1
11.	*Tadarida mops*	free-tailed bat	-	6	-	-	-	6
12.	*Tadarida plicata*	wrinkle-lipped bat	-	1	-	25	-	26
13.	*Pteropus vampyrus*	large-flying fox	-	-	-	#	-	#
		Subtotal (bats):	*72*	*11*	*8*	*46*	*1*	*138*
14.	*Leopoldamys sabanus*	long-tailed giant rat	3	2	1	3	-	9
15.	*Maxomys ochraceiventer*	chestnut bellied spiny rat	-	-	-	1	-	1
16.	*Maxomys rajah*	brown spiny rat	3	-	-	2	3	8
17.	*Maxomys surifer*	red spiny rat	9	1	-	-	-	10
18.	*Maxomys whiteheadi*	Whitehead's rat	3	1	-	2	1	7
19.	*Niviventer cremoriventer*	dark-tailed tree rat	-	-	-	1	-	1
20.	*Niviventer rapit*	long-tailed mountain rat	-	-	-	3	-	3
21.	*Sundamys muelleri*	Muller's rat	3	3	1	1	-	8
22.	*Rattus exulans*	Polynesian rat	1	-	-	-	-	1
23.	*Rattus rattus*	house rat	-	-	*	-	-	*
24.	*Callosciurus notatus*	plantain squirrel	1	3	1	-	-	5
25.	*Callosciurus prevostii*	Prevost's squirrel	-	1	-	-	-	1
26.	*Exilisciurus exilis*	plain pygmy squirrel	-	-	#	-	-	#
27.	*Exilisciurus whiteheadi*	Whitehead's pygmy squirrel	1	-	-	-	-	1
28.	*Nannosciurus melanotis*	black-eared pygmy squirrel	1	-	-	-	-	1
29.	*Ratufa affinis*	giant squirrel	-	#	#	-	-	#
30.	*Rheithrosciurus macrotis*	tufted ground squirrel	#	-	-	-	-	#
31.	*Sundasciurus lowii*	Low's squirrel	-	-	#	-	-	#
32.	*Sundasciurus hippurus*	horse-tailed squirrel	-	-	-	1	-	1
33.	*Hystrix brachyura*	common porcupine	1	-	-	2	1	4
34.	*Thecurus crassispinis*	thick-spined porcupine	@	-	-	1	-	1
35.	*Trichys fasciculata*	long-tailed porcupine	-	-	-	6	1	7
36.	*Tupaia dorsalis*	striped tree shrew	-	1	-	-	1	2
37.	*Tupaia glis*	common tree shrew	1	5	-	-	1	6
38.	*Tupaia gracilis*	slender tree shrew	-	3	-	-	-	3
39.	*Tupaia tana*	large tree shrew	-	3	-	-	-	3
40.	*Tupaia* sp.	Unknown tree shrew	2	-	-	1	-	3
	Scansorial mammal species other than small mammals							
41.	*Aonys cinerea*	small-clawed otter	-	-	-	-	1	1
42.	*Hemigalus derbayanus*	banded palm civet	1	-	-	-	1	2
43.	*Herpestes brachyurus*	short-tailed mongoose	-	-	-	2	1	3
44.	*Muntiacus muntjac*	common barking deer	1	-	-	-	-	1
45.	*Viverra tangalunga*	tangalung	-	-	-	1	-	1
		Total	103	34	11	71	12	231

Note: * : released
: sighted
@: escaped

Appendix II Mammal species not found in the present study but was reported by Kavanagh (1982)

Scientific Names	Common Names
(Bats)	
1. *Rhinolopus sedulus*	lesser woolly horseshoe bat
2. *Rhinolopus trifoliatus*	trefoil horeseshoe bat
(Squirrels)	
3. *Callosciurus orestes*	Bornean black-banded squirrel
4. *Lariscus insignis*	three-striped ground squirrel
5. *Sundasciurus tenuis*	slender squirrel
(Flying Squirrel)	
5. *Petionomys genibarbis*	whiskered flying squirrel
(Tree shrew)	
6. *Ptilocercus lowii*	pentail tree shrew
(Shrew)	
7. *Echinosorex gymnurus*	moon-rat
(Scansorial mammal species other than small mammal)	
8. *Manis javanica*	pangolin
9. *Cervus unicolor*	sambar deer
10. *Tragulus javanicus*	lesser mouse-deer
11. *Marten flavigula*	yellow-throated marten
12. *Tarsius bancanus*	western tarsier

Appendix III Some of the plant species consumed or visited by small mammals In LEWS

	Family	Species	Local names	Visitors/pollinators/seed predators
1.	Alangiaceae	*Alangium* sp.	midong	giant squirrel, tree squirrels
2.	Anacardiaceae	*Gluta* sp.	rengas	horse-tailed squirrel, fruit bats
3.	Anacardiaceae	*Swintonia acuta*	pitoh	tree squirrels
4.	Annonaceae	*Mezzettia leptopoda*	kepayang babi	tree squirrels, tree shrews, rats, porcupine
5.	Annonaceae	*Alphonsea johorensis*	semukau	tree squirrels
6.	Apocynaceae	*Willughbeia flavescens*	tabau	tree squirrels
7.	Bombacaceae	*Durio kutejensis*	pakan	large flying fox, tree squirrel
8.	Bombacaceae	*Durio zibethinus*	durian	large flying fox, tree squirrels
9.	Burceraceae	*Dacryodes rostrata*	kembayau	tree squirrels
10.	Celastracaceae	*Bhesa* sp.	simun	bats, squirrels, tree shrews, rats, porcupine
11.	Celastracaceae	*Kokoona* sp.	bajan	tree squirrel, tree shrew, porcupine
12.	Dillieniaceae	*Dillenia excelsa*	beringin	barking and sambar deers
13.	Dillieniaceae	*Dillenia suffruitcosa*	buan	barking and sambar deer
14.	Dipterocarpaceae	*Dipterocarpus oblongifolius*	ensurai	tree squirrels
15.	Dipterocarpaceae	*Hopea* sp.	luis	squirrel, rats, tree shrew, pig, porcupine
16.	Dipterocarpaceae	*Shorea* sp.	meranti langgai	tree squirrel, rats, pigs
17.	Dipterocarpaceae	*Shorea domatiosa*	tekam	tree squirrels
18.	Dipterocarpaceae	*Shorea* sp.	engkabang	giant squirrel, tree squirrel
19.	Ebenaceae	*Diospyros* sp.	kayu malam	fruit bats
20.	Euphorbiaceae	*Antidesma* sp.	berenai	fruit bats
21.	Euphorbiaceae	*Aporusa aurea*	janggau	squirrels, tree shrews, rats, deer, civet
22.	Euphorbiaceae	*Baccaurea hookeri*	jelentik	tree squirrels, tree shrews
23.	Euphorbiaceae	*Baccaurea macrocarpa*	puak	tree squirrels, tree shrews
24.	Euphorbiaceae	*Baccaurea pyriformis*	pekang	tree squirrel, tree shrews
25.	Euphorbiaceae	*Baccaurea* sp.	sintak nyabor	tree squirrels
26.	Euphorbiaceae	*Blumeondendron kurzii*	lemak manok	tree squirrels
27.	Euphorbiaceae	*Cleistanthus* sp.	pala beriak	tree squirrel, rats, tree shrew, fruit bats
28.	Euphorbiaceae	*Elateriospermum tapos*	kelampai	tree squirrel
29.	Euphorbiaceae	*Macaranga* sp.	purang	tree squirrel, rat, tree shrews, pigs
30.	Euphorbiaceae	*Omphalea bracteata*	entupak	tree squirrel, sunbear
31.	Euphorbiaceae	*Trigonopleura malayana*	sedik kayu	tree squirrel
32.	Fagaceae	*Castanopsis foxworthyi*	berangan	tree squirrel
33.	Fagaceae	*Lithocarpus* sp.	empili	giant squirrel
34.	Gnetaceae	*Gnetum klossii*	akar dundun	civets
35.	Gonystylaceae	*Gonystylus* sp.	ramin	tree squirrel, rats, tree shrews, pigs
36.	Guttiferae	*Calophylum* sp.	bintangor	giant squirrel, tree squirrel, fruit bats
37.	Guttiferae	*Garcinia mangostana*	sikop	tree squirrel, tree shrews
38.	Guttiferae	*Garcinia parvifolia*	kundong	tree squirrel, tree shrews
39.	Guttiferae	*Garcinia* sp.	kandis	tree squirrel
40.	Guttiferae	*Masua collinum*	mergasing	tree squirrel, tree shrews, pig, porcupine
41.	Leguminosae	*Dialium indum*	engkeranji	tree squirrel
42.	Leguminosae	*Koompassia malaccensis*	menggeris	squirrel, tree shrew, rat, porcupine, pig, deer
43.	Leguminosae	*Parkia speciosa*	petai	porcupine, flying foxes
44.	Leguminosae	*Parkia javanica*	petai	porcupine, flying foxes
45.	Melastomataceae	*Memecylon sp,*	nipis kulit	tree squirrel, tree shrews, rat, porcupine, bat

46. Meliaceae	*Algaia* sp.	segera	tree squirrel, tree shrews, rats, porcupine, bat
47. Meliaceae	*Dysoxylum* sp.	segera	porcupines
48. Meliaceae	*Lansium domesticum*	lensat	tree squirrel ,tree shrews, large flying foxes
49. Meliaceae	*Sandoricim borneense*	kelampu	tree squirrel, fruit bats
50. Moraceae	*Artocarpus anisophyllus*	bintawa	tree squirrel, tree shrews, rats, porcupine, bats
51. Moraceae	*Artocarpus dadah*	dadak	tree squirrel, tree shrews, fruit bats, pigs
52. Moraceae	*Artocarpus integer*	temedak	tree squirrel, tree shrews, fruit bats
53. Moraceae	*Artocarpus kemando*	pala munsoh	squirrel, tree shrews, rat, fruit bats, deer
54. Moraceae	*Artocarpus nitidus*	selangking	tree squirrel, tree shrews, fruit bats
55. Moraceae	*Artocarpus odoratissimus*	seterap	squirrel,tree shrews,slow loris,fruit bats
56. Moraceae	*Artocarpus rigidus*	pala tupai	tree squirrel,tree shrews,rat, deer,bats,deer
57. Moraceae	*Artocarpus sarawakensis*	pingan	tree squirrel, tree shrews,porcupine,fruit bat
58. Moraceae	*Ficus* sp.	kara	binturung, tree squirrel,tree shrews,f.bats
59. Musaceae	*Musa* sp.	pisang hutan	tree squirrel,tree shrews,fruit bats
60. Myristicaseae	unidentified	kumpang	tree squirrel
61. Myrtaceae	*Eugenia malaccensis*	jambu	tree squirrel, long-tongued nectar bat
62. Myrtaceae	*Eugenia* sp.	ubah	tree squirrel
63. Oleaceae	*Ochanostachys amentacea*	sentikal	porcupines
64. Rubiaceae	*Canthium confertum*	tulang	ular tree squirrel, tree shrews, rat, porcupine, pig
65. Rubiaceae	*Porterandia anisophyllea*	mulong	udok squirrel, tree shrews, rats, fruit bats, porcupine
66. Rutaceae	*Tetractomia latifolia*	rawang	tree squirrel,
67. Sapindaceae	*Nephelium mutabile*	ma	tree squirrel
68. Sapindaceae	*Nephelium* sp.	sibau	tree squirrel, tree shrews, flying fox, fruit bat
69. Sapindaceae	*Xerospermum norronhianum*	pudun	squirrel, tree shrews, flying fox, bat, sun bear
70. Sapotaceae	*Palaquium* sp.	nyatoh	flying fox
71. Tiliaceae	*Grewia* sp.	bunsi	tree squirrel, tree shrews, rat, fruit bat, flying fox
72. Zingiberaceae	*Etlingera littoralis*	senggang	tree squirrel, rat, porcupine
73. Zingiberaceae	*Etlingera punicea*	tepus rani	tree squirrel
74. Zingiberaceae	*Hornstedtia magnifica*	kechala	tree squirrel
75. Zingiberaceae	*Plagiostachys crocydocalyx*	banjang	tree squirrel, rat.

DISCUSSIONS

Dr. Soepadmo

Apart from *Macroglosus minimus* which is a nectarivorous bat, are there any other species of nectarivorous bats in LEWS, e.g. *Eonyteris* bats? Are the four species of fruit bats namely *Balionycteris*, *Cynopterus*, *Penthetor* and *Pteropus* residents of LEWS or migrants?

Engkamat Lading

The first author only listed *Macroglosus minimus* as the nectarivorous bats in his consultancy report. Frankly I am not sure if other species of nectarivorous bats such as *Eonyteris* are found in LEWS. The four species of fruit bats were found and identified during the course of the inventory of small mammals in the Sanctuary. The study did not include the feeding range of these bats and it was not determined if any of these species was a migrant.

Dr. Soepadmo

I would like to suggest that the authors include in their recommendation a further study on the roles of these critical groups of animals in pollination and seed disposal, and the reproductive biology of forest trees.

Patrick Andau

Perhaps you need to do a tagging study to determine the residential status of these bats.

The Avifauna of Lanjak Entimau Wildlife Sanctuary

by
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Abstract

Borneo is the world's third largest island with an area of 451,865 km^2. More than 1,000 species of land vertebrates have been recorded of which over 60% are bird species. Netting operations and transect observations in the Lanjak Entimau Wildlife Sanctuary yielded 238 bird species from 38 families. Out of these, 14 are Bornean endemics and ten are migrants. The Sanctuary is therefore a major repository of bird species and previous surveys have demonstrated that there is much more to be discovered. Field stations should be set up at three major areas : Katibas, Engkari and Mujok for long-term studies to gain a better understanding of birds in the area.

1.0 INTRODUCTION

Borneo is the world's third largest island with an area of 451,865 km^2. It is located in the Sundaic subregion of the Indo Malayan archipelago. For centuries, Borneo has been renowned as a representative of a tropical forest rich and highly diverse in tropical species largely unstudied. However, ornithological studies conducted on the island date as far back as 150 years and a good portion of the lowland species have been relatively well documented. More than 1,000 species of land vertebrates have been recorded of which over 60% are birds.

The avifauna of Borneo is Sundaic in character where many of the species are similar to those of Sumatra, Malaya and Java. The avifauna communities are more of oriental origin rather than Australasian. The first comprehensive guide to the Bornean avifauna was written by B.E. Smythies. To date, 599 bird species have been recorded in Borneo with approximately 358 resident birds and 37 endemics. The remaining 241 species are categorised as migrants or vagrants.

Lanjak Entimau Wildlife Sanctuary (LEWS) is an area of rugged , hilly terrain located between 111°53' E to 112°28'3" E and 1°19' N to 1°51' N. It is the largest totally protected area in Sarawak with an approximate area of 168,758 hectares. Its altitude ranges from 60 m to 1,200 m above sea level (Stuebing, 1996). LEWS together with Betung Kerihun National Park form a contiguous tract of tropical rainforest almost one million hectares in area. The Sanctuary has been set aside primarily for the conservation of orangutans and in the mean time, other vertebrates including the birds derive protection from the status of this reserve.

2.0 METHODOLOGY

Fieldwork consisted of walking 2 to 4 km long transects through the forest and conducting netting operations for long-term studies on birds. Observations were made by using 10 x 50 binoculars. For netting operations, a total of 10 to 20 four panelled mist nets, 12 m in length and 36 mm mesh were used. Nets were placed in as many microhabitats as possible, such as in streams, drier forest understorey, along ridges and in low lying areas. Nets were kept open from 6.15 a.m. to 6.45 p.m. daily and closed whenever it rained. Birds caught were identified, weighed, measured and ringed with aluminium rings engraved 'Sarawak Forest Department'.

During Phase I of the LEWS project, netting operations were carried out in eight lowland sites and one submontane site. Subsequently, a 10-day survey was carried out during the ITTO Borneo Biodiversity Expedition in 1997 (IBBE 1997) at Sg. Bloh as shown in Table 1.

Table 1 Netting activities

Netting site	Altitude	Habitat type	Duration
1. Ng. Segerak	300 m 300 m	Lowland Lowland	17 - 20 Sep 1993 13 - 17 Jun 1994
2. Sg. Jelak	270 m	Lowland	26 - 29 Sep 1993
3. Bukit Lanjak	1,296 m	Submontane	23 - 24 Sep 1993
4. Sg. Semawang	120 m	Alluvial	4 - 7 Dec 1993
5. Sg. Melinau	195 m	Alluvial	9 - 11 Dec 1993
6. Sg. Ensirieng	135 m	Alluvial	12 - 16 Dec 1993
7. Sg. Serembuang	223 m	Lowland	28 Mar - 9 Apr 1994
8. Sg. Lelap	310 m	Lowland	17 - 24 May 1994
9. Sg. Bloh	120 m 120 m	Alluvial Alluvial	11 - 16 Jul 1994 15 - 25 Nov 1997

3.0 OBSERVATIONS

Based on work from Phase I and IBBE (1997), a total of 238 bird species from 38 families have been recorded from LEWS. This comprises 39.7% of the known avifauna of Borneo. Of these, 14 species are Bornean endemics (Table 2) which is almost 37.8% of the total endemics, and ten are migrants, only 4.1% of total migrants.

Bird families not recorded in LEWS were the Zosteropidae and Phalaropidae. Mist netting at nine sites in the Sanctuary yielded 1,550 individuals comprising 64 species. The IBBE (1997) carried out in November 1997 at Sg Bloh, which yielded 206 individuals comprising 42 species (Prayogo *et. al.*, 1997) reaffirms the species list and added one new species, Fairy pitta *(Pitta nympha)* to the list.

All but one of the eight Bornean species of hornbills have been recorded in the Sanctuary. The majority of birds recorded are from the family Timaliidae (babblers) and Muscicapidae (flycatchers). The occurrence of the great Argus, *Argus argusianus* was recorded and reported to be heard 50% more frequently in LEWS by the primate team in IBBE (1997). The Oriental darter, *Anhinga melanogaster* was rarely sighted in the Sanctuary. However, it was a common sight along the Embaloh river in Betung Kerihun National (BKNP) where six individuals were seen on 4 September 1997. The most commonly netted bird was the Little spiderhunter, *Arachnothera longirostris.*

Table 2 Endemic birds in BKNP and LEWS

No	Species	BKNP	LEWS
1	*Harpactes whiteheadi*	+	
2	*Megalaima eximia*	+	+
3	*Megalaima pulcherrima*	+	+
4	*Megalaima monticola*	+	
5	*Calyptomena hosei*		+
6	*Calyptomena whiteheadi*	+	
7	*Napothera atrigularis*		+
8	*Yuhina everetti*	+	+
9	*Cyornis superbus*	+	+
10	*Arachnothera everetti*	+	
11	*Dicaeum monticolum*	+	
12	*Prionochilus xanthopygius*	+	+
13	*Oculocincta squamifrons*	+	
14	*Chlorocharis emiliae*	+	
15	*Lonchura fuscans*		+
16	*Pitta arquata*		+
17	*Pitta baudi*	+	+
18	*Pityriasis gymnocephala*		+
19	*Ptilocichla leucogrammica*	+	+
20	*Haematortyx sanguiniceps*		+
21	*Lophura bulweri*	+	+
22	*Malacocincla perspicillata*	+	

Another interesting aspect which was observed was that the birds in particular, the passerines were breeding during the sampling period. Four groups were taken into consideration as shown in Figure 1. The bulbuls (Pycnonotidae) showed two peaks in their annual breeding activity, the first being in March (48%) and second in July (14%). The babblers (Timaliidae) showed two peaks, one in the month of April (39%) and the other in July (35%). The flycatchers (Muscicapidae) also exhibited two peaks in their breeding activity, one in July (23%) and another in September (25%). The sunbirds (Nectariidae) which include flowerpeckers and spiderhunters showed two peaks, 19% of the birds breed in March and 10% in September. These data were collected irrespective of weather conditions.

Passage migrants which come this way are observed to utilise the Sanctuary, such as the Fairy pitta, Mugimaki flycatcher and others (Table 3). Apart from that, resident birds for instance, the Emerald Dove, does show some local movements between the months of June and October 1993 at Ulu Engkari. Other species which are thought to migrate locally are the Bulwer's pheasant and Dusky munia (Grubh, 1996).

Ringing activities carried out during the IBBE (1997) in the Lanjak Entimau sector had four interesting recaptures of birds ringed in 1994 at Ng. Joh by Robert Grubh and L.K. Sim. The two individuals of Black throated babbler *(Stachyris nigricollis)* ringed as adults which were recaptured were in excellent condition. One Green broadbill *(Calyptomena viridis)* which was ringed as a subadult in 1994 was recaptured as an adult in 1997.

Table 3 Migrant birds found in BKNP and LEWS

No	Species	BKNP	LEWS
1	*Accipiter nisus*	+	
2	*Alcado atthis*	+	+
3	*Cuculus canorus*	+	
4	*Egretta garzetta*	+	+
5	*Ficedula mugimaki*	+	+
6	*Halcyon coromanda*	+	
7	*Halcyon pileata*	+	+
8	*Hirundo rustica*		+
9	*Locustela certhiola*	+	
10	*Locustela lanceolata*	+	
11	*Motacilla cinerea*	+	+
12	*Motacilla flava*	+	
13	*Muscicapa sibirica*	+	
14	*Oenanthe oenanthe*	+	
15	*Phalaropus lobatus*	+	
16	*Phylloscopus borealis*		+
17	*Pitta brachyara*	+	+
18	*Pitta nympha*	+	+
19	*Tringa hypoleucos*	+	+

4.0 DISCUSSIONS & CONCLUSION

The fact that almost 40% of the Bornean avifauna are found in the Sanctuary proves that LEWS is a major repository of the avifauna on the island of Borneo. Not only does the Sanctuary serve as a refuge for resident birds which are endangered and endemic, it also supports passage migrants such as the Fairy pitta and others. The relatively high proportion of certain sensitive groups such as trogons and flycatchers reflect the pristine quality of the Sanctuary. Other primary forest species such as the Fairy blue bird and forktails observed, demonstrate that the Sanctuary contains many undisturbed habitats. Therefore, in protecting the Sanctuary, the avifauna and the migration routes of migrants are safeguarded.

Though previous surveys indicated that a major portion of the birds had been inventoried, there still remain many biological aspects on the avifauna to be studied. A bird list compiled by the Earl of Cranbrook on the birds of Mulu National Park, an area of 52,865 ha yielded 262 species (Anderson *et al* 1982), records slightly more birds than that in the LEWS. This and other results obtained from netting in the Sanctuary provide us with a glimpse of what is yet to be discovered. Not much management can be done until stations are set up for long-term monitoring of bird species at Katibas, Engkari and Mujok, where intensive netting and visual observations can be carried out to collect data on other aspects of birds.

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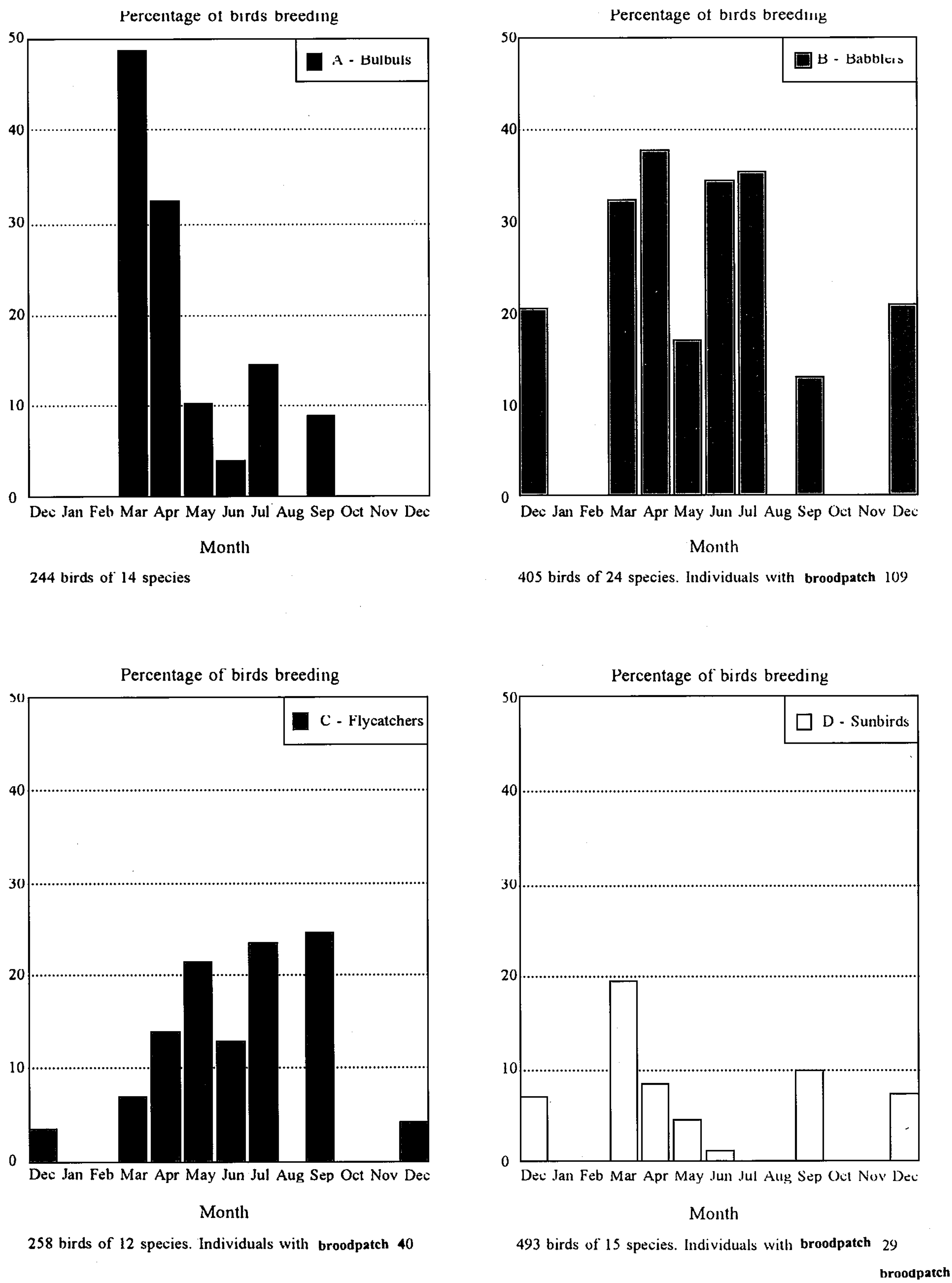
Figure 1

Breeding activity of selected groups of birds from Lanjak Entimau



APPENDIX

A A checklist of birds of Lanjak Entimau Wildlife Sanctuary

Family	Species	English Name	LEWS	Status
Anhingidae	*Anhinga melanogaster*	Oriental Darter	+	NT
Ardeidae	*Butorides striatus*	Striated Heron	+	
	Egretta garzeta	Little Egret	+	M
Accipitridae	*Haliastur indus*	Brahminy Kite	+	
	Hieraaetus kienerii	Rufous-Bellied Eagle	+	
	Ichthyophaga humilis	Lesser-fish Eagle	+	NT
	Ichthyophaga ichthyaetus	Grey-headed Fish Eagle	+	NT
	Ictinaetus malayensis	Black Eagle	+	
	Microhierax fringillarius	Black-thighed Falconet	+	
	Spizaetus cirrhatus	Changeable Hawk-Eagle	+	
	Spilornis cheela	Crested Serpent Eagle	+	
	Spizaetus alboniger	Blyth's Hawk-Eagle	+	
	Spizaetus nanus	Wallace's Hawk-Eagle	+	V
Phasianidae	*Argusianus argus*	Great Argus	+	
	Haematortyx sanguiniceps	Crimson-headed Partridge	+	E
	Lophura bulweri	Bulwer's Pheasant	+	V,E
	Lophura ignita	Crested Fireback	+	V
	Rollulus rouloul	Crested Partridge	+	
Scolopacidae	*Tringa hypoleucos*	Common Sandpiper	+	M
Columbidae	*Chalcophaps indica*	Emerald Dove	+	
	Ptilinopus jambu	Jambu Fruit-Dove	+	
	Treron capellei	Large Green Pigeon	+	NT
	Treron curvirostra	Thick-billed Green Pigeon	+	
	Treron fulvicollis	Cinnamon-headed Green Pigeon	+	NT
	Treron olax	Little Green Pigeon	+	
Psittacidae	*Loriculus galgulus*	Blue-crowned Hanging-Parrot	+	
	Psittinus cyanurus	Blue-Rumped Parrot	+	NT
Cuculidae	*Cacomantis variolosus*	Brush Cuckoo	+	
	Cacomantis sonneratii	Banded Bay Cuckoo	+	
	Centropus bengalensis	Lesser Coucal	+	
	Centropus sinensis	Greater Coucal	+	
	Chalcites xanthorhynchus	Violet Cuckoo	+	
	Cacomantis merulinus	Plaintive Cuckoo	+	
	Cuculus micropterus	Indian Cuckoo	+	
	Cuculus vagans	Moustached Hawk-Cuckoo	+	
	Phaenicophaeus curvirostris	Chestnut-Breasted Malkoha	+	
	Phaenicophaeus javanicus	Red-Billed Malkoha	+	
	Phaenicophaeus sumatranus	Chestnut-Bellied Malkoha	+	
	Phaenicophaeus chlorophaeus	Raffles's Malkoha	+	
	Phaenicophaeus diardii	Black-Bellied Malkoha	+	
	Surniculus lugubris	Drongo Cuckoo	+	

E = endemic, M = migrant, NT = near threatened, V = vulnerable

Family	Species	English Name	LEWS	Status
Strigidae	*Bubo sumatrana*	Barred Eagle-Owl	+	
	Ketupa ketupu	Buffy Fish-Owl	+	
	Ninox scutulata	Brown Boobook	+	
	Otus rufescens	Reddish Scops Owl	+	
	Phodilus badius	Oriental Bay Owl	+	
Caprimulgidae	*Eurostopodus temminckii*	Malaysian Eared-Nightjar	+	
Apodidae	*Apus affinis*	Little Swift	+	
	Collocalia esculenta	Glossy Swiftlet	+	
	Collocalia maxima	Black-Nest Swiftlet	+	
	Hirundapus gigantea	Brown-backed Needletail	+	
	Rhaphidura leucopygialis	Silver-Rumped Swift	+	
Hemiprocnidae	*Hemiprocne longipennis*	Grey-Rumped Treeswift	+	
	Hemiprocne comata	Whiskered Treeswift	+	
Trogonidae	*Harpactes diardii*	Diard's Trogon	+	
	Harpactes duvaucelli	Scarlet-Rumped Trogon	+	
	Harpactes orrhophaeus	Cinnamon-Rumped Trogon	+	
	Harpactes kasumba	Red-Naped Trogon	+	
Alcedinidae	*Actenoides concretus*	Rufous-Collared Kingfisher	+	
	Alcedo atthis	Common Kingfisher	+	M
	Alcedo euryzona	Blue-Banded Kingfisher	+	
	Alcedo meninting	Blue-Eared Kingfisher	+	
	Ceyx erithacus	Black-Backed Kingfisher	+	
	Ceyx rufidorsa	Rufous-Backed Kingfisher	+	
	Halcyon pileata	Black-Capped Kingfisher	+	M
	Lacedo pulchella	Banded Kingfisher	+	
	Pelargopsis capensis	Stork-Billed Kingfisher	+	
Meropidae	*Merops viridis*	Blue-throated Bee-eater	+	
	Nyctyornis amictus	Red-bearded Bee-eater	+	
Bucerotidae	*Aceros comatus*	White-Crowned Hornbill	+	
	Aceros corrugatus	Wrinkled Hornbill	+	V
	Aceros undulatus	Wreathed Hornbill	+	
	Anorrhinus galeritus	Bushy-Crested Hornbill	+	
	Anthracoceros malayanus	Black Hornbill	+	NT
	Buceros rhinoceros	Rhinoceros Hornbill	+	
	Buceros vigil	Helmeted Hornbill	+	
Capitonidae	*Calorhampus fuliginosus*	Brown Barbet	+	
	Megalaima chrysopogon	Gold-Whiskered Barbet	+	
	Megalaima australis	Blue-Eared Barbet	+	
	Megalaima eximia	Bornean Barbet	+	E
	Megalaima henricii	Yellow-Crowned Barbet	+	
	Megalaima mystacophanos	Red-Throated Barbet	+	
	Megalaima pulcherrima	Golden-Naped Barbet	+	E
	Megalaima rafflesii	Red-Crowned Barbet	+	
Indicatoridae	*Indicator archipelagicus*	Malaysian Honeyguide	+	

E = endemic, M = migrant, NT = near threatened, V = vulnerable

Family	Species	English Name	LEWS	Status
Picidae	*Blythipicus rubiginosus*	Maroon Woodpecker	+	
	Dendrocopus canicapillus	Grey-Capped Woodpecker	+	
	Dinopium javanense	Common Goldenback	+	
	Dinopium rafflesii	Olive-Backed Woodpecker	+	
	Dryocopus javensis	White-Bellied Woodpecker	+	
	Hemicircus concretus	Grey and Buff Woodpecker	+	
	Meiglyptes tristis	Buff-Rumped Woodpecker	+	
	Meiglyptes tukki	Buff-Necked Woodpecker	+	
	Micropternus brachyurus	Rufous Woodpecker	+	
	Mulleripicus pulverulentus	Great Slaty Woodpecker	+	
	Picoides moluccensis	Sunda Woodpecker	+	
	Picus mentalis	Checker-throated Woodpecker	+	
	Picus puniceus	Crimson-Winged Woodpecker	+	
	Reinwardtipicus validus	Orange-Backed Woodpecker	+	
	Sasia abnormis	Rufous Piculet	+	
Eurylaimidae	*Calyptomena hosei*	Hose's Broadbill	+	E
	Calyptomena viridis	Green Broadbill	+	
	Corydon sumatranus	Dusky Broadbill	+	
	Cymbirhynchus macrorhynchus	Black and Red Broadbill	+	
	Eurylaimus javanicus	Banded Broadbill	+	
	Eurylaimus ochromalus	Black and Yellow Broadbill	+	
Pittidae	*Pitta arquata*	Blue-Banded Pitta	+	E
	Pitta baudii	Blue-Headed Pitta	+	NT,E
	Pitta brachyura	Blue-Winged Pitta	+	M
	Pitta granatina	Garnet Pitta	+	
	Pitta guajana	Banded Pitta	+	
	Pitta nympha	Fairy Pitta	+	M
Hirundinidae	*Hirundo rustica*	Barn Swallow	+	M
	Hirundo tahitica	Pacific Swallow	+	
Campephagidae	*Coracina striata*	Bar-Bellied Cuckoo-Shrike	+	
	Hemipus hirundinaceus	Black-Winged Flycatcher-Shrike	+	
	Pericrocotus solaris	Grey-Chinned Minivet	+	
Chloropseidae	*Aegithina viridissima*	Green Iora	+	
	Chloropsis cochinchinensis	Blue-Winged Leafbird	+	
	Chloropsis cyanopogon	Lesser Green Leafbird	+	
	Chloropsis sonneratii	Greater Green Leafbird	+	
Pycnonotidae	*Alophoixus bres*	Grey-Cheeked Bulbul	+	
	Alophoixus ochraceus	Ochraceus Bulbul	+	
	Alophoixus phaeocephalus	Yellow-Bellied Bulbul	+	
	Criniger finschii	Finsch's Bulbul	+	
	Hypsipetes flavala	Ashy Bulbul	+	
	Ixos malaccensis	Streaked Bulbul	+	
	Pycnonotus atriceps	Black-Headed Bulbul	+	
	Pycnonotus brunneus	Red-Eyed Bulbul	+	
	Pycnonotus cyaniventris	Grey-Bellied Bulbul	+	

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Family	Species	English Name	LEWS	Status
	Pycnonotus erythrophthalmos	Spectacled Bulbul	+	
	Pycnonotus flavescens	Flavescent Bulbul	+	
	Pycnonotus melanicterus	Black-Crested Bulbul	+	
	Pycnonotus simplex	Cream-Vented Bulbul	+	
	Pycnonotus squamatus	Scaly-Breasted Bulbul	+	
	Pycnonotus zeylanicus	Straw-Headed Bulbul	+	
	Pycnonotus eutilotus	Puff Backed Bulbul	+	
	Pycnonotus melanoleucos	Black and White Bulbul	+	
	Setornis criniger	Hook-Billed Bulbul	+	
	Tricholestes criniger	Hairy-Backed Bulbul	+	
Dicruridae	*Dicrurus aeneus*	Bronzed Drongo	+	
	Dicrurus annectans	Crow-Billed Drongo	+	
	Dicrurus paradiseus	Greater Racket-Tailed Drongo	+	
Oriolidae	*Oriolus xanthonotus*	Dark-Throated Oriole	+	
	Irena puella	Asian Fairy-Bluebird	+	
Corvidae	*Platylophus galericulatus*	Crested Jay	+	
	Platysmurus leucopterus	Black Magpie	+	
	Pityriasis gymnocephala	Bornean Bristlehead	+	NT, E
Sittidae	*Sitta frontalis*	Velvet-Fronted Nuthatch	+	
Timaliidae	*Alcippe bruneicauda*	Brown Fulvetta	+	
	Eupetes macrocercus	Malaysian Rail-Babbler	+	
	Kenopia striata	Striped Wren-Babbler	+	
	Macronous gularis	Striped Tit-Babbler	+	
	Macronous ptilosus	Fluffy-Backed Tit-Babbler	+	
	Malacocincla abbotii	Abbott's Babbler	+	
	Malacocincla malaccense	Short-Tailed Babbler	+	
	Malacocincla sepiarium	Horsfield's Babbler	+	
	Malacopteron affine	Sooty-Caped Babbler	+	
	Malacopteron cinereum	Scaly-Crowned Babbler	+	
	Malacopteron magnirostre	Moustached Babbler	+	
	Malacopteron magnum	Rufous-Crowned Babbler	+	
	Napothera atrigularis	Black-Throated Wren-Babbler	+	E
	Pellorneum capistratum	Black-Capped Babbler	+	
	Trichastoma pyrrogenys	Temminck's Babbler	+	
	Pomatorhinus montanus	Chestnut-Backed Scimitar-Babbler	+	
	Ptilocichla leucogrammica	Bornean Wren-Babbler	+	NT,E
	Stachyris erythropthera	Chestnut-Winged Babbler	+	
	Stachyris leucotis	White-Necked Babbler	+	
	Stachyris maculata	Chestnut-Rumped Babbler	+	
	Stachyris nigriceps	Grey-Throated Babbler	+	
	Stachyris nigricollis	Black-Throated Babbler	+	
	Stachyris poliocephala	Grey-Headed Babbler	+	
	Stachyris rufifrons	Rufous-Fronted Babbler	+	
	Trichastoma bicolor	Ferruginous Babbler	+	NT
	Trichastoma rostratum	White-Chested Babbler	+	NT

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Family	Species	English Name	LEWS	Status
	Yuhina everetti	Chestnut-Crested Yuhina	+	E
	Yuhina zantholeuca	White-Bellied Yuhina	+	
Turdidae	*Copsychus malabaricus*	White-Rumped Shama	+	
	Copsychus saularis	Magpie Robin	+	
	Enicurus leschenaulti	White-Crowned Forktail	+	
	Enicurus ruficapillus	Chestnut-Naped Forktail	+	
	Trichixos pyrrhopygus	Rufous-Tailed Shama	+	
	Zoothera interpres	Chestnut-Capped Thrush	+	
Sylviidae	*Abroscopus superciliaris*	Yellow-Bellied Warbler	+	
	Gerygone sulphurea	Flyeater	+	
	Orthotomus atrogularis	Dark-Necked Tailorbird	+	
	Orthotomus cuculatus	Mountain Tailorbird	+	
	Orthotomus sericeus	Rufous-Tailed Tailorbird	+	
	Phylloscopus borealis	Arctic Leaf-Warbler	+	M
	Prinia flaviventris	Yellow-Bellied Prinia	+	
Muscicapidae	*Culicicapa ceylonensis*	Grey-Headed Flycatcher	+	
	Cyornis banyumas	Hill-Blue-Flycatcher	+	
	Cyornis caerulatus	Large-Billed Blue-Flycatcher	+	NT
	Cyornis concretus	Dark Blue Flycatcher	+	
	Cyornis rufigastra	Mangrove Blue Flycatcher	+	
	Cyornis superbus	Bornean Blue-Flycatcher	+	E
	Cyornis turcosus	Malaysian Blue-Flycatcher	+	NT
	Cyornis unicolor	Pale-Blue-Flycatcher	+	
	Ficedula dumetoria	Rufous-Chested Flycatcher	+	
	Ficedula mugimaki	Mugimaki Flycatcher	+	M
	Ficedula westermanni	Little Pied Flycatcher	+	
	Hypothymis azurea	Black-Naped Monarch	+	
	Muscicapa dauurica	Asian Brown Flycatcher	+	
	Muscicapa griseisticta	Grey-Streaked Flycatcher	+	
	Muscicapella hodgsoni	Pygmy Blue-Flycatcher	+	
	Philentoma pyrrhopterum	Rufous-Winged Philentoma	+	
	Philentoma velatum	Maroon-Breasted Philentoma	+	
	Rhinomyias olivaceae	Fulvous-Chested Jungle Flycatcher	+	
	Rhinomyias ruficauda	Rufous-Tailed Jungle Flycatcher	+	
	Rhinomyias umbratilis	Grey-Chested Flycatcher	+	
	Rhipidura albicollis	White-Throated Fantail	+	
	Rhipidura javanica	Pied Fantail	+	
	Rhipidura perlata	Spotted Fantail	+	
	Terpsiphone paradisi	Asian Paradise Flycatcher	+	
Motacillidae	*Motacilla cinerea*	Grey Wagtail	+	M
Sturnidae	*Gracula religiosa*	Hill Myna	+	
Nectariniidae	*Aethopyga mystacalis*	Scarlet Sunbird	+	
	Aethopyga siparaja	Crimson Sunbird	+	
	Anthreptes malaccensis	Brown-Throated Sunbird	+	
	Anthreptes rhodolaema	Red-Throated Sunbird	+	
	Anthreptes simplex	Plain Sunbird	+	

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Family	Species	English Name	LEWS	Status
Nectariniidae	*Anthreptes singalensis*	Ruby-Chested Sunbird	+	
	Arachnothera affinis	Grey-Breasted Spiderhunter	+	
	Arachnothera chrysogenys	Yellow-Eared Spiderhunter	+	
	Arachnothera crassirostris	Thick-Billed Spiderhunter	+	
	Arachnothera flavigaster	Spectacled Spiderhunter	+	
	Arachnothera longirostra	Little Spiderhunter	+	
	Arachnothera robusta	Long-Billed Spiderhunter	+	
	Hypogramma hypogrammicum	Purple-naped Sunbird	+	
Dicaeidae	*Dicaeum chrysorheum*	Yellow-Vented Flowerpecker	+	
	Dicaeum concolor	Plain Flowerpecker	+	
	Dicaeum everetti	Brown-Backed Flowerpecker	+	NT
	Dicaeum trigonostigma	Orange-Bellied Flowerpecker	+	
	Prionochilus maculatus	Yellow-Breasted Flowerpecker	+	
	Prionochilus percussus	Crimson-Rumped Flowerpecker	+	
	Prionochilus thoracicus	Scarlet-Breasted Flowerpecker	+	
	Prionochilus xanthopygius	Yellow-Rumped Flowerpecker	+	E
Ploceidae	*Lonchura fuscans*	Dusky Munia	+	E

E = endemic, M = migrant, NT = near threatened, V = vulnerable

DISCUSSIONS

Dr. Soepadmo

Your study shows that the breeding periods for at least four groups of birds peak in the months of March and April, and June and July. I suggest that you coincide your future study with the phenological survey of the forest trees so that you can better explain the phenomenon of these peaks. Secondly birds such as sunbirds, flowerpeckers and spiderhunters are potential pollinators while pigeons, hornbills, broadbills, bulbul and babblers are potential seed dispersers. I propose that your future ornithological study should also focus on the feeding habits so that your study would be more relevant to the management of LEWS.

Patrick Andau

I think Dr. Soepadmo has raised a very important point in phenological studies. There is a very distinct relationship between flowering times, breeding and migration of mammals. There should be a base-line study on the phenology in LEWS to help us to understand the relationship between the functions of the forest and fauna.

Sim Lee Kheng

I agree that phenological studies together with the studies on feeding behavior of these birds will reinforce and help to explain our findings on breeding seasons of these birds. Secondly if the bird surveys were carried out at different times of the year, besides getting a more representative sample, the results would be more interesting and complete.

Inventory of Freshwater Fish

by
Charles M. U. Leh
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Abstract

The Lanjak Entimau Wildlife Sanctuary (LEWS) is the single largest Totally Protected Area for the in situ conservation of biodiversity in Sarawak. The fish inventory survey provided a list of fish found in the different localities at Katibas, Ulu Skrang and Ulu Engkari.

The relation of Lanjak Entimau with Betung Kerihun National Park of Kapuas, West Kalimantan Indonesia is investigated through the IBBE 1997 expedition. There are significant fish species similarities between the regions of LEWS and Kapuas. Only 36 out of the 127 fish species recorded from Betung Kerihun National Park and LEWS are common. Except for Puntius kuchingensis, there are no other fish found in the Sanctuary that is endemic to Sarawak. About 10% of the fish species found in LEWS are endemic to Borneo.

A total of 77 sampling stations from 28 river and stream systems were sampled in LEWS. Rivers are defined as flowing aquatic systems of width more than 2.0 metres and streams are small water flows of width less than 2.0 metres. Data of four other river systems in the Ulu Engkari were adapted from the survey carried out in 1994/95. A total of 3,668 fish specimens of 82 species, 31 genera and 8 families were recorded from the present study. Fish species diversity is highest in Sg. Joh where the forest is pristine and forest canopy is high. Fish species diversity decreases drastically as the stream size decreases and as the stream elevation increases. At least 12 species of fish collected from the present study are likely to be new to science pending further confirmation with Type and Paratype specimens held in collections overseas.

1.0 INTRODUCTION

LEWS located in western Borneo consists of about 168,758 ha of tropical rain forest and is the largest wildlife sanctuary in Sarawak. The main drainage of LEWS are the Katibas which flows into the Rajang river in the north, the Skrang in the west and the Batang Ai which flow in the south into the Batang Lupar.

In the context of Southeast Asia, many new species of freshwater fish were described recently (Kottelat, 1991; Ng and Kottelat, 1996; Ng and Ng, 1995; Ng, 1996; Ng, *et. al.*, 1996). Mohsin and Ambak (1983) reviewed the ichthyological literature of Peninsular Malaysia and dealt with fish systematics. The taxonomy of freshwater fishes is often difficult (Roberts, 1989; Kottelat *et. al.*, 1993). Kottelat (1982) described a small collection of fish collected by Korthaus in Central Kalimantan. There were several taxonomic revisions of fish families, genera and species as well as the rediscovery of rare fishes reported (Kottelat, 1984; Ng and Lim, 1995; Tan and Ng, 1996; and Ng, 1996). There is an apparent lack of data on the conservation status of freshwater habitats in the region.

The early specimens collected by the naturalists G. Doria and O. Beccari were reported by Gunther (1968). There were other collections made later and summarised by Weber and de Beaufort (1922). Regan (1906) also described the fishes collected by C. Hose who was once the Resident of Baram before 1900. Ichthyological studies in Sarawak had not been extensive until recently. While Inger and Chin (1962) wrote on the fishes of North Borneo with recent updates in 1993, Roberts (1985) described the fish fauna of western Borneo. Systematic accounts, aspects of fish adaptation, feeding habits, reproductive behaviour, fish distribution and ecology of freshwater fish of western Borneo were given by Inger and Chin (1962), Roberts (1985) and Kottelat *et al.* (1993). The recently concluded ITTO Borneo Biodiversity Expedition 1997 compared fish fauna in Betung Kerihun (Indonesia) with Lanjak Entimau.

Other small collections of freshwater fish were made by Cramphorn (1978), Watson and Balon (1984), Parenti (1986, 1992) and Brown and Brown (1987). In recent years, some additional collections of fish were made by Kottelat and Lim (1993, 1995), Ng and Lim (1995), were further summarised into an annotated checklist by Kottelat and Lim (1995). In that checklist, there were a total of 249 species of freshwater fishes recorded from the mouth of rivers to the interiors of Sarawak and Brunei. Many of the specimens examined during that study were from the Sarawak Museum ichthyology collection. The richness of the ichthyofauna of Sarawak had not been fully appreciated until now where more new species are expected to be uncovered. A small collection of fishes were made with herpetofauna during 1994/95 ITTO studies (ITTO, 1996). The present study intends to expand that fish list and to complete the fish inventory of LEWS.

2.0 MATERIALS AND METHODS

A total of 16 stream stations were sampled in October 1997 in the Katibas and Bloh areas prior to the ITTO Borneo Biodiversity Expedition (IBBE) in November 1997. During the expedition, another 45 stream stations were established in Sungai Katibas and Sungai Bloh during the field work in November 1997. The stream sites consisted of Sungai Menyarin, Sungai Pasir, Sungai Engkabang, Sungai Kulit Kayu, Sungai Melinau, Sungai Bedawak, Sungai Gindi, Sungai Nyungan, Sungai Kelimau Mit, Sungai Merating, Sungai Joh Paraka, Sungai Joh Ibau and Sungai Joh mainstream (Fig. 1).

The other sites sampled were 16 fishing stations located in Ulu Skrang during early December 1997 (Fig. 2). The Engkari sites (Fig. 3) were not sampled as there were existing database collected between 11th September 1994 and 4th May 1995 by Wong (1997). These data were were re-analysed and compiled into the fish inventory. The use of Wong's data is purely for comparison and discussion purposes since Sungai Kaup is the only site nearest to the Sanctuary in the South that had been sampled.

The standard fishing method adopted for field sampling was the use of an electrofisher backpack operating on a motorcycle battery of DC 12V 10Amp input and continuous output of AC 240 V. This method was used for all sampling stations and was effective for streams of water depth less than 2.0 metres. In the deep water side pools, a mono-filament cast net of diameter 3.5 metres and mesh size 20 mm was used to sample fish.

Electrofishing was carried out over a fixed distance of 50 metres per station while the unit effort of a cast net sample was 10 throws along the fixed distance. A generator (Honda EV650) was used in Sungai Nyungan, LEWS as a comparative study on the effectiveness of the method as compared to the elecrofisher. Immediately after capture, all fish specimens were injected and fixed in 10% formalin. Upon returning to the laboratory, and after at least a week in fixative, each collection was washed clean of formalin, the species identified, enumerated and the results recorded on data sheets. The specimen were transferred into 70% ethanol for permanent preservation and storage.

The physical and chemical parameters collected during the field sampling included stream surface flow rate, water temperature, dissolved oxygen content, pH, stream substrate, canopy cover of the stream, stream width, depth of the water column and other notes on the local weather.

Fishes were identified with the use of Inger and Chin (1962), Kottelat (1984), Kottelat *et. al.* (1993), Roberts (1989) and cross references with materials held in Museum Zoologicum Bogorense and the Sarawak Museum. The larger fish specimens were dissected and their gonad maturity stages noted.

Fish species diversity indices (H), evenness and richness were calculated for the stations. Species diversity was calculated for each river and stream sampled with the use of Shannon-Weaver (1963) H'.

$$H' = \sum^{s} Pi \log Pi$$

where $Pi = ni/N$.
ni = the number of individuals of Species i
N = total number of individuals in the collection of S species.

The variable H' is a measure of species diversity which is dimensionless, independent of sample size, and express the relative importance of each species. Diversity is a descriptive statistics used to measure population heterogenity based on the pooled samples examined.

Species Evenness
$(J) = H/(H_{max})$ (Pielou, 1966)

where H = species richness index
H_{max} = ln S
S = number of species in the collection.

The value of J ranges from 0 to 1. A value of 1 indicates a perfectly even distribution of individuals among species. A value approaching 0 indicate a concentration of individuals in one of the species.

The species richness of a station is described by Margalef's D (1968).

$$D = (S-1)/(\log N)$$

where S = the number of species
N = the number of individuals.

3.0 RESULTS

3.1 The Stream Habitats.

Most of the rivers of the LEWS flow over rock and gravel beds. Stream banks are mostly of soil substrate and bank gradient varies between 30° to 70°. Similarly, Sungai Bloh which forms the southeast boundary between the Sanctuary and the logged-over forest of the east have stream bank gradient of between 20° to 60°. The streams would generally turn silty after a rain in its catchment upstream. Similarly, Ulu Skrang river is also a shallow and fast flowing river with many rapids. Streams vary from 0.5 to 15.0 metres in width and 0.2 to 1.5 metres in depth. Average water speed varied from 0.02 to 0.73 metre per second. The dissolved oxygen content of the river varied from 7.1 to 8.6 mg l^{-1} while the pH ranged from 7.1 to 7.5. The water temperature varied between 24.0 to 26.5 °C.

3.2 Fish Species Inventory

A total of 3,668 specimens were collected from the 77 fishing stations. There were 82 species belonging to 31 genera of 8 families recorded from the field collections. (Table 1). The number of species collected made up some 33% of the known freshwater fish species in Sarawak. The number of species known from the Sanctuary is made up entirely of lowland mixed dipterocarp forest stream species. A large percentage of fish in the Sanctuary are Cyprinidae (46%) which are most common. Others are balitorid fish (33%) adapted to stick on to rock surfaces in fast flowing streams. Catfish and eels (8.5%) are also common in occurrence. The rarest of the fish are the freshwater puffer which are collected only twice in the Bloh river system. Some of the fish species found in the Sanctuary that are endemic to Borneo are *Gastromyzon embalohensis* sp. nov., *Glaniopsis* sp.1, *Glaniopsis* sp. 2, *Paracrossochilus acerus, Purhomalopter microstoma, Puntius collingwoodi, Hampala bimaculata, Homaloptera* cf. *stephensoni* and *Garra borneensis.* New distribution records of freshwater fish recorded were *Lobocheilus bo, Glaniopsis* sp. and *Protomyzon griswoldi*, which were previously recorded only from North Borneo.

Table 1 Fish species occurrence in Lanjak Entimau Wildlife Sanctuary, Sarawak. (p = present, a = absent).

SPECIES	FAMILY	Katibas	Bloh	Ulu Skrang	Engkari
Barbodes schwanenfeldii	Cyprinidae	p	p	a	a
Channa lucius	Chanidae	p	p	p	p
Chonerhinos nefastus	Tetradontidae	a	p	a	a
Clarias sp. 1	Clarridae	p	p	p	a
Clarias teysmani	Clarridae	a	a	a	p
Cyclocheilichthys apogon	Cyprinidae	p	p	a	a
Cyclocheilichthys armatus	Cyprinidae	p	p	p	a
Garra borneensis	Cyprinidae	p	p	a	a
Gastromyzon borneensis	Balitoridae	p	a	a	a
Gastromyzon cf. *punctulatus*	Balitoridae	a	p	a	a
Gastromyzon danumensis	Balitoridae	p	a	a	a
Gastromyzon embalohensis	Balitoridae	p	p	a	a
Gastromyzon fasciatus	Balitoridae	p	p	p	p
Gastromyzon lepidogaster	Balitoridae	a	p	a	p
Gastromyzon ridens	Balitoridae	a	a	a	p
Gastromyzon sp. 1	Balitoridae	p	p	p	a
Gastromyzon sp. 3	Balitoridae	p	p	p	a
Gastromyzon sp. 4	Balitoridae	p	p	a	a
Glaniopsis denudata	Balitoridae	a	a	a	p
Glaniopsis gossei	Balitoridae	a	a	p	a
Glaniopsis multiradiata	Balitoridae	a	a	a	p
Glaniopsis sp. 1	Balitoridae	p	p	a	a
Glaniopsis sp. 2	Balitoridae	a	p	a	a
Glyptothorax major	Bagridae	p	p	p	p
Glyptothorax platypogonoides	Bagridae	a	a	a	p
Gobiidae sp. 1	Gobiidae	p	a	a	a
Hampala bimaculata	Cyprinidae	p	p	p	p
Hampala macrolepidota	Cyprinidae	p	p	a	p
Hemibagrus cf. *bongan*	Bagridae	p	p	a	a
Hemibagrus cf. *nemurus*	Bagridae	p	p	p	p
Homaloptera cf. *nebulosa*	Balitoridae	p	p	p	p
Homaloptera cf. stephensoni	Balitoridae	p	p	a	p

Hypergastromyzon eubranchus	Balitoridae	a	a	p	p
Leiocassis micropogon	Bagridae	a	a	a	p
Leiocassis sp. 1	Bagridae	p	a	p	a
Leiocassis stenomus	Bagridae	a	a	a	p
Lobocheilus bo	Cyprinidae	p	p	p	p
Lobocheilus cf. *bo*	Çyprinidae	p	p	a	a
Lobocheilus cf. *Kajanensis*	Cyprinidae	p	p	p	a
Lobocheilus sp. 1	Cyprinidae	p	p	a	a
Luciosoma sp. 1	Cyprinidae	a	p	a	a
Macrognathus aculeatus	Mastacembelidae	p	p	p	p
Macrognathus keithi	Mastacembelidae	p	p	a	a
Macrognathus maculatus	Mastacembelidae	a	a	a	p
Mastacembelus unicolor	Mastacembelidae	p	p	p	p
Nemachilus cf. *Hispidus*	Balitoridae	p	a	a	a
Nemachilus cf. *kapuasensis*	Balitoridae	p	a	a	a
Nemachilus saravacensis	Balitoridae	p	a	a	p
Nemachilus sp. 1	Balitoridae	p	a	a	a
Neogastromyzon nieuwenhuisi	Balitoridae	p	p	p	p
Osteochilus enneaporus	Cyprinidae	a	a	a	p
Osteochilus hasselti	Cyprinidae	a	a	a	p
Osteochilus intermedius	Cyprinidae	p	p	a	a
Osteochilus kahajanensis	Cyprinidae	p	p	a	a
Osteochilus microcephalus	Cyprinidae	p	p	p	a
Osteochilus pleurotaenia	Cyprinidae	a	p	a	a
Osteochilus waandersii	Cyprinidae	a	a	a	p
Oxygaster anomalura	Cyprinidae	p	p	p	a
Pangio anguillaris	Balitoridae	p	a	a	
Paracrossochilus acerus	Cyprinidae	p	p	p	p
Paracrossochilus cf. *acerus*	Cyprinidae	a	a	a	a
Paracrossochilus sp. 1	Cyprinidae	p	p	a	a
Paracrossochilus vittatus	Cyprinidae	a	p	p	p
Parhomaloptera microstoma	Balitoridae	p	p	p	p
Protomyzon griswoldi	Balitoridae	a	p	a	a
Protomyzon sp. 1	Balitoridae	p	a	a	a
Pseudogobius oratai	Gobiidae	a	a	a	p
Puntius banksi	Cyprinidae	p	p	p	p
Puntius cf. *Binotatus*	Cyprinidae	p	p	p	p
Puntius collingwoodi	Cyprinidae	p	p	p	p
Puntius kuchingensis	Cyprinidae	p	p	p	p
Rasbora argyrotaenia	Cyprinidae	p	p	a	a
Rasbora bankanensis	Cyprinidae	p	p	p	a
Rasbora borneensis	Cyprinidae	a	a	p	a
Rasbora caudimaculata	Cyprinidae	p	p	p	p
Rasbora cf. *ennealepis*	Cyprinidae	a	p	a	a
Rasbora sarawakensis	Cyprinidae	a	a	p	a
Rasbora sp. 1	Cyprinidae	p	p	a	p
Rasbora sumatrana	Cyprinidae	p	a	a	p
Rasbora volzi	Cyprinidae	p	p	p	p
Tor tambra	Cyprinidae	p	p	p	a
Tor tambroides	Cyprinidae	p	p	p	a
Total number of species		**56**	**54**	**34**	**37**

A number of potential new species were noted in LEWS. One of these is the forest walking catfish, *Clarias* sp. which resembles *C. teijsmanni*, but differs in its head structure and body colourations. Similarly, *Hemibagrus* cf *nemurus* differs from *Mystus nemurus* in its body measurements. The genus *Mystus* is now replaced with *Hemibagrus*. At least three *Gastromyzon* species (sp. 1, 3 and 4) are likely to be new to science but would require further comparative studies with type materials in the Bogor museum. One of the *Gastromyzon* sp. has bright red dorsal, anal, pectoral, pelvic and caudal fins. Its body is dark brown in colour. This colour feature is prominent in all juvenile and adult specimens examined. One specimen of black *Leiocassis* sp. that was found in the Sungai Kelimau Mit would require further identification. There are two *Glaniopsis* species collected from the Katibas that require further study. *Glaniopsis* sp. 2 had only one single specimen collected from station 40 (Sungai Merating). There is also much variation in the dorsal colouration of the *Homaloptera nebulosa*. The dorsal surface spots are distinct blotches like *H. stephensoni* but its pectoral stripes colouration are rather *nebulosa*-like. *Lobocheilus* sp.1 closely resembled *Schismatorhynchos heterorhynchos* but this had not been recorded from Sarawak although it had been labeled as such by Parenti (1992) in her Baleh collection in 1991. This particular fish has a secondary rostrum and groove, tuberculate snout but differs from *S. heterorhynchos* collected in Betung Kerihun during the IBBE expedition. Several other species such as *Puntius* cf *binotatus*, *Protomyzon* sp. and *Luciosoma* sp. require further taxonomic analysis for species confirmation.

At the time of the sampling in Lanjak Entimau, localised rainfall in the catchment of the Katibas swells the river occasionally bringing down large quantities of silt and litter. However, the silt flow normally lasts for 24 hours and the river reverts back to its original state quickly. Such flood water from upstream also brings down food sources such as worms and insect larvae from the flooded wild animal wallows. During the present sampling period, the *ensurai* trees (*Dipterocarpus oblongifolius*) that line the banks of the rivers were flowering heavily. Significant quantities of *ensurai* flower materials were found from the stomach contents analysis of *Lobocheilus, Tor* and *Barbodes* spp. The *engkabang* trees, *Shorea macrophylla* flowered heavily during the haze in September and October, but there were few fruits formed after the haze. The flowers of *engkabang* trees along the river bank are also eaten by many cyprinids in the river. The present study coincided with the low water levels of streams as it is the local dry season.

Most notable of the Katibas system is the obvious rareness of *Barbodes schwanenfeldii* or *tengadak* fish specimens. This fish is the most expensive food fish collected by the locals from this river system. Two types of *tengadak* are recognised by the locals. The cheaper variety has reddish caudal fringes while the expensive type has whitish edgings. The youngs of *Tor* sp. are found in most of the small streams sampled. The most common food fish collected for domestic consumption by the locals are *pelekat*, *kepiat*, *adong* and *kulung*.

3.3 Fish Species Diversity, Occurrence and Abundance.

A total of 28 aquatic systems comprising of main streams and tributaries in LEWS were studied during the project. These comprised 4 streams in Engkari, 12 from Katibas, 6 from Bloh and 6 from Ulu Skrang. The fish species diversity, evenness and richness of each of the river system is given in Table 2.

Table 2 Fish species diversity (H'), species evenness (J) and species richness (D) of the rivers sampled in Lanjak-Entimau Wildlife Sanctuary (S = number of species, N = number of individuals).

River sampled	S	N	H'	J	D
Engkari Ulu	20	146	1.1660	0.3892	8.7788
Engkari Hilir	28	335	1.1436	0.3432	10.6928
Engkari					
Sungai Kaup	22	276	1.1571	0.3743	8.6033
Sungai Engkaramoh	12	71	0.5166	0.2079	5.9419
Katibas					
Sungai Menyarin	31	397	1.2202	0.3553	11.5438
Sungai Ulu Katibas	26	299	1.2044	0.3696	10.0983
Sungai Pasir	11	74	1.0990	0.4583	5.3498
Sungai Kulit Kayu I	14	84	0.8133	0.3082	6.7558
Sungai Kulit Kayu II	6	12	0.6685	0.3731	4.6331
Sungai Gindi	6	26	0.5336	0.2978	3.5336
Sungai Bedawak	21	232	1.0356	0.3401	8.4549
Sungai Melinau	3	5	0.4582	0.4171	2.8613
Sungai Engkabang	4	41	0.4341	0.3131	1.8601
Sungai Begua	12	31	0.9126	0.3672	7.3758
Sungai Nyungan	21	125	1.0990	0.3609	9.5378
Sungai Kelimau Mit	19	142	1.0359	0.3518	8.3632
Bloh					
Sungai Bloh	11	94	0.8515	0.3551	5.0680
Sungai Joh	43	654	1.3464	0.3579	14.9170
Sungai Joh Paraka	28	208	1.1858	0.3558	11.6476
Sungai Joh Ibau	10	26	0.8921	0.3874	6.3605
Sungai Merating	29	237	1.2189	0.3620	11.7907
Sungai Layak	8	50	0.5958	0.2865	4.1201
Ulu Skrang					
Sungai Gerugu Rintong	22	243	0.8891	0.2876	8.8028
Sungai Berkiat	20	234	0.9497	0.3170	8.0195
Sungai Serembuang	20	255	0.9366	0.3126	7.8951
Sungai Jelian	5	11	0.5936	0.3688	3.8410
Sungai Sirik (merah)	8	92	0.5579	0.2683	3.5645
Sungai Ulu Skrang	16	86	0.9808	0.3537	7.7539

Fish species diversity in the Engkari river and the Kaup river is high. The Ulu Engkari has a higher fish species diversity and richness. Even though there is less fish species as compared with the Kaup river, the fish species are much more uneven in their abundance distribution where one species may have over 42 specimens while another species may have a single specimen. The Engkari Hilir had the highest species richness of the sites studied in the south of Lanjak Entimau. Non-indigenous fish species introduced into Batang Ai Lake by the Department of Agriculture had not been found at the periphery of the Sanctuary. They were not found within Batang Ai National Park in 1995 (Meredith, 1995).

The Katibas system had been the most intensively sampled during the study. Species diversity varied with the width and elevation of the stream. Smaller streams of between 0.5 to 1.0 metre wide such as Sungai Kulit Kayu I and II, Sungai Gindi and Sungai Engkabang all had very low species diversity and richness. Species evenness on a scale of 0.30 to 0.37 is low, indicating that a few species such as *Rasbora* and *Tor* dominate most of the population in the system. Sungai Kulit Kayu and Sungai Engkabang are small streams flowing along elevated slopes which had waterfalls that prevent fish species from ascending. Hence, fish species diversity is low in such streams. Sungai Menyarin and Ulu Katibas mainstream had the highest diversity and species richness in the Katibas system. This is essentially because the rivers are larger, swift flowing over bed rocks, and consist of many habitats suitable for fish to live in.

In the Bloh area, there is a distinct difference between disturbed and undisturbed river systems. Sungai Joh, a tributary of Sungai Bloh, had the highest species diversity and species richness of all sites sampled in Lanjak Entimau. There are many species of fish found in the Joh river that are not found in its tributaries such as Joh Paraka and Joh Ibau. This is because the larger sized Joh offered many more habitats that are not found in the smaller tributaries. Sungai Layak which is just outside the Sanctuary on the north bank of Bloh had very low species diversity and richness probably because the area had been logged previously. Although this river had recovered after a lapse of five years, and that its water quality is good, it would take some time before more fish species recolonise the habitats within the stream. The fact that Sungai Merating which flows from an area of shifting cultivation in the buffer zone of the protected area had the third highest species diversity is surprising. This disturbed river had high evenness and species values. The river bed is rich in nutrients as indicated by the green algae growth among its rocky stream bed.

In the Ulu Skrang sites, the lower reaches of the river systems that flow into the Skrang river had been exposed to secondary timber harvest and shifting cultivation activities. The species diversity of the river systems here are lower when compared to the Katibas, Bloh and Engkari. In general, the small side tributaries of the main river had low fish species diversity when the streams are flowing over rapids, waterfalls and steep slopes. Such small streams favour air-breathers such as the forest walking catfish (*Clarias* sp.) and snakeheads (*Channa* sp.). Many small *Macrobrachium* and Atyid shrimps can climb over the steep slope during rain and are thus able to colonise stream habitats in higher elevations. The fish species is least evenly distributed at Sungai Sirik, a small stream that flows from a little swamp off Sungai Berkiat. In Sungai Sirik, the fish fauna is dominated by *Rasbora*, *Puntius* and *Lobocheilus* juveniles. At Sungai Jelian, a waterfall of height 4.0 metres effectively prevented most species of river fishes from reaching upstream. Gerugu Rintong is richest in fish species, but less diverse when compared to Sungai Berkiat in the Ulu Skrang river system.

Many variables had been used by ichthyologist to predict the distribution of fish fauna in streams and river systems. Since the water quality of most of the streams is similar, the difference in the distribution of fish fauna can be attributed more to habitat differences (Lee *et. al.* 1990).

3.4 Critical Areas for the Conservation of Ichthyofauna.

The central catchment area of Lanjak Entimau which had been proposed as the core zone in the first management plan of ITTO in 1996, must be preserved completely for guaranteeing the continuous supply of good quality water. This area also provides habitats for the breeding of important food fishes such as *semah* (*Tor* sp.), *adong* (*Hampala* sp.), *kepiat* (*Puntius* sp.), *bantak* (*Osteochilus* sp.), *tengadak* (*Barbodes schwanenfeldii*) and *kulong* (*Lobochilus* sp.). Meredith (1995) also proposed similar nature conservation zone usages for Batang Ai National Park. The wilderness zone of the northern boundary of Batang Ai National Park is adjacent to the southern boundary of the Sanctuary, thus offering further protection against the exploitation of the protected area.

Small streams on the higher elevation of the Sanctuary had less species diversity when compared with the main rivers. This does not mean that these streams are not important for conservation. Most of the *ensurai* and *engkabang* trees are located along the banks of larger rivers. Their flowers and fruits fall directly into the rivers and are often eaten by the cyprinid fishes. It is therefore important that such trees along river banks be left undisturbed.

Stream canopies of about 80% are important as most small fish species and juveniles utilise the shaded areas to hide from predators. The lower light intensity over the stream provides suitable habitats among rock and riffles for the balitorid fishes. Lower light intensity also discourage the growth of green algae on the rocks. Where the light penetration is high, coupled with inorganic fertilizer run-offs from the surrounding farms, benthic rock surfaces are often covered with green algae growth. Species of *Osteochilus*, *Lobochilus* and *Gastromyzons* were seen to feed actively over the surfaces of rock boulders where there are no growth of green filamentatous algae.

The present study indicates that rapids and rocky areas are important as habitats for the *semah* (*Tor* sp.) and *tengadak* (*Barbodes schwanenfeldii*) as they feed on materials such as insects, reptiles, amphibians, fish, flowers and fruits that are caught in the turbulent water. This is evidenced from the gut contents of fish specimens collected from the rapids. The importance of feeding areas along rivers and streams in the Sanctuary was also noted. Such areas are always in close proximity to the wild animal wallows along the lower bank of the river. It is important to manage other wildlife resources in close tandem with fish as they could have symbiotic relationships.

The upper Katibas river beyond Nanga Menyarin that lies within the core area of the Sanctuary is identified as one of the critical areas for the conservation of ichthyofauna. This is because the youngs and adults of the *tengadak* (*Barbodes schwanenfeldii*), *semah* (*Tor* sp.) and other families of fish are still found in abundance. It is necessary to protect the river from human disturbance in order to conserve the fish species.

In the multiple use buffer zone, much human activities are generally focused on the fish resources as they are harvested for subsistence and sale. These activities will eventually cause a drain on the fish resources within the Sanctuary. Recruitment of young into the downstream population could only occur after each rainy season when young fish are washed down from the core zone. The Sanctuary will be able to sustain such activities if the use of the rivers are limited to the traditional inhabitants who fish for their own subsistence.

3.5 Ichthyofauna and Habitat Change

There are shifting cultivation activities along Sungai Merating in Bloh where the land along the right bank was cultivated with hill padi in 1997 during the fish sampling programme. However, the fish species diversity is still very high (H'=1.2189) compared to the undisturbed stream at Sungai Joh (H'=1.3464). Fish species richness remained the second highest in the Sanctuary after Sungai Joh. In another stream of similar size at Sungai Kelimau Mit along the Katibas where the stream flows over a shifting cultivation area that had been fallowed for about 5 years, fish species diversity decreased slightly (H'=1.0359) and species richness was almost 30% lower than Sungai Merating. From this study, it can be inferred that the impact of shifting cultivation land use on fish fauna in a forest stream is less in the initial period. It may take a long time before a disturbed stream like Sungai Menyarin (fallowed for over a hundred years judging from the size of the planted *durian* trees) can recover back into its initial diversity. Stream habitat changes attributed to human activities would affect the feeding and breeding of fishes downstream. Fishes of the family Balitoridae were able to tolerate turbid water and deposit of silt for short periods at relatively frequent intervals (Samat and Chin, 1996)

4.0 DISCUSSION AND RECOMMENDATIONS

The present study provided the baseline inventory data of ichthyofauna found in LEWS. Several other aspects of fish ecology require further assessment. The species population dynamics and growth rates of valuable commercial species had to be studied over a minimum period of 1 year in order to observe breeding patterns during the dry and wet seasons of the year. This could be undertaken in subsequent projects of ITTO. Any basic fishery assessment of the Sanctuary should not cause excessive mortality of breeding adults so that recruitments of young fish into the population is sustainable in the long term. There is a need to document the occurrence of disease and parasite on the ichthyofauna of the Sanctuary. This is necessary because fish parasites may pose a health hazard to the local communities who depend on fish as a protein supplement.

Freshwater fish data are poorly reported in museum collections in the past as no detailed systematic studies had been carried out. Systematic collection of fish in the Sanctuary is important in order not to over-collect fish fauna materials from the protected area. The present study has collected fish specimens from within the wilderness zone and not from the core area. Specimens collected were curated and inventorised for the future reference of other agencies.

Cyprinid species that are sensitive to habitat changes such as *tengedak* and *semah* are particularly vulnerable in small tributaries where their youngs lived during their juvenile stage. Depending on the target fish species, the mesh size of hand cast nets should not be less than 30 mm while that for gill nets should not be less than 60 mm. This might be difficult to enforce as the locals tend to hide their fishing gears as they travel through checking points. All forms of fishing should not be allowed in small streams of less than 2.0 metres wide within the Sanctuary.

Local people who are allowed to fish legally within the Sanctuary must be registered at the Ranger Station. Such fishing must be purely for domestic consumption and not for commercial sale. Fish resources in the buffer zone remained low as reported by the locals. It is necessary to manage fish resources within the Sanctuary in order to sustain downstream fishing activities. The local communities may be persuaded to farm expensive commercial fish species in the buffer zone. Fish seeds may be bred from established research stations in Sarawak and should not be collected from the wild. Illegal fishing activities such as the use of poison, electricity and small mesh nets should be controlled. Most of the local communities at the periphery of LEWS have good knowledge of the value of the Sanctuary as a reserve for important commercial fishes.

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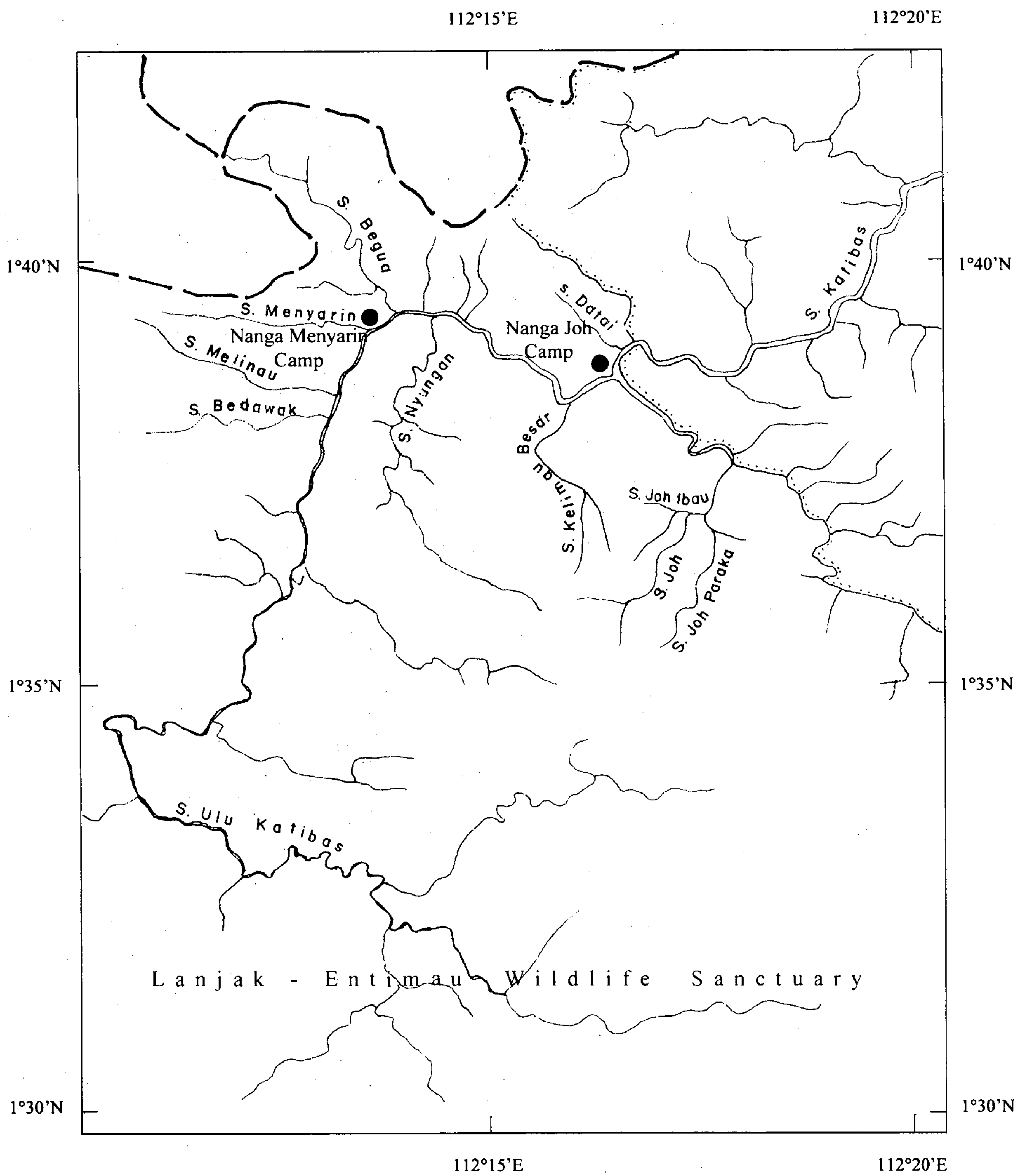
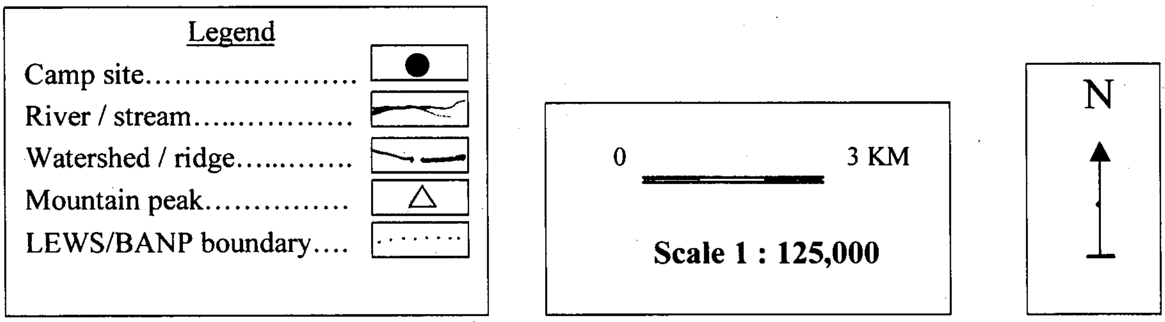


Figure 1 : Map of Nanga Joh and Ulu Katibas fish collecting sites



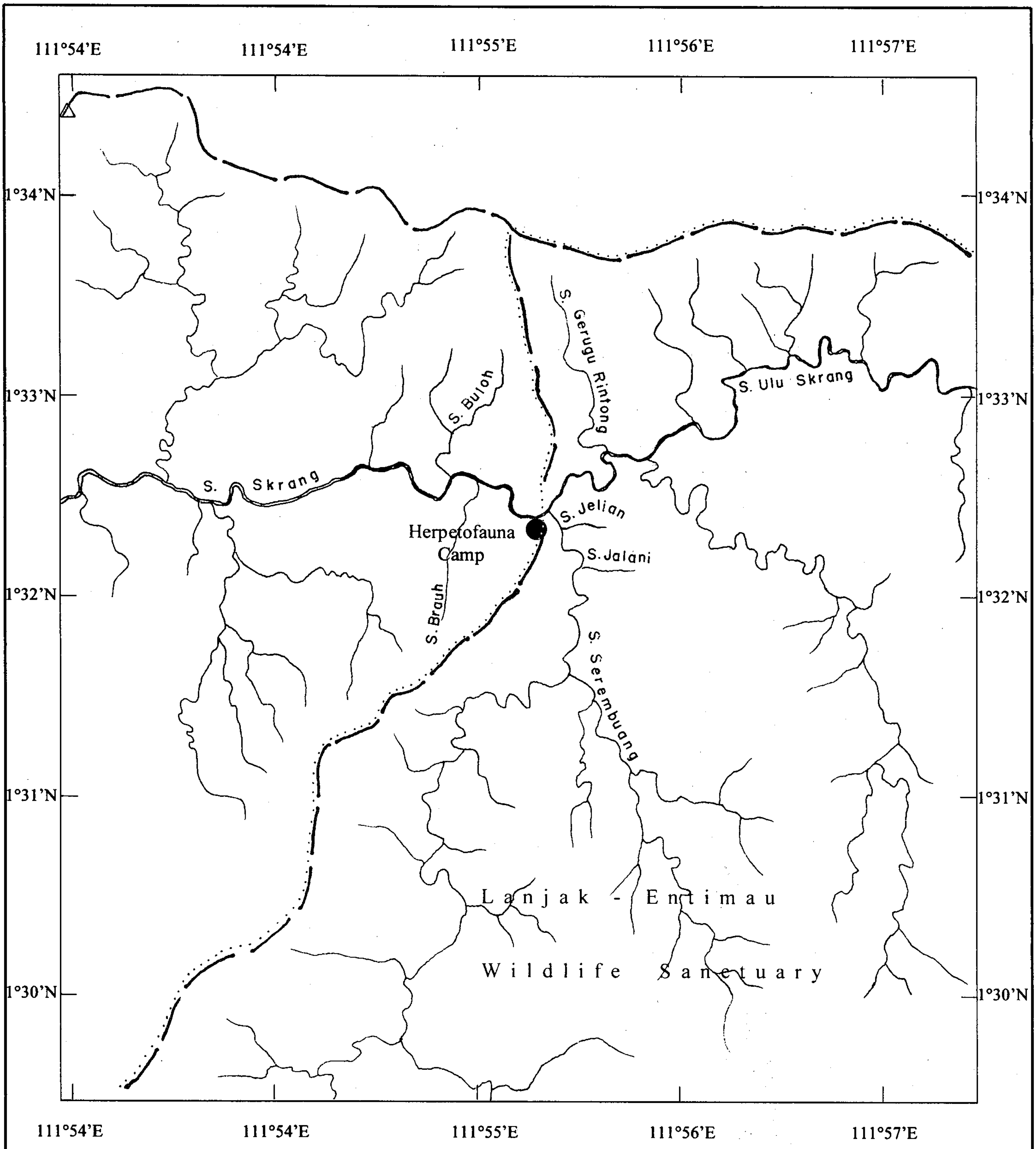
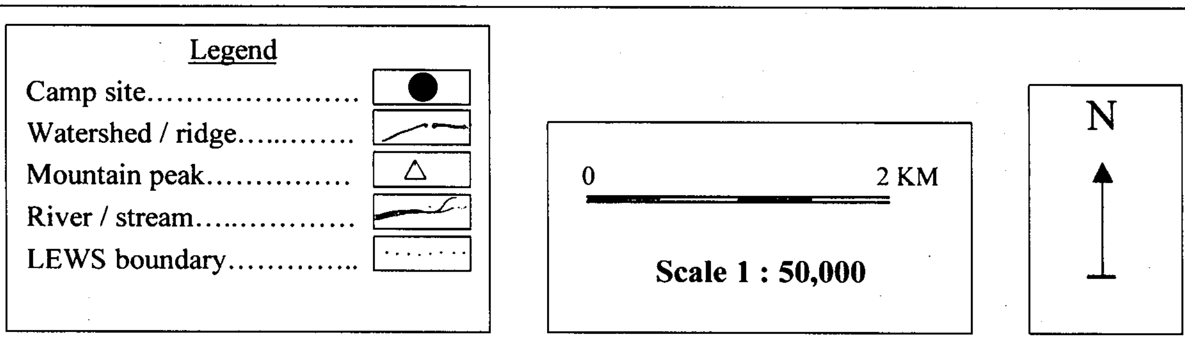


Figure 2 : Map of Ulu Skrang fish collecting sites



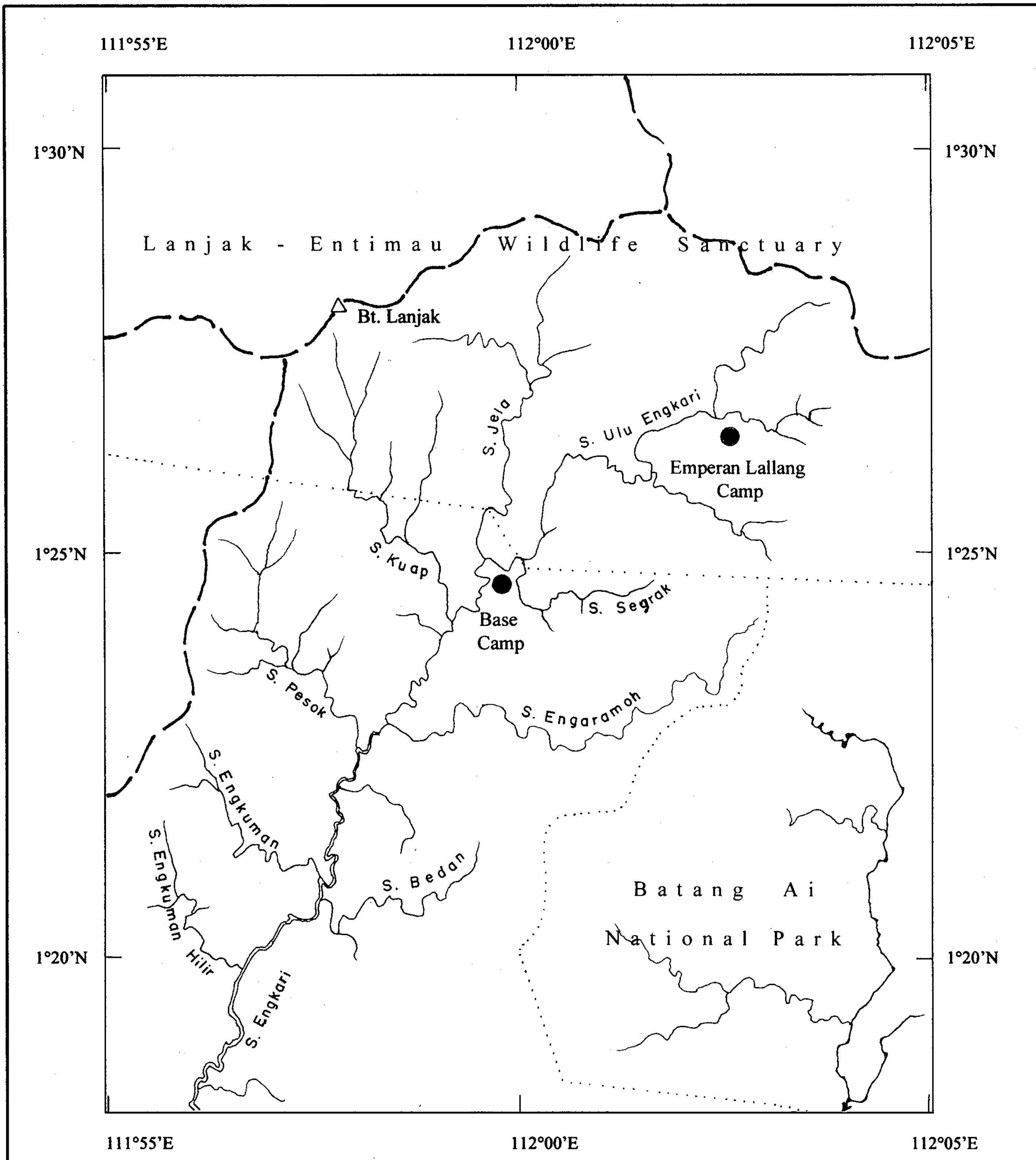
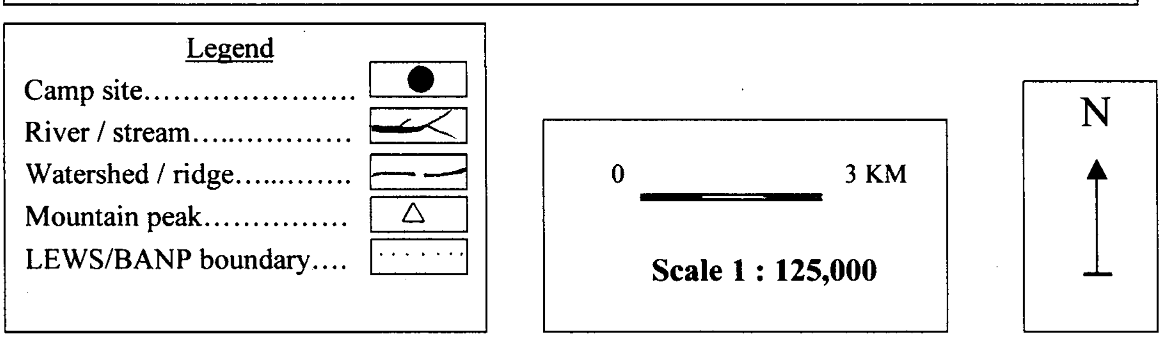


Figure 3 : Map of Engkari fish collecting sites



DISCUSSIONS

Penguang Manggil

As the main emphasis in Phase III will be community-development such as fish breeding in valley ponds, what are the fish species that have potentials to be reared under this condition?

Dr. Charles Leh

From the study and the response of the local communities, *semah* and *tengadak* are the two priced fish. They are encroaching into the Sanctuary to catch these fish for sale in the town centres. It is therefore necessary to look at the target species such as *semah* and *tengadak*. To breed these fish in ponds and enclosures, we need to understand the breeding biology of these fish in the natural systems. We need to know where they breed, when they breed and the critical areas of the habitats. From the Freshwater Fish Inventory Study, we know that small tributaries are extremely important. *Ensurai* trees are important. We know what they feed on, but we do not know how often do they breed, and what is the population dynamic. In the afternoon Mr. Stephen Sungan will talk about the potential of fish breeding and the economics of it.

Sapuan Ahmad

We have seen that the *ensurai* fruit is one of the natural food of some of our indigenous fish. Could the fruits be processed into fish meal?

Dr. Charles Leh

Ensurai is a natural plant along the river banks. In areas where you find e*nsurai*, you find *semah*. Areas without *ensurai* there would be no expensive *semah*. In the fish culture at Rh Api, Rh Enggong and Rh Gerasi, they are feeding the fish with fish pellets. There is no study yet on using *ensurai* to feed the fish such as *semah*, *tengadak* and other less expensive fish. There is a potential to process *ensurai* fruits into fish meal, but we do not know how. We have not studied that yet.

A brief note on the Herpetofauna of Lanjak Entimau Wildlife Sanctuary

by

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and

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Abstract

Herpetofauna work at Lanjak Entimau Wildlife Sanctuary during Phase II, was limited to surveys conducted from 12 to 26 November 1977 in conjunction with the ITTO Borneo Biodiversity Expedition [IBBE] 1997. Sampling was done at two different locations; Nanga Menyarin and Nanga Joh in the Song District. A total of 146 individuals were collected comprising 23 species of amphibians and 12 species of reptiles. Thirteen species were found to be endemic to Borneo.

1.0 INTRODUCTION

The island of Borneo represents a global "hotspot" for biological diversity. A large portion of the vertebrate diversity is made up of the herpetofauna, which contributes at least 40% of this diversity, or well over 400 species. The Bornean herpetofauna contains the highest individual and species densities in South East Asia [Inger, 1978]. Presently, there are about 445 species of amphibians and reptiles known from Borneo. Endemism in the Bornean herpetofauna is also rather high. Nearly one third of the snakes and more than three-quarters of the Bornean frog fauna are found nowhere else. Many lizards, especially among the Scincidae, are also endemic to Borneo.

De Rooij (1917) made the first attempt to assemble a complete list, which was revised and amended by DeHaas (1950). Further work on individual groups was carried out by Inger (1966) and Inger and Stuebing (1997) on frogs, and by Haile (1958) and Stuebing and Inger (1999) on snakes. Recent work on lizards includes a checklist by Tan (1993). Further work on lizards is being carried out by Das (in prep).

Sarawak forms a significant portion of western and northern Borneo, and has presently a total of 117 known species of amphibians and slightly over 200 species of snakes and lizards; the majority of which are found in the forested interior.

Sarawak's Totally Protected Areas such as the Lanjak Entimau Wildlife Sanctuary [LEWS] protect a substantial portion of pristine and original forests. The Sanctuary was initially set up for the purpose of orangutan conservation. LEWS has since proven to be also rich in many species of vertebrates, including herpetofauna (Stuebing, 1994).

During approximately six weeks of fieldwork in 1993-94, four new species were described, along with several new records (Stuebing, 1994a; 1994b; Inger and Stuebing, 1994; 1996; 1999). Herpetofaunal sampling conducted in 1993-94 during Phase I produced 97 species of amphibians and reptiles, including several reported for the first time in Sarawak as well as four species new to science. The study indicated that herpetofaunal diversity is high, and probably encompasses at least 60% of Sarawak's known herpetofaunal species.

During the Phase II; herpetofauna work was confined to two weeks of sampling in November 1997 as part of the IBBE (1997).

2.0 METHODOLOGY

Two locations namely, Nanga Menyarin and Nanga Joh were selected as study sites. Nanga Menyarin (1° 39.212' N, 112° 13.568' E) is located beside the Sungai Katibas near Bukit Guning at approximately 120 m a.s.l. Herpetofauna sampling were done at Sungai Katibas and its smaller tributaries of Sungai Menyarin, Sungai Melinau, Sungai Bedil and Sungai Begua.

Nanga Joh (1° 37.513' N, 112° 17.845' E) is located on the Sungai Bloh at the junction of the Joh , a moderate-sized stream. The nearest hill (about 400 m a.s.l.) is Bukit Pelanduk. Similarly, herpetofaunal sampling were conducted at Sungai Bloh and its smaller tributaries of Sungai Joh and Sungai Layak.

At each sampling site, specimens were collected by hand from stream, river and forest transects at night. Tadpoles were collected by the IBBE (1997) fish group.

The lack of manpower restricted the quadrat and buttresses sampling from being used in this study.

All specimens collected were anaesthetised either with chlorobutanol solution (for amphibia) or via an injection of nembutal solution (for reptiles). All were then measured, weighed and tagged with a serial field number and preserved in 10% formalin solution.

Ecological data for each numbered specimen which included stream size, substrate, current speed and percentage of canopy were recorded. Water quality parameters (temperature, dissolved oxygen, pH and turbidity) was derived from the IBBE (1997) fish group. Nomenclature follows Dubois. Specimens are deposited with the Sarawak Forest Department.

3.0 RESULTS AND DISCUSSION

A total of 148 herpetofaunal specimens (129 amphibians and 19 reptiles) representing 23 species of amphibians and 11 species of reptiles were collected. A list of the species collected is given in Appendix I.

All the 5 families of amphibians in Borneo were represented in this sampling excursion. The family Ranidae [riverine frogs] made up 52% of the amphibians species present and was the dominant family. The Ranidae are generally the most widespread group in the Sanctuary (Stuebing, 1995). Of the Ranidae, the riverine genera such as *Rana* and *Meristogenys* were common in all sampling sites. Second most abundant were the Bufonidae [true toads] such as *Bufo* spp. and *Ansonia* spp. which accounted for 23% of the total amphibian species. The Rhacophoridae (tree frogs) represented 17%. The least abundant were the Megophryidae (1%) and Microhylidae (1%). This is probably due to their habitat, the forest floor, being not sufficiently sampled.

Stream composition for frog species in LEWS were similar to those observed in 1994, with the exception of finding the river toad, *Bufo asper,* which was relatively abundant when compared with earlier surveys.

The reptiles encountered were rather relatively low in number as compared to the amphibians. There was only one species of freshwater turtle; the chelonian *Heosemys spinosa*, eight species of lizards and three species of snakes. The capture rate for reptiles was about one individual every three days. This occurrence probably can be attributed to insufficient sampling, in particular for snakes, which require long-term intensive effort to obtain a considerable number.

A total of 12 species of amphibians and one species of lizards were found to be endemic to Borneo. No rare or new species were found during the sampling activities. Diversity indices were not calculated since the samples [particularly the frogs] were not randomly collected.

4.0 IMPLICATIONS FOR MANAGEMENT

The value of LEWS lies in its preservation of a wide diversity of climax habitats. Within its complex topography, a wide range of micro-environments also exists which is highly crucial in ensuring maximum preservation of herpetofaunal diversity for the future.

- Current knowledge is extremely minimal, so that continued inventories are needed. Inventories are the best way of documenting herpetofauna to obtain solid information on species presence, abundance, ecology and distribution. It also leads to discoveries (in Sarawak at least) of new species and new records. The potential for discoveries of new Bornean species is quite substantial.

- Monitoring based on these initial inventories will provide a clear picture of natural population and community fluctuations, and local versus regional (or even larger scale) changes in herpetofaunal communities. Examples include *Meristogenys* sp., which is sensitive to disturbance and will make a good indicator for pristine streams and rivers. The density of *Limnonectes leporina* increases with stream siltation which might be caused by habitat disturbances.

  Therefore, regular surveys will help to keep tabs on the "health" of LEWS, and a wider area. Surveys within LEWS can be compared with surveys outside the boundary to monitor changes, for purposes of boundary management.

- LEWS can serve as a training ground for biological managers, where they may learn taxonomy and ecology of herpetofauna and come to appreciate long-term issues with respect to conservation of this group.

5.0 CONCLUSION

Despite the restricted effort of the herpetofauna programme under the 'Development of LEWS as a Totally Protected Area, Phase II', the high number of endemic species recorded from 11 days of actual survey clearly indicated a tremendous richness and diversity of herpetofauna species. Herpetofauna as a group is vulnerable to habitat disturbance and the fast pace of development in Sarawak has seen original and pristine habitats undergone numerous habitat modification. Thus the conservation of LEWS as a totally protected area is crucial to the long-term survival of herpetofauna in Sarawak.

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Appendix I

I. AMPHIBIA	**Megophryidae [Leaf Litter Frogs]**	
	*Leptobrachella mjobergi**	Smith
	Bufonidae [Toads]	
	*Ansonia albomaculata**	Inger
	*Ansonia longidigita**	Inger
	Bufo asper	Gravenhorst
	*Bufo juxtasper**	Inger
	*Pedostibes hosii**	Boulenger
	Microhylidae [Narrow-mouthed frogs]	
	Metaphrynella sundana	Peters
	Rhacophoridae[Tree Frogs]	
	Nyctixalus pictus	Peters
	Polypedates macrotis	Boulenger
	Rhacophorus appendiculatus	Guenther
	Rhacophorus pardalis	Guenther
	Ranidae	
	*Huia cavitympanum**	Boulenger
	*Meristogenys poecilis**	Inger & Gritis
	Limnonectes conspicillatus	
	*Limnonectes ibanorum**	Inger
	*Limnonectes leporina**	Andersson
	Limnonectes malesiana	Kiew
	Rana chalconota	Schlegel
	Rana hosii	Boulenger
	Rana laticeps	Boulenger
	*Rana picturata**	Boulenger
	*Staurois latopalmatus**	Boulenger
	*Staurois natator**	Guenther
II. REPTILIA	*Heosemys spinosa*	
	Draco maximus	
	Draco sp.	
	Gonocephalus grandis	
	Aleuroscalobotes felinus	
	*Gonudactylus cf. Ingeri**	
	Mabuya multifasciata	
	Mabuya rudis	
	Tropidophorus brookei	
	Amphiesma flavifrons	
	Boiga dendrophila	
	Tropidolaemus wagleri	

* Endemic species of Borneo

DISCUSSIONS

Dr. Efransjah

There is a new discovery of antibiotic. This antibiotic is developed from a substance in the skin of the frogs. This antibiotic will fight against the microbes in quite a different manner compared to penicillin or its derivatives currently being used. This new antibiotic will be in the market in the near future.

Dr. Soepadmo

Has any similar survey been carried out in Mulu NP, Bako NP or Lambir NP in Sarawak? Unless you do that, you would not know how important LEWS is for the conservation of these animals, be they small mammals, birds, fish or herpetofauna.

Shahbudin

We are actually carrying out the inventory of herpetofauna in all the totally protected areas. We hope to complete the checklists by the end of this year. We would then extend our inventory to other areas outside the TPA. One area that we are very interested to visit is Pulong Tau in Bario where one rare species of snake was reported.

Dr. Paul Chai

In your slide presentation, you mentioned that there were 97 species of herpetofauna comprising 51 species of amphibians and 46 species of reptiles whereas in your paper there are 23 species of herpetofauna. Could you clarify?

Shahbudin

This paper is based on the findings of the work done in Phase II, that is during the ITTO Borneo Biodiversity Expedition 1997. The results shown in the slide are based on the work done during Phase I and Phase II of the project.

Insects of Lanjak Entimau Wildlife Sanctuary

by
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Abstract

Under the International Tropical Timber Organisation (ITTO)-sponsored Lanjak Entimau Wildlife Sanctuary (LEWS) conservation project Phase II, six months (April-September 1998) were spent working on the richness, abundance, diversity of the insect fauna in relation to the alluvial, lowland mixed dipterocarp, hill dipterocarp, montane as well as secondary forest types.

The insect fauna was found to be exceedingly rich. A grand total of 6,176 specimens, from 8 orders and 56 families, with 1,050 sorted species, were sampled. Emphasis was given to moths, butterflies, dragonflies/damselflies, bees and termites, as these groups are useful in environment assessment, and of conservation and economic importance.

Moth diversity as measured by Williams Alpha diversity index was highest at the hill dipterocarp forest, with an overlap of lowland and montane elements. Moth endemism increased with altitude, with a high proportion of species at Bukit Lanjak summit not found at lower altitudes. The secondary forest site, made up of previous swidden plots and regenerated forest, yielded many big, attractive moths. This indicates the ability of the forest to recover from traditional shifting cultivation practices.

The beautiful Rajah Brooke's Birdwing (Troides brookiana brookiana Wallace) was found to be most abundant in the alluvial forest of Nanga Joh. Five out of six endemic butterfly species sampled were found in the lowland forest of upriver Engkari (Sungai Jela), underlining the conservation importance of the area.

Dragonflies and damselflies found along the rivers of undisturbed forest of LEWS showed distinct species composition, with many species confined to the undisturbed habitats and which are never seen in urban areas. They were also virtually absent in the muddy Sungai Bloh where logging was done further upriver.

The bees were more abundant along riverbanks which they may use for navigation. They were found to be unexpectedly low in abundance in the deep forest understorey. However, it was not possible to investigate the canopy species and there was no mast-flowering.

Termites were found to be rather diverse, which despite the small sampling plots produced 40 species out of 100 odd known in Borneo. They play more of a beneficial role in the natural forest by breaking down dead organic matter and recycling nutrients. Pest termites, common in plantation monocultures, are rare in LEWS.

Beetles, cicadas and other insects were also sampled.

1.0 BACKGROUND

Survey of insects of LEWS was conducted by staff of the Forest Research Centre in Kuching during Phase I of the project in the first half of the 1990s. A list of the insects collected is included in Appendix XII of the report 'Development of the Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area, Phase I: The Management Plan' by ITTO and Sarawak Forest Department, 31 March 1996. According to the appendix, 5,927 specimens from 48 families were collected from 11 localities, with a high number of unidentified species. No report, however, was available on the insect diversity and ecology in LEWS. And apart from a short two-day preliminary survey on the cicadas of LEWS (Zaidi & Hamid 1996), there was no other publication on the insect fauna of LEWS.

2.0 SAMPLING SITES

Basically two areas were chosen which give a representation of the major forest types: the alluvial forest (around 150 m a.s.l.) of Ulu Katibas (here encompassing Sungai Joh, Sungai Bloh, Sungai Kilimau); and Lanjak which includes the lowland mixed dipterocarp forest (300 to 400 m a.s.l..) of Ulu Engkari, Sungai Segerak, Sungai Jela, the hill dipterocarp forest (700 m a.s.l.) of Ubah Ribu, and the montane forest of Bukit Lanjak (1,285 m a.s.l.).

The first collection trip was made to the alluvial forest of Ulu Katibas in May 1998, the second trip to the lowland forest of Lanjak in July 1998, and the third trip mainly to the hill dipterocarp and montane forest as well as lowland and secondary forest in Lanjak in August 1998.

3.0 INSECT FAUNA SURVEYED

The insect fauna, with its abundance and vast number of species, makes up the biggest proportion of the biodiversity of any tropical rain forest. A 6-month period does not permit in-depth investigations into the insect fauna of LEWS. So the present study, unsatisfactory as it is, only covers the Lepidoptera (moths, butterflies), Odonata (dragonflies-Anisoptera, damselflies-Zygoptera), Hymenoptera: Apidae (bees), Isoptera (termites), and briefly other groups including beetles and cicadas.

The moths are chosen as they are suitable indicators of the various forest ecosystems. They are highly speciose, their larvae being herbivores are indicative of the floristic diversity of the habitat. Many are habitat specific, which show species replacement over ecological gradients. Their ease of sampling and better known taxonomy are further plus points.

Butterflies and dragonflies are flagship groups in any conservation project. They are of high aesthetic value, and people care about their survival more than any other insect group.

Bees, apart from honey production are important in pollination. While termites are vital in the recycling of forest nutrients by decomposing dead organic matter, and some are noxious pests in plantations.

3.1 Moths

3.1.1 Methods

Moths were collected at night using a ultra-violet (UV) light tube, TOKI F20T10BLB made in Japan, powered by a portable generator. All moths attracted to the UV light illuminating a one metre square white sheet were caught in killing bottles charged with ethyl acetate, papered and labelled. The light-trapping hours were from 7 p.m. to 10 p.m., the peak hours of moth activity. A minimum of 3 sampling nights was conducted at each site, except at Bukit Lanjak summit where only one night of sampling was possible using a less powerful French-made gas lamp Superlumogaz PZ206.

The samples were subsequently pooled for each site to minimize the effects of physical variables.

The specimens (macromoths) were identified by using published monographs (Barlow 1982; Holloway 1976, 1983, 1985, 1986, 1987, 1988, 1989, 1993, 1996, 1997, 1998; Kobes 1985, 1989, 1994), as well as in part by referring to the moth collection of the Sabah Forest Research Centre in Sepilok, Sandakan.

Williams Alpha diversity index was used to measure the moth diversity as it is independent of sample size, and the most widely used index in comparing light-trapped moth samples. The higher the value of the index, the higher the diversity.

Preston's coefficient of faunal resemblance was used to compare sites when necessary to investigate the similarity of two chosen sites based on the number of species found in each as well as the number of shared species. Its value ranges from 0 (total similarity) to 1 (total dissimilarity).

3.1.2 Results

In all 15 macromoth families with 787 species and 3,185 individuals were sampled. Holloway (1993) estimated a total of 3,429 species in Borneo, and the present samples comprised 23 %, or about a quarter of the Bornean species.

The geometrid subfamily Ennominae has the highest number of species (168) and individuals (1,076). The noctuid subfamily Ophiderinae has the second highest species (123) with relatively few individuals (259), while the arctiid subfamily Lithosiinae has 70 species out of a relatively high number of 379 individuals. These 3 groups were the more generally distributed moths in LEWS.

The hill dipterocarp forest at Ubah Ribu (700 m a.s.l.), with a overlap of lowland and montane elements, was the most diverse in moths and gave the highest Williams Alpha diversity index (178.89). The Myrtaceae, which is known to support a diverse moth fauna, is also abundant in the area (Chai, 1995). There are also species, including endemics, restricted to the habitat.

The percentage endemism generally increased with altitude. The Bukit Lanjak summit (1,285 m a.s.l.) sample, despite its small size, produced the highest endemism. Out of the 31 species sampled, 14 are uniques including 4 endemics.

The secondary forest site, light-trapped on the helipad behind the Segerak camp, gave big and attractive saturniids (the Moon Moth *Actias maenas* Doubleday, the Atlas Moth *Attacus atlas* Linnaeus), as well as numerous sphingids (hawkmoths) and cossids, which were not sampled at other sites. This might be partly due to the site's elevated open nature, with a canopy outlook of a surrounding mosaic of previous swidden with proximity of undisturbed forest. Early to late stage successional species were apparent, with more emphasis on the latter, which indicates that traditional shifting cultivation practices do not seriously impede forest regeneration. The site's diversity value (127.64) was depressed by the presence of a large number of the White-Tailed Moth *Lyssa menoetius* Hopffer.

When species composition was compared using Preston's coefficient, lowland dipterocarp sites gave coefficients of above 0.7, while alluvial sites produced a coefficient of 0.65. These dissimilarity values are much higher than values obtained from monoculture forest plantations which generally hover between 0.4 to 0.5 (Chey, Holloway & Speight 1997). This indicates the diverse nature of the moth fauna even within similar forest ecosystem in LEWS compared to plantation systems.

When all the samples from LEWS were pooled as a single entity (with 787 species and 3,185 individuals), a Williams Alpha diversity value of 334.34 $\pm$ 18.86 was produced, which is within the range of 300 to 350 recorded in other undisturbed Bornean forest habitats (Holloway & Barlow 1992; Holloway 1984).

In addition to the above samples, another 1,240 micromoths (mostly Pyralidae) were collected, but sorting of these specimens was not possible due to time and taxonomic constraints.

3.2 Butterflies

3.2.1 Methods

The butterflies were collected using nets mainly on the river banks, from 9 a.m. to 12 noon, as they are more abundant along rivers in the morning. No bait was used in the sampling.

As no suitable river could be found beyond the lowland forest, butterflies were collected at random in Ubah Ribu and Lanjak summit. Random collection was also made at the various camp sites.

The butterflies were identified by using monographs (Otsuka 1988; Seki, Takanami & Otsuka 1991; Maruyama 1991).

3.2.2 Results

Altogether 8 families with 104 species and 450 individuals were sampled. The species made up of about 1/9 of those found in Borneo (910 species in total). The upper reaches of Sungai Jela gave the highest number of individuals (80) and species (25).

The hill dipterocarp forest of Ubah Ribu appeared to be comparatively poor in butterflies, as there is no sizable river and clearing, but it has forested hill elements such as *Thauria aliris aliris* Westwood, *Faunis stomphax stomphax* Westwood, both satyrids not found in other samples. It is also noted for the abundance of the sexually dimorphic *Lexias dirtea chalcenoides* Fruhstorfer, which generally replaces a similar lowland species *Lexias pardalis dirteana* Corbet on higher elevations.

The most significant finding was the abundance of the Rajah Brooke's Birdwing butterfly *Troides brookiana brookiana* Wallace in the Nanga Joh area, which is the river mouth of Sungai Joh in Ulu Katibas. Swarms of 10 to 20 of the male butterfly were commonly seen sipping moisture on the wet forest floor or riverbanks. The reason for its abundance could be due to the presence of its larval host-plant, the *Aristolochia* vine (Chey 1997). This most glamorous of all butterflies is getting scarce in other parts of Borneo. As this is the only insect protected by law in Sarawak, high priority must be placed on the conservation of its habitat apart from stringent control on its illegal capture by commercial collectors. The current market price of the butterfly has gone up to around RM 100 per specimen. Incidentally a pair of Rajah Brooke's were seen mating in the cool air of Bukit Lanjak summit, which was rather unexpected.

Several endemic species were found in the upper reaches of Engkari including Sungai Segerak, Sungai Jela. In fact five of the six endemics sampled were found in Sungai Jela. The five species were *Cepora pactolicus* Butler, *Ixias undatus* Butler, *Prioneris cornelia* Vollenhoeven, *Acytolepis ripte* Druce, and *Nacaduba normani normani* Eliot. The sixth endemic was *Paralaxita nicevillei* Rober collected at the alluvial forest of Ulu Katibas. The present samples made up over 10% of the 50 endemic butterfly species in Borneo.

3.3 Dragonflies & Damselflies

3.3.1 Methods

Sampling methods and sites are similar to those of butterflies in 3.2.1, as they were collected together.

The specimens were identified using books (Pinratana, Kiauta & Hamalainen 1988; Lieftinck 1954), as well as the reference collection in the Sarawak Forest Research Centre, Kuching.

3.3.2 Results

25 species (out of a Bornean total of 259) with 256 specimens were sampled.

The most striking result was the almost total absence of the dragonflies and damselflies along the Sungai Bloh sites where logging was on-going further upriver. This river was thoroughly muddy when the rains came. As the immatures of these insects are aquatic, they may not be able to tolerate the drastic changes in the polluted river ecosystem.

Another noteworthy result was the exclusiveness of the species composition of dragonflies and damselflies in the undisturbed habitats of LEWS. These species, many of them sporting metallic blue-green wings, are totally absent in the disturbed urban ecosystems. The most common species in LEWS is *Euphaea subcostalis* Selys, probably endemic to Borneo, which is most abundant along Sungai Jela. The upper reaches of Sungai Jela produced the most number of species (11), which also gave the highest number of butterflies.

3.4 Bees

3.4.1 Methods

Native honey purchased from local market was diluted with water (1:1) and sprayed onto the understorey portion of the vegetation (foliage or stem of a single plant or tree) at around 9 a.m. for sampling bees. Bees attracted to the honey were collected every half hour until midday. Respraying was done every half an hour. Only one bait was conducted per morning.

Bees were identified by referring to the collections at the Sarawak and Sabah Forest Research Centres.

3.4.2 Results

Ten species were sampled, consisting of 8 stingless bees (*Trigona* spp.), and 2 honey bees (*Apis* spp.). There are 29 species of stingless bees (Earl of Cranbrook & Edwards 1994) and 5 species of honey bees (Koeniger *et al* 1998) in Borneo.

Generally the bees appeared to be more abundant around 11 a.m. The two most widespread species were *Trigona atripes* gp. *collina* Smith and *Apis cerana* Fabricius.

Most bees were collected along river banks which may be used by the bees as navigation corridors.

Surprisingly relatively few bees were sampled in the deep forest understorey sites. This suggests that the bees have limited foraging range within the forest understorey. The fact that many of the stingless bees are scavengers may also affect their effectiveness as pollinators. However, most stingless bees are known to nest near the base of big trees such as dipterocarps, and the giant honey bee *Apis dorsata* Fabricius usually nests on the branches of the towering *Koompassia excelsa.* There was no mast-flowering of dipterocarps at the time of sampling. The absence of tree towers also made canopy observations impossible.

3.5 Termites

3.5.1 Methods

A systematic termite survey involving the use of circular plots was conducted in the alluvial (A), lowland mixed dipterocarp (LD), and hill dipterocarp (HD) forest types.

Five circular plots were set up on the forest floor at each forest type. Each plot was 5 m in radius and separated from the next by 10 m.

All termites found within the plots were collected and put into vials with 70 % alcohol. Each vial containing termites from a particular substrate. The soldier caste of each species was picked as identification is based mainly on termite soldiers.

Identification was done with a microscope micrometer based mainly on the measurements of Thapa (1981). A further reference is Ahmad & Akhtar (1981).

3.5.2 Results

The termite fauna of LEWS was found to be rich, which despite the small plots yielded a total of 40 species, 10 of which are endemics. A single plot in the alluvial forest of Nanga Joh produced as many as 11 species. Thapa (1981) Only 103 species are recorded in Sabah, but that figure may not adequately represent the total number of species found in Borneo. *Macrotermes malaccensis* Haviland, one of the biggest termites, was found in all three forest types.

Most of the taxonomically interesting species (*Schedorhinotermes*, *Microcerotermes*, *Prohamitermes*, *Bulbitermes*, *Nasutitermes*), however, were found in the hill dipterocarp forest, where termite measurements do not fit with those of described species. It shows the termite fauna was under-collected at higher elevations, where possibly many new species still await discovery.

The termite fauna was found to be lowest in diversity at the lowland mixed dipterocarp forest behind the Geronggang camp situated next to Sungai Jela. However, the area surveyed was rather soggy and this could be a local effect and may not reflect the termite richness of the habitat as a whole. Further work will throw a light on this.

Also, the vast majority of the termites sampled are species which feed on dead organic matter. They are hence beneficial to the well-being of the forest by breaking down and decomposing dead vegetation and in the process help in the recycling of forest nutrients. In plantation monocultures, several termite species are notorious pests (Chey, 1996), but in the undisturbed natural forest habitats of LEWS, these pest termites appeared to be scarce and are found in low density, as only one major pest species (*Coptotermes curvignathus* Holmgren) was found on a single substrate (a fallen trunk) in the alluvial forest of Nanga Joh in the entire survey.

3.6 Beetles, Cicadas, & Other Insects

3.6.1 Methods

Beetles (Coleoptera), cicadas (Homoptera: Cicadidae), and other insects namely Homoptera and Hemiptera bugs, Hymenoptera wasps, Orthoptera including grasshoppers (Tettigoniidae), crickets (Gryllidae), praying mantids (Mantodea) and stick insects (Phasmatodea) were collected alongside the light-trap sampling of moths. They were sampled randomly in small numbers.

Beetles were identified in part by using Tung (1983). Other specimens were identified by referring to the insect collection in the Sarawak Forest Research Centre, Kuching.

3.6.2 Results

It must be stressed here that these specimens were collected alongside the moth samples, and no particular effort was made to specifically sample them. Even so, as many as 12 species of cicadas were collected from the various forest habitats of LEWS. Seventy three species of cicada occur in Borneo. Moulton (1923)

The beetles appeared to be more diverse between 400 and 700 m asl in LEWS. This is particularly obvious for the longhorn beetles (Cerambycidae), three-horned and rhinocerous beetles (Scarabaeidae), stag beetles (Lucanidae), as well as click beetles (Elateridae).

Nothing else can be said about the other insect groups due to their small numbers in the samples.

4.0 OVERALL SAMPLES

This 6-month study yielded 6,176 individuals with 1,050 sorted species from 56 families out of 8 insect orders. The data are summarised in Appendix 1. The specimens are lodged in the Entomology Unit of the Sarawak Forest Research Centre in Kuching.

5.0 RECOMMENDATIONS

Based on the above results, the following are recommended:

(i) The Rajah Brooke's Birdwing butterfly is unusually abundant in the Ulu Katibas area (Sungai Joh, Sungai Kilimau). This most gorgeous of butterflies is getting rare in other parts of Borneo. The LEWS management can do well to extend the protected area to the region in the immediate north, to ensure that the population of the butterfly is maintained at a viable level.

(ii) The area in the upper reaches of Sungai Jela is comparatively rich in endemic butterflies and dragonflies/damselflies, which are not found in disturbed habitats. Further sampling should be conducted in the area to catalogue these two groups more fully for conservation purposes;

(iii) Traditional shifting cultivation practised by villagers in the buffer zone of LEWS does not seem to be harmful to forest regeneration as indicated by the moths sampled over a brief period. More work ought to be done on the effects of swidden;

(iv) The termite fauna in the Ubah Ribu area has numerous species which are taxonomically fascinating. More work could be done;

(v) Bees may not be the major pollinators in the LEWS forest. Pollinators research to coincide with the mast-flowering of dipterocarps in the area should be conducted with the aid of tree towers and canopy walkways;

(vi) More biological information on the insects in LEWS has to be assembled, particularly on the life histories of the species, not only in relation to the commercially important timber species, but also other flora including understorey herbaceous vegetation, lower plants, climbers, etc. Only then can we have a better understanding of the intricate relations between the insect communities and the various forest types and ecosystems.

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Appendix 1 Total numbers of insect individuals and sorted species in LEWS Project Phase II.

Group	**LEWS (Individuals)**	**LEWS (Species)**	**BORNEO (Species)**
Moths (Lepidoptera)	3,185	787	3,429
Butterflies (Lepidoptera)	450	104	910
Dragonflies/Damselflies (Odonata)	256	25	259
Bees (Hymenoptera: Apidae)	760	10	34
Termites (Isoptera)	139	40	103 (Sabah)
Beetles (Coleoptera)	74	40	
Cicadas (Homoptera: Cicadidae)	36	12	73
Other Homoptera	2	2	
Hemiptera	3	3	
Orthoptera *sensu lato*	22	22	
Other Hymenoptera	9	5	
Micromoths (Lepidoptera), unsorted	1,240		
Total	**6,176**	**1,050**	

DISCUSSIONS

Dr. Soepadmo

I do not quite agree with the statement that bees may not be the major pollinators in the forest of LEWS because studies elsewhere indicated that insects such as butterflies, bees, etc. are important pollinators of forest trees. I am also concerned that the *Trigona* bees are scavengers. I would like to urge the author to examine the few groups of insects in more detailed not only in the internal species diversity but also the roles they may play in the forest ecology.

Dr. Chey Vun Khen

What I meant in the paper is that bees in LEWS may not be the major pollinators of the canopy in the forest. We trapped them in the understorey of the forest but we could not get many bees. Instead we found the bees were attracted to rubbish heaps. The stingless bees however tended to visit the base of the leaves which have been sprayed with diluted honey. They did not visit flowers at that time. As I said it is not conclusive because we have not examined the forest canopy in the absence of canopy walkways or tree towers.

Ivy Wong

How much of the biology and the life cycle of Rajah Brooke butterflies are known? Can the Rajah Brooke butterflies products be used to help the local communities? Should the trees that the butterflies depend on be protected?

Dr. Chey Vun Khen

I have seen souvenir shops selling Rajah Brooke butterflies for RM100.00 per specimen. But the point is not to collect them for sale. You can do that in a butterfly farm. The caterpillars of the Rajah Brooke butterfly feed on the leaves of *Aristolochia* vines. Seeing the butterfly in a farm is not quite the same as seeing it in the wild. Areas including Sungai Joh have been designated as Special Protection Zones for insects, which means that the *Aristolochia* vines would be protected.

Chung Kueh Shin

Is leech an insect or herpetofauna? How many species of leeches are found in Sarawak? What is its use in medical science?

Dr. Chey Vun Khen

I would not know how many species of leeches are found in Sarawak. What I have known is that some surgeons use leeches to stop blood clotting.

Dr. Charles Leh

Leeches belong to the family of Hiruginae. There may be more than five species in Sarawak. Some people have collected leeches from Borneo and brought to England for culture for medical science. We do not know what's the progress. There is a potential for anti coagulant chemical. Leech is definitely not an insect.

Dr. Nengah Wirawan

During the 1982 – 83 fire in Kalimantan, I have noticed a big explosion of butterflies and moths. Can forest fire induce the population explosion of butterflies and moths?

Dr. Chey

What I know is that there are some butterflies which are migratory. These species may be less vulnerable to forest fire and they migrate to other safer heaven when there is a forest fire. Usually they will fly in swarm from place to place in search of habitats. I am not quite certain in the case of moths. I do not usually see many species of moths on one particular host tree such as *Melastoma*. They usually occur in swarm of the same species, but rarely of different species.

Patrick Andau

I notice that the issue of poaching was not discussed among the five papers. Do you have problems on poaching and how do you enforce the rules and regulations?

Sapuan Ahmad

We deal with the problems of poaching in a different way. We appoint the Tuai Rumah and community leaders as Honorary Wildlife Rangers. They are empowered to enforce the Wildlife Rules and Regulations in their own areas. In the town, we have the District Councillors as Honorary Wildlife Rangers. We will be appointing the logging camp managers as Honorary Wildlife Rangers to do the same enforcement duties in the logging areas. We hope such an arrangement will assist the Department in law enforcement as we have too few Wildlife Officers to be spread all over Sarawak to make enforcement effective.

Patrick Andau

Do you set up stations or substations in the areas?

Sapuan Ahmad

We are submitting our proposals for a number of research stations under the 8th Malaysian Plan (Year 2001 – 2005). These research stations will be used for monitoring the wildlife population. We will also be training the local people on wildlife monitoring and other related activities. Such training will benefit the local people. We will also establish the Special Wildlife Committee which involves the local people in the management of the TPA as provided for under the Wildlife Protection Ordinance, 1998. This arrangement is important because the threat to wildlife conservation is the people themselves.

WORKSHOP SESSION III

COMMUNITY RELATED ACTIVITIES

CHAIRMAN : DR. NENGAH WIRAWAN

RAPPORTEURS : MR. JULAIHI ABDULLAH
MS. IVY WONG

Hunting Practices and the Status of Wild Game Species at the Periphery of Lanjak Entimau Wildlife Sanctuary

by

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Abstract

A study on the game status of wild game species in three different sites around Lanjak Entimau Wildlife Sanctuary has shown that game populations were still relatively high. The major threats to the viability of game species surrounding and within the Sanctuary was the existence of commercial wild game market around the Sanctuary. With the Wild Life Protection Ordinance 1998 coming into force putting a total ban on the sale of wildlife and wildlife products taken from the wild, population of game species such as sambar deer which were reported to be getting scarce are expected to recover. The bearded pig population is more resilient to human exploitation due to rapid breeding is also expected to increase rapidly with the enforcement of the Ordinance. It is recommended that the ban on commercial hunting be strictly enforced and entry by unauthorised person into the three sites needs to be screened at every entry point. However hunting for subsistence by people with gazetted rights should still be allowed.

1.0 INTRODUCTION

Lanjak Entimau Wildlife Sanctuary is located in a rugged area in southwestern Sarawak between 1°19' N to 1°51' N and 111° 53' E to 112° 28' E in part of Kapit, Sarikei, Sibu and Sri Amam Divisions. Lanjak Entimau Wildlife Sanctuary is primarily composed of rugged, hilly terrain ranging from about 60 to 1285 meters above sea level, and includes the headwaters of Batang Lupar and Batang Rajang. Soils within the Sanctuary are generally poor and the majority are unsuitable for any agricultural project.

With its large size and remoteness, the Sanctuary is subjected to possible encroachment including logging, shifting cultivation, illegal hunting and other resource extraction activities. Conflicts of interests between the protected area and the local communities who have settled in the neighbouring areas for generations are bound to occur. To avoid this conflict, the State Government, through its Lanjak Entimau Wildlife Sanctuary Order, 1983, formally granted the rights to thirty-five nearby longhouses to hunt, fish and to gather forest produce from designated areas in the Sanctuary for their own use.

Even though parts of the region were sparsely settled by Iban people who originally came from Kapuas in Kalmimantan during the last century, there were no permanent settlements within the boundary. This lack of human presence within Lanjak Entimau could be attributed to several factors such as its rugged topography, inaccessibility and soil infertility. However, the area has been frequented and used by local people living along the lower stretches of the Katibas, Mujok and Kanowit rivers for gathering farm produce, fishing and hunting.

Hunting is still part of the culture of many of the Ibans inhabiting the periphery of the Sanctuary. The wild meat, mainly from wild ungulate species, not only provides food as the main source of protein but can also be a regular source of cash.

2.0 STUDY SITES AND METHODS

Three sites at the periphery of the Sanctuary were selected for the study (Figure 1). Batang Ai and Ulu Katibas (Site 1 and Site 3) were chosen because they were the most densely populated areas along the Sanctuary's boundary. Shifting cultivation is the main activity especially in Ulu Katibas. Hill rice and tuber such as tapioca are cultivated. This attracts ungulates to forage in the area. Ulu Skerang and Lemanak (Site 2) is a timber licence area at the Sanctuary's periphery. The large network of logging roads make the area accessible to hunters from outside. Large human populations in these sites mean a higher demand for wild meat, thus hunting pressure would be high.

Information was gathered through field surveys, community surveys and market surveys. The field surveys were carried out by following the hunters to visit their favourite hunting spots such as salt licks. Their hunting routes were roughly plotted on a map to determine the hunting distance from their home as well as from the Sanctuary's boundary. Sighting of ungulate species and their tracks were recorded. This enabled a rough estimate on the species abundance and the impact of hunting on the Sanctuary's wildlife.

Community surveys by means of questionaires and interviews of local communities were aimed at gathering information on the economic and dietary importance of wild meat to the local communities. It enabled a rough estimation of average harvest rate of game species per month and served as an indicator of how much wildlife was affected by hunting.

Market surveys were done by means of questionnaire and interviews of hunters and canteen operators at a number of rural canteens within the study sites and at meat stalls in the town areas. The average number of game animals killed, estimated total weight and annual income derived from the trade of wild meat were calculated for each site. The price of wild meat at the time of survey was compared with that of past five to ten years. An increase in price would indicate scarcity in supply which may be due to over hunting.

3.0 FINDINGS

3.1 Field Surveys

A number of favourite hunting spots in Ulu Batang Ai (Site 1) lies within Batang Ai National Park. These are the Tanjong Assam salt lick and Penyelaong salt lick. Both salt licks are about one day's walk south of the Sanctuary's boundary. No animal was shot during the two days with the hunters. Footprints at one of the salt licks indicated that two sambar deers (*Cervus unicolor)* visited the salt lick the previous night. No wild meat was served for lunch or dinner during the trip. A number of dried bearded pig's jaws was on display on the kitchen wall of the hunting hut indicating previous kills. Most of the animals were killed at an ex-shifting cultivation plot (temuda) near their longhouse. Besides bearded pigs and sambar deers, pig-tailed macaques (*Macaca nemestrana*) and porcupines (*Hystrix brachuria*) were sometimes trapped with snares around their shifting cultivation plots. These species were considered as pests to their crops.

In Ulu Skerang (Site 2), hunting was mainly along the logging roads outside the Sanctuary. Both local hunters and hunters from towns such as Julau, Sarikei and Sibu hunted in this area. During the surveys, outside hunters in two pickup trucks were spotted in the area. According to the logging camp manager as many as ten groups of town hunters come to hunt during weekends. During a night hunting with the timber workers using a pickup truck, one sambar deer was shot. Another group of hunters who were hunting just outside the boundary of the Sanctuary killed two bearded pigs in the same night. Enjak, a local canteen operator, mentioned that when logging operations just started in the area, a hunter with a pickup truck can easily kill up to five animals on a night's trip. Nowadays a local hunter can hardly get anything and would consider himself fortunate if he could get a bearded pig out of two or three hunting trips in the area.

In Ulu Bloh (Site 3), the most preferred hunting spots by local hunters are old shifting cultivation plots just outside the Sanctuary and the riparian forest. However, during fruiting seasons the local hunters often travel up to three kilometers into the Sanctuary. Hunting in old secondary forests and along rivers are often carried out with the help of hunting dogs. With limited cartridges, trained hunting dogs are considered an important asset to most local hunters in Ulu Katibas. An experienced hunting dog can detect and locate game animal from a slow-moving boat and within a thick undergrowth. During the hunting trip with local hunters, two bearded pigs and a barking deer were seen. Preserved bearded pig meat was served for lunch at a farmhouse belonging to the one of the hunters. The meat was part of the kill made a day earlier. Most of the preserved meat was sold to a nearby canteen.

3.2 Community Surveys

Community surveys covered a total of four longhouses in Batang Ai (Site 1), two timber camps in Ulu Skerang (Site 2) and two longhouses in Ulu Katibas (Site 3). Out of a total of fifteen hunters from the four longhouses in Batang Ai, seven were active hunters. In Ulu Katibas, six of the twelve hunters surveyed were active hunters. The actual number of hunters in Ulu Skerang is not known but it is expected to far exceed those of Batang Ai and Ulu Katibas. Three active local hunters in Ulu Skerang are the main suppliers of wild meat to the two canteens at the timber camp.

No detailed information was collected regarding hunters from outside. It was reported that much of the hunting in Ulu Skerang was done by outside hunters using pickup trucks equipped with freezers. It was also not unusual for these hunters to harvest two or three ungulates per night during the fruiting season (Enjak, pers. comm.). Wild meat was sold to canteens in the timber camps and to towns such as Julau, Sarikei and Sibu.

Bearded pigs were hunted more than deer. On average ten pigs were killed per month by hunters from four longhouses in Batang Ai. The last two longhouses in Ulu Katibas recorded a slightly higher harvest of 12 pigs per month. The rate of harvest was highest in Ulu Skerang, averaging 20 pigs per month. This does not include the number hunted by outside hunters from towns (Table 1).

Table 1 Community Survey: Number of hunters and average number of ungulates killed per month.

Site	No. of long houses or camps	No. of Adult	No. of Hunters	Active Hunters	Bearded pig	Sambar Deer	Others
1	4	62	15	7	10	2	10
2	2 camps	70	20	3	20	4	25
3	2	60	12	6	12	1	11
Total	*8*	*192*	*47**	*16**	*42**	*7**	*46*

*: The figures do not include that of the outside hunters from the town.

3.3 Market Surveys

'Tamu' (meat market) at Lubok Antu town received a regular supply of wild meat from Batang Ai selling at an average price of RM9.00 per kg. The price of wild meat was similar in the 'tamu' in Pakan and Julau, both received their supply from Ulu Skerang. In Song (Site 3), the price of wild pigs range from RM8.00 to RM10.00 per kg. The price of wild meat is slightly lower in the interior canteens with an average of RM6.00 per kg in Ulu Skerang and RM 4.00 per kg in Ulu Katibas. The different in price in the interior market as compared to the town markets attracts some of the local hunters to sell their catch in towns thus creating a regular supply.

The price of wild meat has remained quite stable for the last five years within these areas (Table 2). Despite the irregular supply of deer meat, the price was similar to that of wild boar meat. Salted meat was mainly sold in Julau, Song and Kanowit at a relatively lower price.

Table 2 Market survey on price of wild meat

		Locality		
Locality	**Supply**	**Avg. price/kg (RM)**	**Origin**	**Supplying Sites**
Lubok Antu	Regular (daily)	9.00	Batang Ai	Site 1
Julau/Pakan	Regular	9.00	Skerang	Site 2
Sarikei	Irregular	10.00	Skerang/Lemanak	Site 2
Sepantu Camp	Regular	6.00	Skerang	Site 2
Song	Regular	8.00	Katibas	Site 3
Kanowit	Regular	8.00	Katibas	Site 3

3.4 Estimated Economic Returns from Sale of Wild Meat.

The sale of wild meat especially that of wild pigs in areas surrounding the Sanctuary covering Batang Ai, Ulu Skerang and Ulu Katibas generated an estimated annual income of RM126,680 to the local people. The estimated economic value of wildlife meat harvested by outside hunters in Ulu Skerang was not available (Table 3).

Table 3 Estimated annual economic value of wild meat (wild boar) earned by **hunters and canteen operators in the three selected Sites.**

Site	Average Kill/year	Estimated Dressed Weight (kg)	Estimated Total Value (RM/year)	Remarks
1	90	2,460	18,905.00*	*: total earned by local hunters through direct sales
2	114	3,940**	18,997.50✓	**:total weight of meat purchased by canteen operators ✓ :total profit.
3	699	16,330**	88,777.50✓	**:total weight purchased by 3 canteen operators. ✓ :total profit
Grand Total	*933*	*22,730*	*126,680.00*	–

3.5 Response by Local Hunters to the Ban on Trade in Wild Meat

The Wild Life Protection Ordinance 1998 puts a total ban on sale of wildlife and wildlife products taken from the wild. The law however does not stop local people from hunting non-protected species for their own consumption. The active and regular hunters who earn their major income from sale of wild meat were interviewed. Of the 21 regular hunters interviewed, nine (43%) disagreed with the total ban while 14% agreed with the ban provided there were alternative means of income. Another 14% agreed with a seasonal ban on sale. Only 5% agreed with the total ban (Table 4).

Table 4. Summary of feedback by local communities/hunters from the three study sites on the current ban on sale of wild meat

Feedback	Percentage
Agreed with total ban on sale of wild boar meat with alternatives	14.29%
Disagreed with total ban on sale of all kinds of wild meat even with alternatives	23.81%
Agreed with partial ban on sale of wild meat with alternatives	14.29%
Disagreed with total ban on sale of wild boar meat even with given alternatives	42.86%

4.0 DISCUSSION

Bearded pigs reach sexual maturity at the age of ten months to one year and reproduce up to twice a year. Reproduction can be explosive when food supplies are adequate (Caldecott, 1988). A single mature female wild boar could easily produce up to eleven piglets per year (Barrett and Spitz, 1991). As such the high litter size and reproductive rate of the species could mitigate individual mortality from continuous hunting. If hunting is prohibited, the drastic increase in wild boar population might become pests to crops in the areas.

The situation is different for sambar deer that have smaller litter sizes. A mature female can only reproduce once a year with only one litter. As such, excessive hunting at salt licks could deplete deer populations to an endangered level. It is fortunate that hunting of deer and other smaller species are often incidental and considered as secondary compared to that of bearded pigs which most hunting dogs are specially trained to hunt.

The trend of rural youths leaving their longhouses to take up wage employment in urban centres is expected to continue. This means that the number of hunters in these areas are likely to decline.

The existence of local canteens supplying wild meat to nearby markets such as Song, Kanowit, Kapit and Sibu is a long-term threat to the wildlife populations in Lanjak Entimau Wildlife Sanctuary. With the ban on trade of wildlife coming into force in October 1998, supply of wild meat to the towns is reduced. Without the existence of these wild meat markets, hunting for subsistence alone is not a threat to the Sanctuary's ungulate populations. Game management specialists suggest that reproduction in game species are actually stimulated by harvesting (Stuebing, 1994). Because of their destructive behaviour to crops and in cultivated areas, it is impossible to make a plea for its protection. This was another factor why the species was hunted more than other wild ungulates. Hunting for subsistence in "temuda" areas has the dual function of providing food and reducing crop pests. Further studies needs to be done to assess damage on crop by game species.

4.1 Batang Ai (Site 1)

The main hunting spots in Batang Ai (Site 1) were concentrated around salt licks about a day's walk south of the Sanctuary. Tracks and signs indicated abundance of game animals. This was supported by regular supply of wild meat to meat market in nearby towns. The number of wild pig jaws displayed by one of the hunter showed that at least ten animals were killed by one hunter in the past two years. This is consistent with the estimated number of wild pigs killed per month by hunters from four longhouses within Batang Ai.

The present rate of hunting does not threaten the ungulate populations in the Sanctuary itself as most of the favourite hunting spots are located outside. With the establishment of Ranger's Stations at strategic entry points of Nanga Delok and Nanga Lubang Baya, poaching by hunters without gazzetted rights can be controlled. Hunting for subsistence by the local hunters with gazetted rights should be allowed to continue in areas outside the one kilometers radius from the salt licks.

4.2 Ulu Skerang (Site 2)

In Ulu Skerang, a different hunting pattern is observed within logging areas with a network of logging roads right to the Sanctuary's boundary. The abundance of young leaves, shoots and tubers like tapioca by the road side and in the 'temuda' were the main attractions to ungulates. Hunting along these roads were frequently done by timber workers, local residents and people from towns such as Julau, Pakan, Sarikei and Sibu. Hunting for subsistence did not seem to cause the bearded pig population to decline greatly. A rough estimate of game animals harvested by local hunters suggested that the stocks were presently not badly threatened. The existence of wild meat markets at Julau, Sarikei and Pakan promote hunting in the area. Continuous hunting by outsiders who usually came in landcruisers equipped with freezers was the cause of complaints by local residents (Enjak, pers. comm.). A marked decrease in the number of animals caught per hunting trip in the last five to six years indicated that the commercial hunting was not sustainable. The decrease in wildlife populations within the area forces hunting into the Sanctuary.

4.3 Ulu Katibas (Site 3)

In Ulu Katibas, huntings were not confined to areas outside the Sanctuary, but also along riverine areas and 'temuda' within the Sanctuary. The number of fresh footprints of bearded pigs in the area and the harvest rate per month indicated that the species was still abundant. A hunter could easily hunt bearded pigs along river banks from his boat with the assistance of trained hunting dogs. 'Temuda' within the Sanctuary was another favourite hunting spot. As bearded pigs are resilient to small scale hunting for subsistence; hunting within a limited area of the Sanctuary should be sustainable. Without any proper control, however, this level of hunting is detrimental to any other ungulates such as sambar deer with small litter size.

4.4 Attitude of Local Communities toward Conservation

Residents of Nanga Jengin in Batang Ai and those in Ulu Kanowit expressed their interest to have the Sanctuary extended to their respective areas. They hope that with the extension, possible encroachment by outsiders into their areas would be controlled or reduced. This positive change in attitude of local people towards the establishment of the Sanctuary is an indication of their acceptance on the prime objective (conservation) of setting up the Sanctuary.

In conclusion, in view of the continuing demand for wild meat, certain conservation measures should be enforced although the overall level of subsistence hunting is probably still sustainable for bearded pigs. These measures include enforcing the ban on sale of wild meat, prohibition of commercial hunting in timber concession areas, and enforcing the no-hunting rule by non-privileged hunters in the Sanctuary. Hunting even by people with rights should be limited to non-protected species and as much as possible on bearded pigs. In addition, the Sanctuary should be extended. Hunters' income derived from sale of wild meat could possibly be replaced by introducing some development projects that could generate some kind of income.

5.0 RECOMMENDATIONS FOR WILDLIFE MANAGEMENT AT THE PERIPHERY OF LANJAK ENTIMAU WILDLIFE SANCTUARY

5.1 Batang Ai (Site 1)

Much of Ulu Ai and Ulu Engkari are inside Batang Ai National Park. Stringent control on any access into the Sanctuary could easily be done from entry points within the park, specifically Nanga Delok and Nanga Lubang Baya Rangers Stations. It is recommended that:

(i) entry be strictly controlled from Lubang Baya and Ng. Delok Rangers Stations, and from Ulu Engkari Rangers Station at Ng. Segrak;

(ii) more frequent patrolling should be done by enforcement staff in the area, including spot checks at every potential exit for wild meat enroute to the market in Lubok Antu;

(iii) entry by local residents with privileges and rights, either into the Park or the Sanctuary should be recorded to ensure that no abuse of privileges occurs. (A number of cases occurred in the past whereby local residents took friends from other places to hunt and fish within the Park);

(iv) strictly no hunting should be allowed within salt licks even by people with gazetted privileges. This is to avoid killing of excessive number of wild animals attracted to the minerals in the area.

5.2 Ulu Skerang (Site 2)

Ulu Skerang mainly comprise the logging areas, so wildlife management should be addressed in a slightly different way. It is recommended that:

(i) check points be put at every entrance into the concession area. The check points should be manned by enforcement staff on a rotation basis. People and their vehicles going in and coming out of the area should be checked, and entry by those without privileges in the area should be denied. Part of this task should be shouldered by the logging company operating within the area;

(ii) logging workers must not hunt in licensed areas, so no guns should be allowed in licensed areas. Selective logging itself does not generally drive animals such as bearded pigs and deer to extinction. The depletion of wildlife in most logging areas are mainly due to excessive commercial and sport hunting;

(iii) frequent surprise checks on the sale of wild meat should be made by enforcement staff at logging camps. The logging companies that break these rules and regulations should have the licences withdrawn immediately;

(iv) extensive education programmes in wildlife conservation should be conducted at logging camps. This should include training in wildlife laws and regulations for all Forest Guards who are due to be based in logging camps;

(v) no clearing should be done within a radius of one km from the salt licks or mud volcanoes where wild animals usually congregate for minerals, even if these sites are located within the concession areas. In addition, patches of forest connecting these so-called 'Salt Licks or Mud Volcano Reserves' to the boundary of Lanjak Entimau Wildlife Sanctuary should also be maintained as corridors for wildlife;

(vi) the Sanctuary's boundary must be clearly marked and maintained to avoid possible encroachment. Infringements of this rule should be dealt with strictly;

(vii) at least one kilometer of buffer zone should be established outside the boundary of the Sanctuary. Logging operations and shifting cultivation should be prohibited within this zone even if it is within the permanent forest estate area. Protection of buffer zone adjoining the Sanctuary should be made a condition in the Permit to Enter Coupe wherever applicable.

5.3 Ulu Katibas (Site 3)

Ulu Katibas consists of mainly rugged terrain. The Sanctuary's boundary was extended down into local community's 'temuda'. Residents from several longhouses in Ulu Katibas are given the privileges not only to hunt but also to farm beyond certain distance from the boundary into the Sanctuary. Wildlife management within the area should be properly tailored to be compatible both with the Government's objective of wildlife conservation as well as the needs of local communities. As such, it is recommended that;

(i) hunting using dogs in 'temuda' within the Sanctuary should still be allowed, partly to protect their crops. As dogs mainly hunt bearded pigs, they are not detrimental to other species of wildlife;

(ii) setting of traps and snares are to be confined within the 'temuda' areas and not beyond that into the Santuary. This method of hunting is just another way to control crop pests;

(iii) hunting from boats along rivers should still be allowed as it only affects a limited area;

(iv) more frequent surprise checks on illegal sale of wild meat should be made by enforcement staff in towns like Song, Kanowit and Sibu. Offenders should be dealt with accordingly;

(v) the checking point at Nanga Bloh should play its roles more effectively by recording all entry into the Sanctuary. People coming out from the Sanctuary should also recorded in the same manner. Entry of people without gazetted right into the Sanctuary should be denied, and their equipment and catch seized for legal action;

(vi) Lanjak Entimau Wildlife Sanctuary should be extended. This is to have a larger area for wildlife conservation or rather as a buffer to the Sanctuary itself. By having larger area means increasing the overall sustainability of hunting for local residents.

5.4 General Recommendations

(i) A joint committee should be established between local people with gazetted rights and staff from Forest Department to manage the Sanctuary. This would give local and privileged people the benefit in stopping outsiders from encroaching into or hunting in their gazetted areas. It will also help the Forest Department to protect and manage the Sanctuary. Lodging charges paid by researchers staying in the stations should go directly to the joint-committee. This is possible under Section 9 of the Wildlife Protection Ordinance, 1998;

(ii) In order to reduce demand for wild meat, the relevant authorities should introduce and legalise farming of some local wildlife species with subsidy as an alternative source of protein and income. This move should be initiated by the relevant authorities in the form of co-operatives involving local communities. Benefit derived from sales of the animals from the farms should be equally shared by its members. This is just one of the examples of eco-development project that could benefit local communities;

(iii) An extensive education programme on wildlife conservation should be conducted among the local communities of the area. This programme should be conducted by the Education Extension Unit of the Forest Department;

(iv) Further research should be done in the area to determine the current status of wildlife abundance, reproductive rate of hunted species such as deer and rate of damage to crops by the animals. This is essential for further recommendations of management of game species;

(v) Frequent boundary cleaning should be done together with local residents in all three sites;

(vi) More Ranger Posts should be constructed and permanently manned for more effective enforcement in the Sanctuary;

(vii) Revision of the current Wild Life Protection Ordinance and Master Plan for Wildlife in Sarawak should be done every 5 years. This is because some game species will become pests to crops especially when they are over populated;

(viii) The Sanctuary should be extended to include all the three study sites as requested by a number of local residents of the area. This is partially to safeguard the gazetted rights of local people from being exploited by hunters from outside and also to ensure sustainable supply of wild meat to them.

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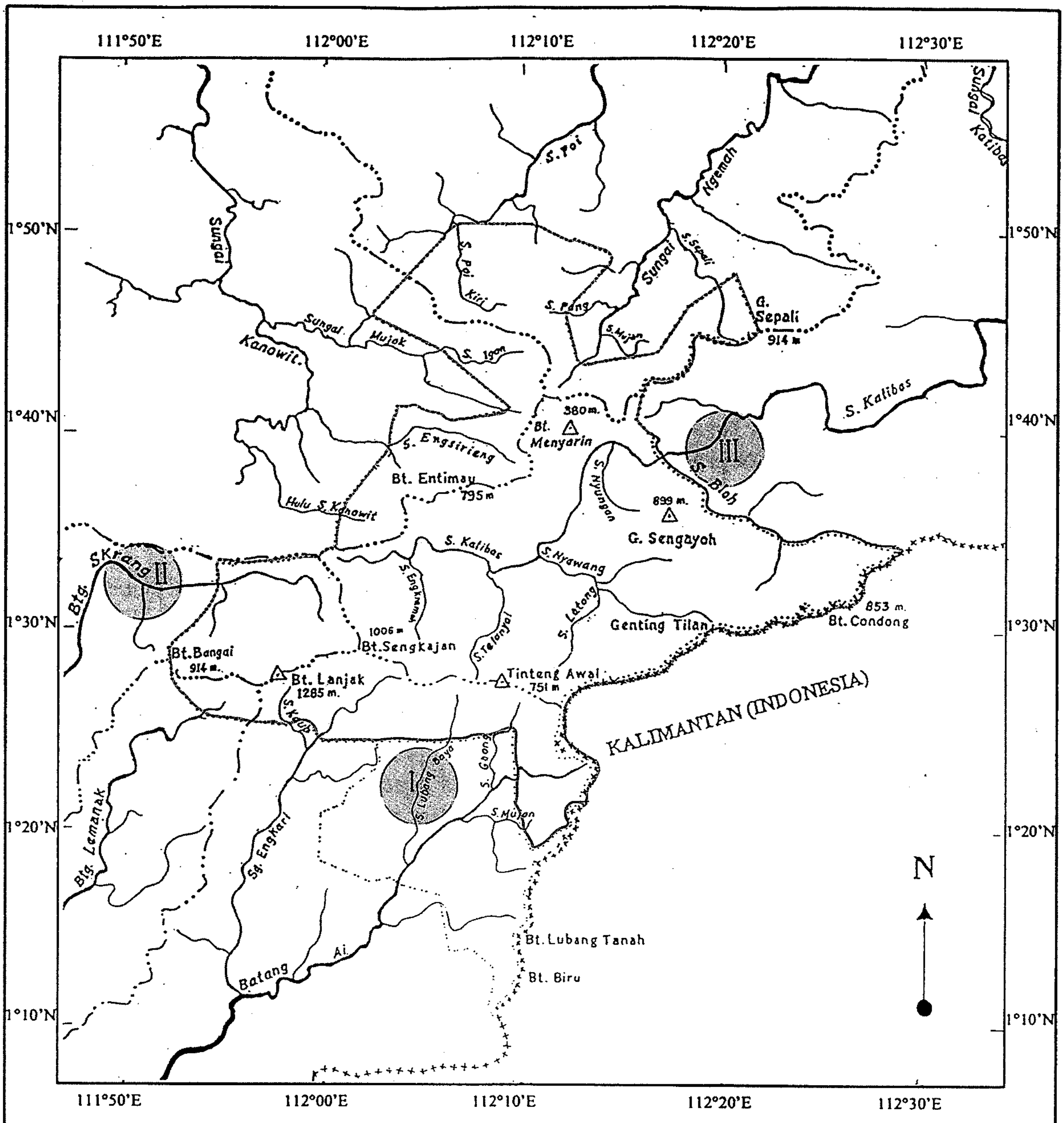

Figure 1 : THE THREE STUDY SITES FOR GAME MANAGEMENT IN THE PERIPHERY OF LEWS

0 20 KM

Scale 1 : 625,000

Legend

Lanjak Entimau Wildlife Sanctuary..

Batang Ai National Park................

Favourite Hunting Site.................

International boundary.................

DISCUSSIONS

Dr. Lim Meng Tsai

Did you include in the study the population size, the reproduction rates and the harvesting rates of these animals.

Engkamat Lading

The study did not include the population estimate of wild boar and sambar deer. I would recommend a study on the population of wild game species in future may be under Phase III.

Ernest Chai

Have you compared the individual's income derived through shifting cultivation and hunting of wild game and the number of individuals involved in these activities.

Engkamat Lading

Hunting of wild game is done throughout the year. Among the shifting cultivators some are regular hunters. Regular hunters are those who earn their living through the sale of wild meat. This was done before the enforcement on the ban of sale of wild meat. The present study did not include the income derived through hill padi planting activities.

Jayl Langub

Is sharing of wild meat still commonly practised in the longhouses?

Engkamat Lading

Yes.

Dr. Nengah Wirawan

If sharing of wild meat is still practised, that means the number of animals killed will be much higher as the meat that is consumed in the longhouses is not be reflected in Table 3.

Engkamat Lading

The estimate presented in this paper on the number of animals killed and sold is based on the market surveys. It would be less than the actual number of animals killed.

Dr. Lim Meng Tsai

Wild boar migration is quite well known in Sarawak. Does LEWS play a role in this phenomenon and how significant is it?

Engkamat Lading

I would not be able to say how significant is the wild boar migration within LEWS. According to the local communities there are abundant wild boar during a certain season of the year. Sometimes they become pests to the crops. They probably migrate from other places to LEWS during that season.

Dr. Lim Meng Tsai

Do they go into or come out of the Sanctuary?

Engkamat Lading

They come out of the Sanctuary during the fruiting seasons. The local communities informed us that there are more wild boars in the Sanctuary than in the periphery.

Nor Rashidah Hashim

You mentioned that wild boars or deers would be pests to crops if they were over populated. Would you allow hunting to reduce their population from the Sanctuary management point of view?

Engkamat Lading

The local communities are allowed to hunt wild game for own consumption within the periphery of LEWS and within the designated areas inside the Sanctuary. They have the rights and privilege as specified in the gazette notification.

Nor Rashidah Hashim

Is there any hunting on primates?

Engkamat Lading

The study is confined to wild boars and deers only as the meat is the most common wild meat sold in towns. We did not do a survey on hunting of primates. If primates were hunted, they were for own consumption.

Dr. Charles Leh

The local communities sometimes would hunt the monkeys or leaf langurs for the bezoar stones. They normally hunt these animals at the salt licks in LEWS.

Fish Management Study

by
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Department of Agriculture, Tarat

Abstract

Fish is undoubtedly one of the most important components of the biodiversity in LEWS. It is of great significance to LEWS, the peripheral communities and to Sarawak. In further developing the LEWS as a TPA, the fish resources deserve proper attention with respect to management and protection to sustain the resources.

The pilot fish rearing project has created further interest among the communities in the culture of indigenous fish for food and side income. Extending such project to the other areas should be considered.

There has been a decline in the abundance of the much favoured fish species especially semah, empurau and tengadak by 50 to 100%. Some of the tributaries inside the Sanctuary still have semah and empurau population. With the decline in the popular species, the minor species are now the subject of exploitation.

Uncontrolled fishing activities could adversely affect the natural fish stocks. Fishing inside the core zone should be totally banned while that within the buffer zone should be stringently regulated and monitored. The rivers Joh, Jenuah and Takai and their watershed areas should be accorded special protection status to safeguard the fish therein, particularly the Tor species.

The pristine environment of the Sanctuary should be maintained to ensure the ecological balance of the area. Conservation education, strict enforcement of the rules, regular surveillance and monitoring and further studies on the fish resources should be carried out.

1.0 INTRODUCTION

This paper contains extracts from the main report on the Fish Management Study which was carried out from March to September 1998. The study was undertaken during Phase II of the International Tropical Timber Organization (ITTO) project PD 15/95 Rev. 3(F) relating to Lanjak Entimau Wildlife Sanctuary (LEWS). The intention here is to present, briefly, some of the activities, important findings and recommendations from that study. The reader may refer to the main report for details.

Under the terms of reference, the study undertaken comprised two components, experimental fish rearing and assessment of the fish resources of the Lanjak Entimau Wildlife Sanctuary.

This study is part of the continuous efforts toward the development, proper utilization and sustainable management of fish resource component of LEWS. It must be stressed here that the study is by no means exhaustive. It is hoped that this paper may serve as a guideline or stimulus for further studies

2.0 RATIONALE AND OBJECTIVES

The State government has formulated a policy "to reserve permanently for the benefits of the present and future inhabitants of this country forest land suitable for the assurance of sound climatic and physical conditions of the country". It would be most unfortunate if, in view of Sarawak's size of approximately 124,450 km^2 and numerous natural water bodies, no area was set aside for legal protection of the State's natural resources, including water and aquatic life, especially fish.

Many reports have indicated LEWS as potentially the richest forest in Sarawak with its diverse flora and fauna. Initially proposed primarily to protect and sustain viable breeding population of orangutans, LEWS has since been upgraded and expanded for the *in situ* conservation of its rich biodiversity resources. Management should focus on the protection and development of these resources at all levels.

Statewide, there are increasing general complaints and expressions of worry and concern about the dwindling fish resources from the vast inland water bodies - rivers, streams and lakes. In this regard, the establishment of LEWS as a Totally Protected Area (TPA) is indeed appropriate.

3.0 BACKGROUND

3.1 Socio-economic aspects

An estimated 12,400 people of predominantly Iban community reside in the periphery of LEWS, with their 102 longhouses scattered mainly along the four major tributaries (Katibas, Skrang, Engkari and Mujok) leading to the area. Historically and traditionally, the locals have been hunting, fishing and collecting forest produce from the area so much so that they have had strong and intimate links with the area (Sidu, 1994). Conflicts of interest between the protected area and the local communities who have settled in and around the area for generations (some more that 150 years ago) are bound to occur. Development of the area as a TPA must involve development to improve the socio-economic status of the communities.

The involvement of the people, directly or indirectly, could influence the success and sustainability of projects related to the Sanctuary. These would help to minimize pressure on the area. One such project is the rearing of indigenous fish which is one component of this study.

3.3 Fisheries aspects

Among the biological components of LEWS, the fish resource is viewed as one of the most important and of more obvious and immediate significance, particularly to the natives. Fish and fishing are important aspects of their lives; fishing is more than just a pastime to most of the locals - they are still very much dependent on supply from the wild.

With declining fish resources in the immediate areas near their longhouses, there is every temptation for the locals, as well as outsiders, to encroach into the LEWS.

Under the above premises, how can the fish resources be sustainably managed for the benefits of LEWS, the surrounding communities and the State ? This is another aspect of the study.

4.0 PURPOSES OF THE STUDY

The objectives of the study were:

(i) To encourage the locals to rear indigenous fish for food and supplementary income; and

(ii) To assess the fish resources of the Sanctuary.

The overriding objective was to suggest recommendations for the sustainable development and management of the fish resources of the Sanctuary.

5.0 STUDY AREAS AND ACTIVITIES

In view of the time constraint, the study focused mainly on Katibas and Mujok areas. The upper reaches of the Engkari and Skrang rivers were visited only once due to the remote nature of the places.

5.1 Experimental fish rearing

This took the form of pilot project for which three longhouses were selected. These are:

- Rh Gerasi in Ulu Mujok;
- Rh Api in Ulu Katibas, and
- Rh Enggong in Ulu Katibas

The project was aimed at involving the participants in the culture of suitable indigenous fish for their own consumption and for sale. Priority was to culture species with high market value.

5.1.1 Rearing facilities constructed

A valley pond was constructed each for Rh Gerasi and Rh Enggong. For Rh Api, a concrete tank was set up. Construction materials such as cement, iron bars, PVC pipes, screen netting and some essential tools were supplied by the Project. The participants provided timber for the frame work, sand, gravel and labour on a co-operative (*gotong-royong*) basis.

The valley ponds of Rh Gerasi and Rh Enggong had impounded water volumes of approximately 253 m^3 and 130 m^3 respectively. Water is supplied from the small streams which run through the valley and they never dry up. The tank of Rh Api can hold about 76 m^3 of water which is supplied through the village's gravity water pipeline.

Delay in the construction of the rearing facilities seemed inevitable. This was attributed to organizational problems related to community approach and complicated by their other traditional activities including hill rice cultivation.

5.1.2 Fish stocking

Priority was to stock high value indigenous fish especially *Tor douronensis (semah), Tor tambroides (empurau)* and *Puntius schwanenfeldii (tengadak)* as well as other popular species. These were supposed to be collected from the wild by the participants themselves. The Sarawak Agriculture Department (SAD) did supply fry of *tengadak* for Rh Gerasi.

The proposed stocking rate was 9 tails/m^3 for all the projects. The ponds of Rh Gerasi and Rh Enggong could be stocked with 2,280 and 1,170 tails of fish fry or fingerlings respectively. In the case of the concrete tank, an initial number of fish that could be put in would be 680 tails (however, in this case it was recommended to stock 650 tails). The stocking composition would depend on the availability of the respective species, and preferably one third of each priority species. Overstocking was discouraged to ensure good growth rate.

5.1.3 Monitoring of growth performance and water quality

Samples of the fish stocked were to be measured for length and weight initially and at intervals. The water quality (in terms of pH, dissolved oxygen, temperature, turbidity and conductivity) were to be monitored using a digital water quality checker equipment. Recording formats were devised for the data collection. The data on fish measurements will provide indications on the performance of the indigenous fish culture under a community-based management regime.

5.1.4 Feeds and feeding

For this pilot project, it was agreed that a limited initial amount of commercial pelleted feed was supplied by ITTO. Subsequent additional feeds were to be sourced by the participants. They were also encouraged to give locally available food materials, including the natural fish food to reduce feed costs and ensure sustainability.

5.1.5 Project Committee

The participants were advised to form a committee in each longhouse to manage the project to ensure feeding, recording and security are maintained. At the time of writing the main report, only Rh Gerasi participants had formed their committee.

5.2 Assessment of fish resources

In general, fish resource assessment covers many aspects such as species composition, abundance, estimation of standing biomass, age, growth, mortality rates, fecundity, catch biomass, fishing efforts and so on (Bagenal, 1978). For this study, only a few aspects were covered in view of the time constraint.

5.2.2 Methodology

Most of the works were carried out in Ulu Katibas and Ulu Mujok. Works carried out to gather information on the existing fisheries included:

(a) Field trips
These referred to trips made to some areas within and around the Sanctuary. The purposes were to familiarize with and assess the general field conditions prior to carrying out the works.

(b) Sampling of rivers and streams
Fish sampling was carried out for selected rivers and streams only and confined to tributaries of Sg. Katibas, Sg. Bloh and Sg. Mujok. Tributaries of rivers such as Sg. Engkari, Batang Lemanak, Batang Skrang and other rivers inside the Sanctuary were not sampled in view of the time factor and the comparatively remote location of these areas.

A standard sampling method was employed for all the stations. This involved the use of two units of monofilament cast net, one with diameter of 3.5 m, height 3.5 m and mesh size of 2.54 cm (1"); and another unit of diameter 2.5 m, height 3.5 m and 1.27 cm (1/2") mesh size. One unit of electrofisher backpack (operating on a motorcycle battery of DC 12V, 10 Amp and continuous output of AC 240 V), which was on loan from Dr. Charles Leh of the Sarawak Museum, was also used for sampling work.

Sampling station size depended on the nature of the river or stream being surveyed. Where possible, at least one riffles and one pool station were sampled along each of the selected river or stream. Particularly for the pool station, it was simply not possible to fix the length as it depended very much on the existing natural size of the pool. It was therefore considered better to sample the whole length and breadth of the pool rather than sampling up to a certain length only as it could render the sampling less effective. For the riffle station another net of mesh size 1.27 cm (1/2") was used to block the lower part to minimize fish escape.

The sampling nets were cast intensively over the sampling area. The electrofisher was used mainly to fish under the stones, woods and inside the nooks and crevices of bankside rocks.

A total of 29 stations were sampled (Table 1). Fish samples caught were packed separately for different stations and marked. The samples were brought back to the camp site where they were sorted by species, counted, measured and weighed.

Table 1: Dimensions of stations sampled along selected river and streams

No.	Name of river/stream	Sampling station	Dimensions L x W (m)	Habitat type
1	Sg. Joh, Bloh	1 2 3 4	119.2 x 13 106 x 13.7 40 x 13.2 33.7 x 17	Pool area Riffles area Riffles area Deep pool
2	Sg. Buai, Bloh	1 2 3 4	28 x 13.4 50 x 11.5 40.7 x 9.5 50 x 12.6	Pool area Pool area Riffles area Riffles area
3	Sg. Jenuah, Bloh	1 2	41 x 14 35 x 12	Riffles area Pool area
4	Sg. Beguwa, Katibas	1 2 3	28.8 x 20 30 x 15 27.6 x 14.6	Pool area Pool area Riffles area
5	Sg. Nyungan, Katibas	1 2	44 x 13.5 46 x 13.5	Riffles area Pool area
6	Sg. Menyarin, Katibas	1 2	30 x 4.8 28 x 5.2	Pool area Riffles area
7	Sg. Bedawak, Katibas	1 2	50 x 13.7 60 x 18.8	Riffles area Pool area
8	Sg. Melinau, Katibas	1	10 x 8	semi-pool area
9	Sg. Takai, Katibas	1 2	12 x 27 12 x 32	Pool area Riffles area
10	Sg. Kemau, Katibas	1 2 3	34 x 16.6 29 x 11.1 23 x 9.7	Pool area Riffles area Riffles area
11	Sg. Semawang, Mujok	1 2	33 x 4.9 28 x 5.2	Pool area Riffles area
12	Sg. Spuna Ili, Mujok	1	48 x 8.1	Semi-riffles area
13	Upper Sg. Mujok	1	56 x 10.7	Riffles area
Total Sampling Stations		29	-	-

(c) Questionnaires

A total of nine longhouses were interviewed using the questionnaires. The longhouses included two in Ulu Engkari, three in Ulu katibas and four in Ulu Mujok.

(d) Informal dialogue sessions with the local people

This is considered a very useful method of obtaining additional information that may not be covered in the questionnaires. Informal talk with the longhouse residents, particularly the elders who are normally more knowledgeable, can reveal some interesting pieces of information. Consulting them with respect to their views, comments and suggestions are important towards planning and formulating management strategies for the LEWS.

6.0 FINDINGS

6.1 Pilot fish rearing project.

6.1.1 Construction and stocking

Construction of valley ponds and concrete tank for fish rearing was completed which showed the interest and organizational ability of the participants. Delays were inevitable because of the community approach. To ensure commitment to the project, stocking was to be completed by the participants by collecting fish fry or fingerlings of the various popular species from the streams or rivers. A number of tails had been collected and stocked during the study period; the SAD also supplied *tengadak* fry. They had been advised to stock in fish as soon as possible.

6.1.2 Economic potential

Rearing of high value indigenous fish species should prove to be a good alternative source of fish supply for food and cash income. The economic potential of the pilot project (Table 2) is estimated based on the SAD's results and price assumption on a recent survey.

Several assumptions were made. The mortality rate is 25 - 30 %; the average fish weight at harvest after one year of stocking is 1 kg and the ex-farm gate price is RM50.00/kg. If input costs such as construction cost (approx. RM7000.00 per pond or concrete tank), feeding costs and labour cost become available in future the net profit and Internal Rate of Return can be calculated. Considering that Rh Gerasi, Rh Api and Rh Enggong participants numbered 40, 13 and 6 households respectively, the incomes from the project per household were estimated at RM1,995.00, RM1,873.00 and RM6,825.00/annum which demonstrates that such project can contribute significantly towards the income generating capacity of the participants provided that the projects are properly managed.

Table 2 Economic potential of indigenous fish rearing pilot projects

Location and water volume	No. of fish stocked (Rate:9 tails/m^3)	Total yield (average at 1 kg/fish/year)	Estimated income/year (Ex-farm price RM50/kg)	Estimated income/household/ year
Rh Gerasi, Ulu Mujok. Valley pond 253 m^3	2,280 tails	1,596 kg (mortality rate 30%)	RM 79,800	RM 1,995
Rh Api, Ulu Katibas. Concrete tank 76 m^3	650 tails	487 kg (mortality rate 25%)	RM 24,350	RM 1,873
Rh Enggong, Ulu Katibas. Valley pond 130 m^3	1,170 tails	819 kg (mortality rate 30%)	RM 40,950	RM 6,825

6.1.3 Response of the people to the pilot project

The participants have interest in the project but there seemed to be not enough commitment to treat the project as top priority and carry out the project in a timely and proper manner. There seems to be a lack in organization and leadership. There is a need to convince the villagers on the technical possibility and financial viability of the project. In such remote locations where commercial fish feeds are expensive and difficult to obtain, locally available feed materials must be used to reduce costs and increase profitability. Also marketing must be properly organized to ensure good prices.

The idea of fish rearing is not alien to the community as some of the people already have their own ponds or concrete tanks. Other longhouses enquired if fish rearing projects could be extended to them. More villagers should be encouraged to take up indigenous fish rearing but they should also not depend on subsidy right from the beginning.

6.2 Assessment of fish resources

6.2.1 Fish species inventory

As the survey covered species of fish popularly harvested for food, only about 12 species were included out of the 82 species listed in the ITTO fish inventory report (Leh, 1998).

6.2.2 Fish abundance

One of the most significant findings is that the major popular species *empurau, tengadak* and *semah* once abundant in the river systems have decreased appreciably by 50 to100%. Even *penyau* (c.f. *Puntius schwanenfeldii*) which is similar to *tengadak*, has become very rare. The main reason for the decline in population of these species is over exploitation. Less popular species such as *kepiat (Puntius collingwoodi), kulong (Lobocheilus bo), bantak (Osteochilus* sp.) and *seluang (Rasbora* spp.) are the most common now in all the rivers.

The pristine tributaries of Sungai Bloh such as Sungai Joh and Sungai Jenuah still have *semah* and *empurau* although none of the rivers yielded *tengadak*. Sungai Takai and Sungai Beguwa, tributaries of Sungai Katibas also have abundant *semah* while Sungai Takai and Sungai Bedawak have both *semah* and *empurau*.

In Mujok, it was found that Ulu Sungai Mujok, Sungai Semawang and Sungai Spuna Ili did not yield any *semah, empurau* or *tengadak*. Sungai Juh, another tributary of Sg Mujok appears to have abundant *semah*. The commonest species in all this river system is *kepiat*, followed by *kulong* and *seluang*.

6.2.3 Species Composition

The survey showed that composition of species have changed over the years. The popular high quality species have decreased significantly in comparison with the less popular species (Table 3). The less popular species are now the targets of fishing and may follow the same fate as the other popular species if uncontrolled fishing is allowed to continue.

6.2.4 Fish Consumption

Based on the interview of nine longhouses in Ulu Katibas, Ulu Mujok and Ulu Engkari, the amount of fish consumed ranged from 2 to 15 kg/household/month (mean 6.6 kg), The highest is Rh Api in Ulu Katibas (315 kg/month) and lowest Rh Raba (42 kg/month) in Ulu Engkari (Table 4). It can be reasonably assumed that the fish consumed is also the fish caught as the amount sold for cash is minimal.

6.2.5 Fishing and Fishing Effort

Although a number of fishing methods are used, the main gear used are cast net (*jala*) and gill net (*pukat*). It can be assumed that each household has at least one each of cast net and gill net. Based on the amount consumed, the mean catch per day is assumed to be at least 500 g. There is a decline in the catch compared to 1.7 to 2.8 kg per trip (Sidu, 1994). The declining catch means that more effort is required for fishing in terms of time spent, area covered, casting frequency, petrol

Table 3 Effect of species preference on indigenous fish availability based on the interview

No.	River system	Species preference in descending order	Relative availability of species before	Relative abundance of species at present	Remarks
1	Katibas-Bloh	*Tor tambroides (empurau)* *Tor douronensis (semah)* *Puntius schwanenfeldii (tengadak)* *P. schwanenfeldii (penyau)* *Osteochilus kahajensis (palau)* *Pangasius* sp. *(buris)* *Lobocheilus bo (Kulong)* *Puntius collingwoodi (kepiat)*	*T. tambroides (empurau)* *T. douronensis (semah)* *Puntius schwanenfeldii (tengadak)* *Osphronemus gouramy (kalui)* *Pangasius* sp. *(buris)* *P. schwanenfeldii (penyau)* *Mystus* sp. *(baung)* *Macrobrachium rosenbergii (udang galah)* *Osteochilus melanopleura (padi)* *Notopterus* sp. *(belida)*	*Puntius collingwoodi (kepiat)* *Lobocheilus bo (kulong)* *Rasbora* spp. *(seluang)* *Chela oxygastroides (entebuluh)* *Puntius shwanenfeldii (penyau)* *Osteochilus* sp. *(bantak)* *Cyclocheilichthys apogon (boeng)*	All the major preferred species have greatly decreased in abundance. *Osphronemus gouramy (kalui), Notopterus* sp. *(belida) and O. melanopleura (padi)* have disappeared. Percentage decrease in relative abundance: *T. douronensis (semah)* 50 to 85 % *T. tambroides (empurau)* 60 to 90 % *P. schwanenfeldii (tengadak)* 50 to 80 % *P. schwanenfeldii (penyau)* < 50 % *Hampala macrolepidota (adong)* 40 to 50 %
2	Mujok	*Tor douronensis (semah)* *Puntius schwanenfeldii (tengadak)* *T. tambroides (empurau)* *Osphronemus gouramy (kalui)* *Osteochilus kahajensis (palau)* *Clarias* sp. *(keli)* *Macrobrachium rosenbergii (udang galah)*	*T. douronensis (semah)* *P. schwanenfeldii (tengadak)* *T. tambroides (empurau)* *O. gouramy (kalui)* *O. kahajensis (palau)* *Clarias* sp. *(keli)* *Hampala bimaculata (juak)* *Osteochilus* sp. *(bantak)* *Lobocheilus bo (kulong)* *M. rosenbergii (udang galah)* *Chela* sp. *(nyual)*	*P. collingwoodi (kepiat)* *Wallago* sp. *(langsi)* *C. apogon (boeng)* *Chela oxygastroides (entebuluh)* *Osteochilus* sp. *(bantak)* *Rasbora* spp. *(seluang)* *L. bo (kulong)* *Cyclocheilichthys reprasson (engkarak)*	*T. douronensis (semah)* abundance has gone down by 80 to 90 %; *T. tambroides (empurau)* 100 % *O. gouramy (kalui)* 100 % *Osteochilus kahajensis (palau)* 80 to 90 % *Mystus* sp. *(baung)* 30 to 50 % *Osteochilus* sp. *(bantak)* 30 to- 50 % *M. rosenbergii (udang galah)* 70 %
3	Engkari	*Tor douronensis (semah)* *T. tambroides (empurau)* *Mystus* sp. *(baung)* *Clarias* sp. *(keli)* *Lobocheilus bo (kulong)*	*T. tambroides (empurau)* *T. douronensis (semah)* *L. bo (kulong)* *Osteochilus* sp. *(bantak)* *Puntius collingwoodi (kepiat)* *Rasbora* spp. *(seluang)*	*Rasbora* spp. *(seluang)* *P. collingwoodi (kepiat)* *L. bo (kulong)* *Osteochilus* sp. *(bantak)*	Generally, the natural populations have reduced by as much as 70 %. (No mention of *P. schwanenfeldii (tengadak)* which is rarely present even in the lower Batang Ai river.

Table 4 Fishing gears and fish consumption of longhouse communities based on the survey

No.	Longhouse	Types of fishing gear	No. of meals containing fish/month	Estimated consumption (kg)	
				Household/month	Longhouse/month
1	Rh. Enggong, Ulu Katibas (16 doors)	Cast net : 10 units Gill net : 30 units Hook + line : 300 units Spear gun and fish spear : few net mesh size : 1.25 to10.0 cm	10 (500g/meal)	5	80
2	Rh. Api, Ulu Katibas (21 doors)	Cast net : 32 units Gill net : 16 units Hook + line : 800 units Fish trap (*bubu*) : 8 units Spear gun and fish spear : few net mesh size : 1.25 to 12.5 cm	30 (500g/meal)	15	315
3	Rh. Ngong, Ulu Katibas (10 doors)	Cast net : 40 units Gill net : 40 units Hook + line : 1,000 units *Bubu* : 20 to 30 units net mesh size : 1.25 to 12.5 cm	8 to 10 (1 kg/meal)	8 - 10	80 - 100
4	Rh. Mengiring, Ulu Mujok (20 doors)	Cast net : 5 units Gill net : 10 units Hook + line : 100 units *Bubu* : 2 units Spear gun : 20 units net mesh size : 1.25 to 5.0 cm	4 (1kg/meal)	4	80

Table 4 (cont'd)

No.	Longhouse	Type of fishing gear		No. of meals containing fish/month	Estimated consumption (kg)	
					Household/month	Longhouse/month
5	Rh. Gerasi, Ulu Mujok (42 doors)	Cast net Gill net Hook + line *Bubu* Spear guns net mesh size	: 15 units : 30 units ; 200 units ; 10 units : 45 units ; 1.25 to 6.25 cm	4 (500g/meal)	2	84
6	Rh. Entili, Ulu Mujok (13 doors)	Castnet Gillnet Hook + line *Bubu* Spear gun Lift net net mesh size	: 13 units : 26 units : 130 units : 8 units : 19 units : 15 units : 3.75 to 7.5 cm	8 (500g/meal)	4	52
7	Rh. Anthony Bau, Ulu Mujok (16 doors)	Cast net Gill net Hook + line Spear gun Drag net Fish basket net mesh size	: 11 units : 8 units : 150 units : 15 units : 7 units : 15 units : 2.5 to 10.0 cm	12 (750g/meal)	9	144
8	Rh. Raba, Ulu Engkari (15 doors)	Castnet Gillnet net mesh size	: 15 units : 15 units : 1.25 to 6.25 cm	4 (700g/meal)	2.8	42
9	Rh. Lenggang, Ulu Engkari (24 doors)	Cast net Gill net *Bubu* Spear guns net mesh size	: 24 units : 24 units : 24 units : 20 units : 1.25 to 5.0 cm	8 (800g/meal)	6.4	153.6

used and even fishing gears used. The mesh size ranged from 1.27 cm (1/2") to 12.7 cm (5"). In view of the marked decline of larger fish, the mesh size is reduced to the detriment of the fish population.

6.2.6 Causes of fish decline

Fish decline is due mainly to over exploitation, pollution due to forest destruction, degradation and loss of breeding grounds and illegal fishing methods.

6.2.7 Fish Prices

Only large-sized high value fish are sold for cash. The prices of various species, based on the survey, are shown in Table 5. The prices are exceptionally high for *empurau, tengadak* and *semah* highlighting the great demand and fish scarcity. It also implies that, it would be financially viable to rear these species commercially.

6.2.8 Natural Breeding Grounds.

The locals are very knowledgeable about natural spawning grounds of various fish species. Although the locals are aware that fish should be allowed to spawn to replenish the stock, yet they would not pass the opportunity of catching them during spawning when the fish are most vulnerable. The attitude seems to be that if they do not catch the fish, others will. The Sarawak Forestry Department and ITTO need to take the lead to educate the people and enforce the rules to protect the breeding grounds for fish in LEWS. Natural spawning grounds play a very important functional role in the replenishment and enhancement of river fish stocks and should be conserved (Sungan, 1995).

Table 5 Prices of indigenous fishes based on the survey

River System	Longhouse	Market price of fish (RM/kg)		Remarks
		Species	Price/kg	
Katibas	Rh Enggong	*Tor douronensis (semah)* *T. tambroides (empurau)* *Puntius schwanenfeldii (tengadak)*	RM35 RM200 RM100-200	For fish of weight > 1 kg song Market
	Rh Api	*T. douronensis (semah)* *P. schwanenfeldii (tengadak)* *T. tambroides (empurau putih)* *T. tambroides (empurau merah)* *P. schwanenfeldii (penyau)* Preserved fish *(kasam)*	RM 25 RM100 RM100 RM30 RM10 RM15	Fish of weight > 1 kg Made from various species
	Rh Ngong	*P. schwanenfeldii (tengadak)*; *T. tambroides (empurau putih)* *T. tambroides (empurau merah)* *T. douronensis (semah)*	RM30 RM120 RM20-30 RM25	
Mujok	Rh Gerasi	*Puntius schwanenfeldii (tengadak)* *Mystus* sp. *(baung)*	RM30 RM12	
	Rh Entili	*Clarias* sp. *(keli)* *Tor douronensis (semah)*	RM6 RM6	
	Rh Anthony Bau	*Wallago maculatus (tapah)* *Mystus* sp. *(baung)* *Wallago* sp. *(langsi)* *Clarias* sp. *(keli)*	RM14 RM6 RM12 RM12	
Engkari	Rh Lenggang Rh Raba	did not indicate		No mention of prices. Seldom sell fish

Additional information:

From Farmer Mr. Jarum (Rh Jempai) who has a fish farm along Sg Katibas
Selling prices by species:

Tor tambroides (empurau) = RM120.00/kg (fish size sold from 3 kg)
T. douronensis (semah) = RM30.00/kg (fish size sod from 3 kg)
Puntius schwanenfeldii (tengadak) = RM100.00/kg (fish size from 1 kg)

7.0 CONCLUSIONS

- A pilot project for the rearing of popular indigenous fish species was successfully carried out in Rh Gerasi, Rh Enggong (both valley pond) and Rh Api (concrete tank)

- Properly managed, the project can bring benefits to the participants in terms of providing additional source of fish for food and cash income, thereby improving their living standards.

- The community is interested in indigenous fish rearing for food and for cash income. To facilitate the enterprise, local stocking and feeding materials must be used and marketing need to be organized.

- The commercial species *empurau, tengadak* and *semah* population are dwindling by 50 to 100% because of over exploitation, deteriorating water quality and degradation and loss of natural breeding grounds. The most common fish now in all the river systems are the less popular species especially *kepiat, kulong* and *seluang.* They are now also becoming subject to exploitation.

- Within the Sanctuary, the fish resources are still comparatively abundant. With the resources declining in the immediate surroundings of the respective villages, there is every temptation for the peripheral communities to turn their attention to those available inside the Sanctuary, albeit strict control by the relevant authorities.

- The pristine conditions of tributaries in the upper reaches of rivers in the Sanctuary still have reasonable populations of *semah* and *empurau* but few *tengadak.* The pristine environment within the Sanctuary is crucial for the sustenance of the fish diversity and population stocks. In fact the locals admitted the overall significance of the Sanctuary; for example, its fish resources act as very useful reserve stocks to replenish fish supply down stream.

8.0 RECOMMENDATIONS FOR THE MANAGEMENT AND DEVELOPMENT OF THE FISH RESOURCES OF LEWS

- Excessive fishing pressure could adversely affect the existing fish resources. Fishing activities, especially inside the core zone of the Sanctuary should be banned totally. Within the buffer zone, fishing activities should be stringently regulated and monitored.

- In addition to the current zonation of the Sanctuary, the rivers Joh, Jenuah and Takai and their respective watershed areas should be accorded special protection status. This should include total ban on fishing to safeguard the high-value fish species especially the *Tor* spp. All natural breeding grounds should be left undisturbed.

- The existing environment within the Sanctuary, which is still comparatively pristine, should be maintained and any future development carefully planned to ensure the ecological balance of the area.

- Conservation education, strict enforcement of the rules, area surveillance and monitoring and, most of all, the staff strength of the Sarawak Forest Department as the Executing Agency should be upgraded. The Forest Ranger Stations need to be properly staffed. Community development projects such as indigenous fish rearing need to be continued and extended to the other longhouses as one way of gradually reducing pressure on the existing resources. Continuing efforts are needed to guide and advice the project participants.

- Further studies on the fish resources such as the ecology, reproductive biology and population dynamics of the important fish species, and gathering of other base-line information, should be carried out. These would enhance the development and conservation of the resources in the Sanctuary.

Management plans and actions must necessarily be multi-faceted and invariably take into account the human or social environment and the total physical environment of LEWS. Man is the greatest single threat to the environment, both directly and indirectly. As much as the surrounding communities view the TPA status of LEWS a threat (initially) to their livelihood, people are also considered a threat to the management and conservation of the Sanctuary.

Whilst all the above pose great challenges to the Implementing Agency in enforcement, political will is also required towards achieving the goal of developing LEWS for both the *in situ* conservation of its mega-biodiversity and into a totally protected area.

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DISCUSSIONS

Penguang Manggil

You said in your paper that the participants have interests in the project, but lack commitment. Could you tell us why and how you would change their attitude towards the project?

Stephen Sungan

The participants are still very much attached to their traditional way of life. Secondly it is a community project. The participants still regard their own work as priority over the community project, hence the delay in implementation. To convince the local communities that the fish-rearing project will benefit the community as a whole and to change their attitude towards accepting the project as priority over personal matters will require education. It is a long-term process and has to be done on a full time basis.

Dr. Lim Meng Tsai

We have heard all the reasons for the conservation of LEWS, highlighted the benefits from the forest wildlife resources, protein, medicinal plants, etc., but conservation education was not highlighted. I would suggest that educating the local community on the sustainable use of the biological resources be incorporated as an important aspect of socio-economic component in Phase III.

Indigenous Crop Cultivation

by
Kueh Hong Siong
Horticulturist, formerly with ITTO

Abstract

A pilot project on cultivation of indigenous crops in the vicinity of the buffer zone of the LEWS in Sarawak was carried out in 1997. It consisted of on-farm trials by 11 farm families who planted indigenous fruits, vegetables and rattan in Ulu Katibas and Ulu Mujok. Demonstration plots of indigenous fruits, vegetables and medicinal plants were also planted in Ng Bloh and Ng Ju Ranger Stations. Preliminary results showed that indigenous crops can be established successfully by farmers as shown by mortality rate of 10.1% (0 to 44%). A low input package including the use of leguminous cover crops and nitrogen fixing trees (NFTs) is recommended. Further growth and yield records shall be kept in order to provide a more accurate assessment of crop performance. A preliminary economic assessment based on available yield and price information points to the fact that the planting of indigenous fruits can significantly increase the household income at least four fold. In addition, the indigenous fruits and vegetables can be used as food to improve the nutritional status of the inhabitants. Rattan has multiple uses locally and a market also exists. More R & D need to be done before medicinal plants can be commercialised. The planting of indigenous crops will also rehabilitate degraded shifting cultivation areas, promote ex situ conservation of genetic resources and above all reduce pressure on the TPA.

1.0 INTRODUCTION

Since its inception in 1986, the International Tropical Timber Organization (ITTO) has zealously nurtured the win-win formula of promoting the tropical timber trade and the conservation of tropical forests. ITTO's appeal is that producer countries and consumer countries recognise their inter-dependence and work towards the sustainable management of tropical forests as a useful tool of development.

The Lanjak Entimau Wildlife Sanctuary (LEWS) was initially gazetted in 1983 and the Sarawak Government granted special rights to several adjacent communities to collect jungle produce from specified areas of the Sanctuary (Figure 1). In 1994, it was declared a totally protected area (TPA). LEWS contains many rare or endemic plant species. Numerous plant species abound including palms, gingers, ferns, *pandans,* pitcher plants and orchids which have diverse uses including as vegetables, medicinal plants, handicraft materials and ornamentals.

Of the more than 12,000 Iban population residing in the vicinity of the Sanctuary the majority are shifting cultivators, eking out a livelihood with household income averaging less than half of the State's official poverty line of RM495* per month. Because of this poverty, the Sanctuary remains an important source of forest produce, fish and wild game. It is clear that such a standard of living must not be allowed to continue. Steps must be taken to address this problem. The ITTO Executive Director, Dr B.C.Y. Freezailah in his opening speech at the 25th ITTC Session in 1998 described poverty as the worst form of pollution.

The zoning of the Sanctuary provides a Buffer Zone outside its boundary in which community forests or small holder agriculture can be practised (Figure 2). Hunting, fishing, farming and collection of natural forest products is permitted.

Applied research should be carried out to ensure that local stake holders should benefit from the studies as much as possible. Domestication and commercialisation of indigenous crops are foremost in the minds of ITTO's planners. ITTO's excellent policy of the win-win formula for both conservation and utilization of resources in a sustainable manner will be closely adhered to.

It has been claimed that the development of extractive reserves could contribute to alleviating the problem of rainforest destruction : non timber forest produce have the potential to become a significant source of export income for developing countries with large tracts of forest to provide a sustainable source of jobs and income to forest dwellers and to contribute to forest conservation.

Among the traditional non-timber forest produce exported from Borneo were *gaharu,* gum benjamin, rattan, edible birds nest, gutta percha, camphor, bees wax, damar resin and hornbill ivory.

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* US$1 = RM3.775

2.0 STUDY AREAS

2.1 Location

The location of the project area is as shown in Figure 2. The LEWS lies between latitudes 1° 19' N and 1° 51' N and longitudes 111° 53' E and 112° 28' E in the Kapit, Sarikei, Sibu and Sri Aman Divisions (ITTO 1996). It is contiguous with the Betung Kerihun National Park of Indonesia in the south-east and is continuous with the Batang Ai National Park along its southern boundary. It covers an area of 168,758 ha but the Buffer Zone is much smaller in area. The project areas are located in Rh Api and Rh Enggong in Ulu Katibas and Rh Gerasi and Rh Mengiring in Ulu Mujok. These are the most remote longhouses in the Sg Mujok and Sg Katibas and nearest to LEWS.

2.2 Physiography

Lanjak Entimau is rugged throughout with the most dissected terrain in the south. Elevations range from 60 m a.s.l. in the flood plains in the north to a maximum height of 1,285 m asl at the summit of Bukit Lanjak in the south-western quadrant. The hills of the north are generally of lower elevation of 700 m or less. Much of the land in the project area is steep although pockets of relatively flat land can be found.

The Sanctuary is drained by the Batang Lupar tributaries (Sungai Ai, Sungai Lemanak and Sungai Skrang) and the Batang Rajang tributaries (Sungai Katibas, Sungai Kanowit, Sungai Poi and Sungai Ngemah).

2.3 Climate

The climate is typical of equatorial regions which is hot and humid. Data obtained from stations in Ng. Tutong and Lubok Antu in the south and Ng. Ngemah in the north between 1966 and 1985 indicate an annual precipitation of 3,500 mm. The wettest months (October to January) received 300 to 350 mm while the driest months about 200 mm. During the wet period localised flash floods are common and can be severe along the rivers and limiting agricultural potential. Such areas should be avoided during site selection for the project. It is, however, anticipated that rainfall at higher elevations are probably higher than the peripheral lowlands. There is little risk of drought in the area.

2.4 Soils

The soils of Lanjak Entimau fall into three Great Groups namely Alluvial, Red Yellow Podzolic and Skeletal.

Lands within the Sanctuary considered as suitable for agriculture with variable degrees of limitation are the soils of the hilly riverine valley as well as those on low hilly to moderately dissected terrain. These are class 3 lands with minor class 2 lands. Nevertheless, these types of land occupy less than 1% in area of LEWS. About 13% are the strongly dissected lands rated as class 4 or 5. These are marginally suitable for agriculture. This leaves 86% of the Sanctuary not suitable for agriculture lying on predominantly strongly dissected terrain.

In site selection the soil capability is given due consideration as the success and sustainability of pilot project hinges on it.

2.5 Vegetation

Virtually all of the LEWS is forest covered with seven distinct vegetation formations plus old secondary forest 80 to 130 years old. There is great diversity including fruits, vegetables, medicinal plants and plants used as dyes, handicraft making and ornamentals.

2.6 Socio-economy

2.6.1 Demographic characteristics

A total of 102 longhouses comprising 1,761 households with an estimated population of 12,400 people of the Iban community reside in the periphery of the LEWS. It represents 0.6% of Sarawak's population. Women outnumber men by 54 : 46 due mainly to *bejalai* or men seeking outside work. 53% of the population are in the economically active age of 15 to 60.

2.6.2 Education and health

Only 52% of the population received education. Health facilities are limited to rural dispensaries. Malnutrition among children is common. Although most communities have gravity fed water, river water is used during droughts. 33 - 82% of the longhouses are without electricity.

2.6.3 Land tenure

Longhouse communities own an average of 20 ha of Native Customary Rights land. Less than 10% do not have land. Special privileges were given to certain communities in Ulu Ngemah, Ulu Kanowit and Ulu Katibas for collecting forest produce from gazetted areas.

2.6.4 Farming

Subsistence farming of hill rice in a shifting cultivation system is practised by 94% of the households. The satellite imageries of 1990 to 1991 estimated the total area of land affected by shifting cultivation in the State at 3 million ha. Of this area 116,121 ha.. are located within the permanent estate while 11,404 ha. are inside the TPAs (Lee 1997). These areas can be rehabilitated by fallowing, reforestation and agroforestry. Average yield of hill *padi* is 500 kg/ha. The fallow period has been reduced from 20 years to 5 years due to shortage of land. The shortened fallow period resulted in reduced yields. Income for heads of households averaging less than half of the poverty line income of RM495 per month resulted in increased pressure on the Sanctuary. About half the population did not produce sufficient rice for their own needs.

Hunting, fishing and collection of wild vegetables and fruits become important sources of food and cash income.

2.6.5 Community relations

The community is generally supportive of the preservation of the virgin areas as long as they retain some harvesting rights of the forest produce.

3.0 INDIGENOUS CROPS

3.1 Ethnobotany

Ethnobotany is defined as the relationship between people and plants especially the utilization of wild species by people. It encompasses. all aspects of traditional use including fuel, food, clothing, poisons, masticatories, narcotics and stimulants, perfumes, dyes and medicine (to name a few). Due to time constraint, the present project will be confined to some food, medicinal and handicraft uses.

3.2 R & D Status

The Sarawak Forest Department (SFD) and ITTO have commenced inventory work for medicinal plants, indigenous fruits and vegetables. Sarawak boasts one of the richest rattan floras in the world with 106 recorded species (Dransfield, 1992). The Sarawak Agriculture Department (SAD) has established collections of indigenous fruits, vegetables and medicinal plants and rattans with a view to domesticate and commercialise them. A Sarawak-Denmark collaborative programme undertook the cultivation of six popular indigenous vegetables. It concluded that cultivation of indigenous vegetables is feasible and often more attractive option than planting exotic crops for farmers with subsistence oriented production systems (Mertz 1997). The SFD is actively involved in R & D on *Calophyllum* as an anti-AIDS agent. The Sarawak Biodiversity Centre established in 1998 shall be coordinating and intensifying this work in the State.

3.3 Domestication

Domestication is bringing indigenous species to cultivation. Today, subsistence agriculture is not the aim even though food production for self-consumption remains important. Commercialisation of agriculture is the main focus in the Seventh Malaysia Plan. Crop production must be financially viable. Indigenous fruits, vegetables and rattan have great potential for commercialisation. For medicinal plants more research need to be undertaken before commercialisation can be attempted.

4.0 CULTIVATION OF INDIGENOUS CROPS

4.1 Background

Initially, two projects for cultivation of non-timber products and establishment of ethnobotanical gardens within the LEWS buffer zone are to be completed within six months of commencement. The Project Leader agreed to the suggestion to run the projects concurrently to allow more time for planting of perennial indigenous crops which took considerable time to nursery and further complicated by their seasonality.

A study carried out recently in Borneo found that keruing oil, honey, illipe nut, *jamu,* mushrooms and spices have considerable potential for markets in the United States (Dixon *et. al.* 1991). In the local context it is the health giving indigenous fruits and vegetables, medicinal plants and rattan that have the greatest potential.

The planting consisted of on-farm trials and demonstration plots.

4.2 Objectives

The community development project on indigenous crops meets the following objectives and Article I of the International Tropical Timber Agreement 1994 (ITTA):

(c) To contribute to the process of sustainable development;

(f) To promote and support research and development with a view to improving forest management and efficiency of wood utilization as well as increasing the capacity to conserve and enhance other forest values in timber producing tropical forests;

(j) To encourage members to support and develop industrial tropical timber reforestation and forest management activities as well as rehabilitation of degraded forest land, with due regard for the interests of local communities dependent on forest resources.

The specific objectives of the project are:

- To promote the cultivation of indigenous herbs, medicinal plants and non-timber products;
- To promote utilization of herbs, medicinal plants and non-timber products in order to improve the nutritional status of the inhabitants and as an alternative health care option;
- To commercialise herbs, medicinal plants and non-timber products and to generate cash income through job creation and sale of products to improve the economic well being of the inhabitants;
- To reduce pressure on the Lanjak Entimau Wildlife Sanctuary. The success of the project will significantly reduce entry for collection of forest produce by the inhabitants of the Buffer Zone. Once they enter the forest, they will also fish and hunt;
- To promote the *ex situ* conservation of the genetic resources, *and*
- To rehabilitate the areas in the Buffer Zone used for shifting cultivation to prevent further soil degradation.

4.3 On-farm trials in Ulu Katibas and Ulu Mujok

Site visits and dialogue sessions were held to select participants, crops and sites. Implementation followed by sourcing of planting materials, setting up nurseries, land clearing and preparation, planting, maintenance and data collection.

4.3.1 Selection of Participants

The on-farm trials are located at Rh Api and Rh Enggong in Ulu Katibas and Rh Gerasi and Rh Mengiring in Ulu Mujok (Figure 3). These are the most remote longhouses on these rivers and the nearest to LEWS (Table 1). They are, however, reasonably accessible being five hours by longboat to the nearest town. Other longhouses in the vicinity of LEWS Buffer Zone are less accessible often taking two or three days to reach.

Table 1 Location and population of four longhouses where on-farm trails are implemented

Name of longhouse	Locality	Distance (hrs/mins)	No of households	Total population
Rh Enggong ak Juing	Ng. Ngeranau Ulu Katibas Song District Kapit Division	7 hrs 45 min	16	142
Rh Api ak Sanun	Ng Terusak Ulu Katibas Song District Kapit Division	7 hrs.45 min	21	158
Rh Mengiring ak Masil	Lepong Bilat Ulu Mujok Julau District Sarikei Division	6 hrs 00 min	20	115
Rh Gerasi ak Kapi	Ng. Ju Ulu Mujok Julau District Sarikei Division	5 hrs 50 min	37	223

Based on the physical environment and vegetation, it can be reasonably concluded that LEWS Buffer Zone is suitable for planting of indigenous crops provided the correct agronomic practices are adopted. Although 86% of the soils are Skeletal Soils with little or no agricultural potential, Alluvial Soils in the small flood plains, levees and river banks are very suitable for vegetables, a range of fruits, medicinal plants and rattan while the less steep Red Yellow Podzolic Soils are suitable for perennial crops.

The people of the four longhouses are typical of the ITTO rural sociologist's description of a rural community of shifting cultivators who depend heavily on hill rice cultivation, fishing, hunting, food gathering and irregular off-farm work. They are receptive to suggestions as the need to increase food production and cash income is great. Above all, they are enthusiastic and co-operative. The question of whether the project should be undertaken by the community or the individual was settled by concensus. The participants in all the four longhouses preferred to do the project individually. In retrospect it appeared to be a critical success factor for the following reasons:

(i) The Ibans although living in a longhouse community are in fact very individualistic. This means that community projects will only succeed under strong leadership which may not be present in the headman;

(ii) Individual decisions are made faster than community decision by concensus. The one year period for the two projects does not allow for this;

(iii) Community land is not easily available as no one is willing to give up large areas of good agricultural land for the community. The project will likely be given unsuitable land with the accompanying problems. Individuals on the other hand would select the best land for the project to ensure success, and

(iv) In community projects, participants are not sure of ownership and share of benefits from the project. They are therefore not fully committed to the project.

The difference in community approach as against individual approach is not unlike communism and capitalism. Mertz (1997a) found that the communal approach he adopted in Marup Baroh was less successful compared to the individual approach adopted in Ng. Sumpa in an indigenous vegetable on-farm trial.

In selection of participants, leadership is important hence all the four village headmen were selected. They must have suitable land determined by site visit and must have sufficient labour to carry out the project. Although many males in the longhouses seek outside work, there is adequate labour among the men who remain behind and the women. A household with adequate labour from the participant, spouse, parents and children are ideal. Others are likely to experience labour shortage during the *padi* planting season or when they find off-farm work.

4.3.2 Site Selection

In site selection the following factors are considered:

(i) Easy access is important. All selected areas are near the river which is the most convenient mode of transportation to bring in inputs, for ease of supervision and eventually to bring out the produce.

(ii) The land must not be excessively steep.

(iii) The soil must be suitable.

(iv) The areas must not be subject to frequent flooding.

(v) The area must not be used for intercroppping of hill *padi* as the burning will damage the crops. Also the inter-row areas are needed for planting of cover crops and nitrogen fixing trees (NFTs) to add fertility to the soil and to control erosion.

Based on the above criteria, 11 households and sites were selected, seven in Ulu Katibas and four in Ulu Mujok. Details of participants and planting are as shown in Tables 2 and 3.

4.3.3 Selection of Crop Species

The indigenous fruits were selected based on their potential for domestication and commercialisation (Appendix 1). The SAD's assessments based on ad hoc market surveys, on-farm and on-station trials, quality and nutritional value was considered (Anon 1992). This was further verified by market surveys in Song, Julau, Sarikei and Kuching which determined the popularity and prices of the various fruits.

Dabai (*Canarium odontophyllum*) and *isau* (*Dimocarpus longan* var. *malesianus*) have been domesticated and are considered the most important to form the principal planting (Figure 4). Seven other indigenous fruits, *nyekak* (*Durio oblongus*), *isu* (*Durio graveolens*), *mawang* (*Mangifera pajang*), *terap* (*Artocarpus odoratissimus*), *keranji* (*Dialium indum*), *engkala* (*Litsea garciae*) and *pelajau* (*Pentaspadon motleyi*) with great commercial potential are included for verification under farmers conditions. Eight commercial fruit species of which three are non-seasonal are included in an effort to have an integrated orchard and to ensure fruit supply on a daily basis for home consumption and for sale. Wherever possible, the best available clones are planted except for seedling derived plants where local selection is done based on the mother plant.

The same applies for rattan where of the six commercial species (Appendix 2) one multiple stemmed species *rotan sega* (*Calamus caesius*) which is greatly favoured by the participants and a single stemmed *rotan manau* (*C. manan*) are planted. Seedlings of the other four species could not be obtained. The inability of Reforestation Division of SFD to supply seeds or seedlings was unforeseen.

Eleven species of indigenous vegetables were selected based on the same criteria as fruits (Appendix 3). *Petai* (*Parkia speciosa*) forms the principal planting as it has been domesticated in Peninsular Malaysia and has great commercial potential for both the local and export markets. It possesses medicinal value for treatment of hypertension and diabetes. Other indigenous or naturalised vegetables the winged bean *(Psophocarpus tetragonolobus), paku ikan (Diplezium esculentum), ensabi (Brassica juncea)* and *pegaga (Centella asiatica)* are commonly served in eating places and can be considered as semi-commercialised and commercialised. *Terong Dayak (Solanum lasiocarpum), kecala (Hornstedtia magnifica)* and *sabong (Gnetum gnemon)* have great potential for commercialisation (Figure 5).

The forests of Southeast Asia and New Guinea have given us the winged bean. With up to 42% protein, more amino acids than any other staple vegetable food, and leaves containing up to 20,000 units of vitamin A, it is no wonder the U.S. National Academy of Sciences in 1975 stated, "Of all the plants examined, the winged bean emerged as most capable of relieving protein hunger (in the Third World)". (Newman 1990). According to Wong (pers. comm. 1998), the winged bean is the tropical grain legume with the greatest commercial potential with dry grain yield of over 6,000 kg/ha. It can compete successfully against soya bean especially ratooning cultivars

Table 2 Indigenous crops planted in the on-farm trials at Ulu Katibas and Ulu Mujok

Indigenous crop	Rh Api					Rh Enggong		Rh Gerasi		Rh Mengiring		Total
	Kallang ak Melamun	Ligon ak Umpang	Belasan ak Samin	Api ak Sanun	George ak Lumeng	Jana ak Tukau	Enggong ak Juing	Gerasi ak Kapi	Jawa ak Ribut	Mengiring ak Masil	Ingkau ak Entalai	
Isau (Dimocarpus longan var. *malesianus)*	10	10	10	10	10	10	10	10	10	10	10	110
Dabai (Canarium odontophyllum)	10	10	10	10	10	10	10	10	10	10	10	110
Petai (Parkia speciosa)	10	10	10	10	10	10	10	10	10	10	10	110
Nyekak (Durio oblongus)	2	2	10			2	2	2	2	2	2	26
Engkala (Litsea garciae)	2	2	5	2		2	2			2		17
Terap (Artocarpus odoratissimus)	2	2	5	2		2	2					15
Keranji (Dialium indum)	2	2	5	2		2	2	2		2	2	21
Pelajau (Pentaspadon motleyi)	2	2	5			2	2					13
Isu (Durio graveolens)	2		2	2	2							8
Mawang (Mangifera pajang)										2	2	4
Mangga (Mangifera indica)	2		2	2	2	2		2	2	2	2	18
Durian (Durio zibethinus)	2		5	2	2	2	2	2	2		2	21
Langsat (Lansium domesticum)	2	2	2	2	2	2	2	2	2			18
Rambutan (Nephelium lappaceum)	2	2	5	2	2	2	2					17
Limau manis (Citrus reticulata)									2	2		4
Belimbing manis (Averrhoa carambola)									2	2		4
Jambu air (Syzygium aqueum)	2		2	2		2	2		2	2		14
Nanas (Ananas comosus)								120	120	120	120	480
Rotan sega (Calamus caesius)	40	40	40	40	40	40	40	40	40	40	40	440
Rotan manau (Calamus manan)	40	40	40	40	40	40	40	40	40	40	40	440
Indigenous vegetables	10 spp.	10 spp.	10 spp.	10 spp.	10 spp.	10 spp.	10 spp.		10 spp.			

Table 3 Area of indigenous crops planted in the on-farm trials at Ulu Katibas and Ulu Mujok (ha)

Indigenous crop	Participant											Total
	Kallang ak Melamun	Ligon ak Umpang	Belasan ak Samin	Api ak Sanun	George ak Lumeng	Jana ak Tukau	Enggong ak Juing	Gerasi ak Kapi	Jawa ak Ribut	Mengiring ak Masil	Ingkau ak Entalai	
Fruits	0.47	0.36	0.65	0.40	0.34	0.42	0.40	0.34	0.38	0.39	0.34	4.45
Rattan	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	2.09
Vegetables	0.04	0.04	0.04	0.04	0.04	0.04	0.04	-	0.04	-	-	0.32
Total	0.70	0.59	0.88	0.63	0.57	0.65	0.63	0.53	0.61	0.58	0.53	6.86

which significantly reduce cost of production. It can be developed into a crop of global importance.

The farmers were in general not interested in the cultivation of indigenous vegetables (except *petai*) as these were easily available in the wild and no market existed in remote locations. The introduction of plastic agricultural mulch to reduce weeding managed to encourage the farmers to plant ten species of indigenous vegetables.

The farmers had no interest whatsoever towards the cultivation of medicinal plants as modern medicines are more convenient to use. It is more problematic to commercialise medicinal plants which should adopt a long-term rather than a short-term strategy to allow time for proper research to be done. *Oldenlandia diffusa* used in a herbal drink can perhaps be commercialised if a joint venture can be forged with China and *jamu*, a traditional Indonesian herbal medicinal product likewise with Indonesia.

Fifteen species of popular vegetables and sweet corn seeds were supplied to farmers on a regular basis. In addition, pepper cuttings of two superior clones, the *Semongok Emas* and *LNK* were supplied for bulking up as farmers could not obtain them from SAD because of the remoteness of the longhouses.

4.4 Demonstration Plots in Ng Bloh and Ng Ju Ranger Stations

Forty seven species of fruits (Table 4) were planted in a demonstration plot in Ng Ju Ranger Station (see the accompany layout plan) in Ulu Mujok of which 17 are commercial species and six are non-seasonal (Figure 3). The non-seasonal fruits are included to ensure continuous yield for food and sale on a daily basis. Permanent staff are available in the station to maintain and keep records. Ten commercial species of fruits were also planted in Ng Bloh Ranger Station.

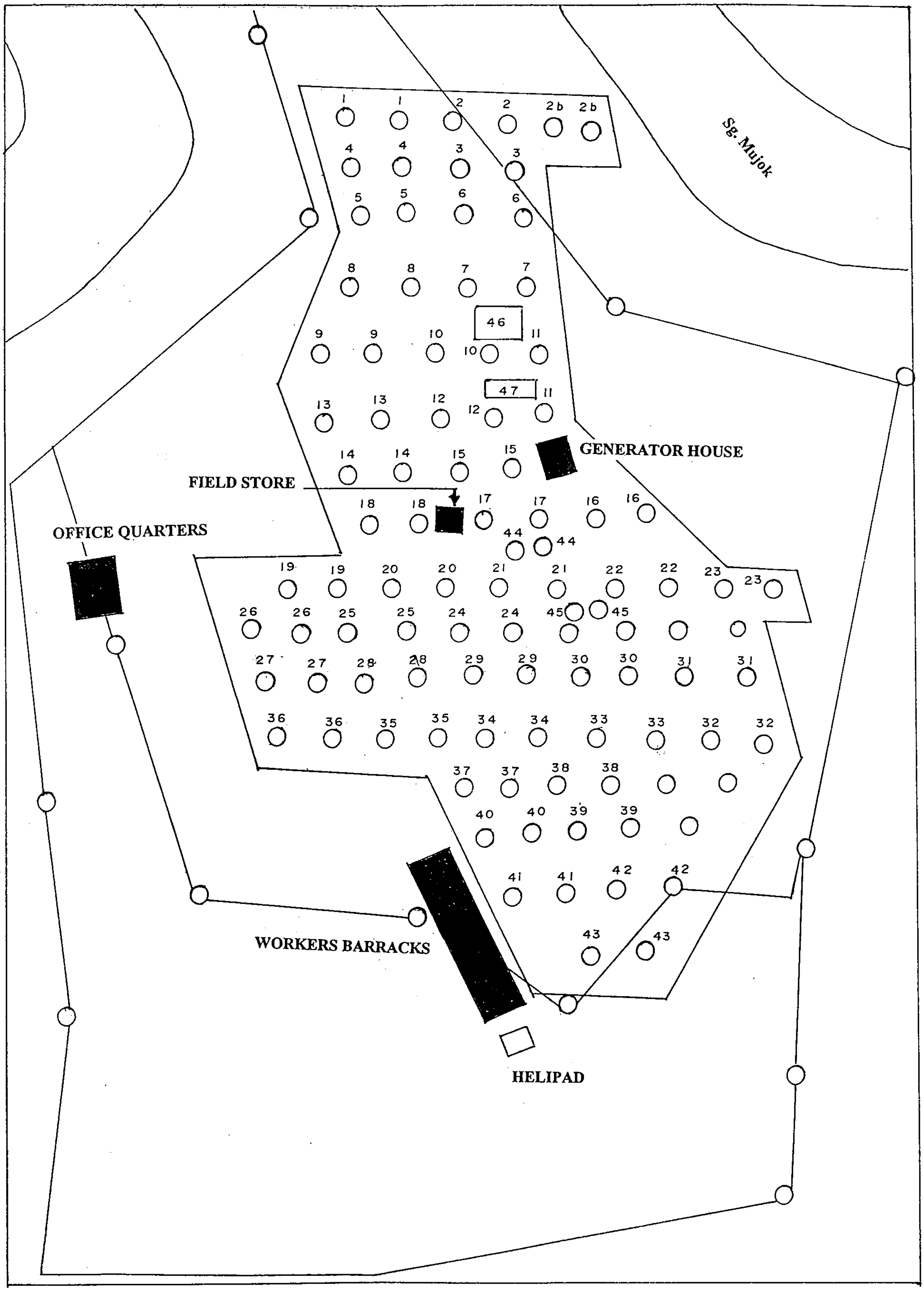
Sixteen species of indigenous vegetables were planted in Ng Bloh and Ng Ju Ranger Stations. (Appendix 3).

A demonstration plot consisting of 16 medicinal plant species (Appendix 4) with potential for domestication was successfully established in Ng Bloh Ranger Station (Figure 3) even though some damage was caused by unexpected severe flood apparently caused by the La Nina weather phenomenon. Three species of *Calophyllum* (*C. teysmannii, C. lanigerum* and *C. soulattri)* which contain the anti-AIDS compound were planted. More species would have been planted if Research Division of SFD could supply planting materials promptly.

Table 4 : List of fruits planted in Ng Ju Station demonstration plot

No.	Local name	Botanical name
1	*Petai*	*Parkia speciosa* Hassk.
2	*Dabai* (2b budded)	*Canarium odontophyllum* Miq.
3	*Isau*	*Dimocarpus longan var. malesianus* Lour.
4	*Langsat*	*Lansium domesticum* Corr.
5	*Nyekak*	*Durio oblongus* Mast.
6	*Durian kuning*	*Durio graveolens* Becc.
7	*Durian*	*Durio zibethinus* Murray
8	*Mawang*	*Mangifera pajang* Kost.
9	*Binjai*	*Mangifera caesia* Jack.
10	*Raba tekuyong*	*Mangifera grifithii* Hook f..
11	*Kejirak*	*Baccaurea* sp.
12	*Rambai*	*Baccaurea motleyana* Muell.
13	*Peris/Jelintek*	*Baccaurea hookeri* Gage
14	*Manggis*	*Garcinia mangostana* L.
15	*Rambutan*	*Nephelium lappaceum* L.
16	*Lingga merah*	*Nephelium* sp.
17	*Lingga buban*	*Nephelium* sp.
18	*Mujau*	*Nephelium maingayi* Hiern.
19	*Pulasan*	*Nephelium mutabile* Blume.
20	*Keranji*	*Dialium indum* L.
21	*Engkala*	*Litsea garciae* Vidal.
22	*Kandis*	*Garcinia nitida* Pierre
23	*Pelajau*	*Pentaspadon motleyi* Hook.f.
24	*Terap*	*Artocarpus odoratissimus* Blanco.
25	*Cempedak*	*Artocarpus chempeden* Spreng.
26	*Kembayau*	*Dacryodes rostrata f. cuspidata* Blume
27	*Merenti/Kop*	*Ostodes* sp.
28	*Kelampai*	*Elateriospermum tapos* Blume
29	*Engkilili*	*Lepisanthes alata* Blume
30	*Langgir*	*Xanthophyllum amoenum*
31	*Jiring*	*Pithecellobium jiringa* (Jack) Prain
32	*Kakus*	*Dimocarpus longan var. malesianus* Lour
33	*Nangka*	*Artocarpus heterophyllus* L.
34	*Belimbing manis*	*Averrhoea carambola* L.
35	*Jambu batu*	*Psidium guajava* L.
36	*Jambu air*	*Syzygium aqueum* Blume
37	*Limau tapah*	*Citrus grandis* L.
38	*Limau manis*	*Citrus reticulata* Blanco
39	*Mangga*	*Mangifera indica* Linn.
40	*Ciku*	*Manilkara zapota*
41	*Durian Belanda*	*Anona muricata*
42	*Puak*	*Baccaurea macrocarpa (*Miq). Muell
43	*Ucong*	*Baccaurea reticulata* Hook.f.
44	*Kubal susu*	*Willughbeia* sp.
45	*Tabau*	*Willughbeia* sp.
46	*Betik*	*Carica papaya*
47	*Nanas*	*Ananas comosus*

Layout plan of indigenous fruits demonstration plot at Ng Ju Station, Ulu Mujok



5.0 IMPLEMENTATION

5.1 Planting Materials

Planting materials of fruit trees and rattan were supplied by ITTO Kuching. Fruit tree seedlings were procured from commercial nurseries and SAD while some were collected and raised in nurseries during the fruiting season in December 1997 to February 1998. Rattan seeds and seedlings were purchased from commercial nurseries. For indigenous vegetables, most of the planting materials were collected by the farmers themselves except *terong Dayak*, winged bean, *timun Dayak* seeds and *daun tubu, bungkang, sabong* and *pegaga* plants which were supplied by ITTO Kuching. Medicinal plants were obtained from Biological Research Centre (BRC), Semengoh and collection from the wild, or purchased from the jungle produce market. Cover crop cuttings of *Arachis pintoi* and NFT cuttings of *Gliricidia sepium* and *Erythrina poeppigiana* were supplied by SAD. Work would be significantly facilitated if the Reforestation and Research Divisions of SFD could supply planting materials and rattan and medicinal plants more readily.

5.2 Land Preparation

Land clearing involving underbrushing, felling and burning was done by the farmers with nominal contract payments. Preparation of planting holes and beds was similarly done by the farmers.

5.3 Planting

All planting materials and other inputs including fertilizers, were provided and delivered to the longhouse. Planting was done by farmers on contract at a nominal rate of payment. Planting of cover crops and NFTs was done by farmers without payment.

5.4 Low Input Package

In order to ensure sustainability in remote areas, a low input cultivation system is recommended. The use of NFTs (e.g. *Gliricidia sepium* and *Erythrina poeppigiana*) is advocated as the leaf litter and prunings from the trees can be used as green manure to maintain the soil fertility. *Erythrina poeppigiana* (Walpers) originated from South America to Panama is used as ornamental, fence row, windbreak, nurse tree (coffee), pulpwood, mulch/green manure. Trees to 20 m; thorny; grows best in mesic to cool tropics (NFTA, 1987). According to Haggar *et. al.* (1993) *Erythrina* prunings can add 153 kg/ha/annum of nitrogen to the soil.

Gliricidia sepium originated from Central America/Mexico; now worldwide used as fences, firewood, shade, rat poison, ornamental, fodder of high DMD (55%). Tree to 15 m tall is easily propagated by cuttings, rapid growth suitable for dry to mesic tropics to 1,000 m a.s.l.. It is one of the most important agroforestry legumes; highly flexible in management and widely adapted (NFTA 1987). *Gliricidia* can add 84 kg/ha/annum of nitrogen to the soil (Haggar *et. al.* 1993). Tian *et. al.* (1993) gave higher figures of 180 kg/ha/annum. *Gliricidia sepium* produces high foliage yields in hot humid areas receiving 1,500 mm or more rainfall per year at elevations from sea level to 700 m a.s.l.. It coppices vigorously and tolerates regular lopping. Green leaf yield data shows that it produces about 1 to 3 t dry leaf matter per month from 10,000 trees/ha. It nodulates freely producing itrogen-rich (2.9 to 4.3%) green manure. One tonne *Gliricidia* leaf meal (dry matter) provides the following nutrients (Kang *et. al.* 1985).

Nitrogen	29 to 43 kg
Phosphorus	2.9 kg
Potassium	16 to 26 kg
Calcium	14.0 kg
Magnesium	5.4 kg

Leguminous cover crops such as *Calopogonium mucunoides* and *Pueraria phaseoloides* have been successfully used in plantation tree crops, oil palm and rubber. For fruit trees, *Arachis pintoi* is recommended as the cover crop (Figure 6). The advantage of this cover crop is that it does not climb up the fruit trees and smother them. It conserves the soil especially on steep slopes, adds organic matter in the leaf litter and fixes nitrogen symbiotically. It is one of the most persistent and promising legumes to date. In grazing experiments in the eastern plains of Colombia this legume has persisted under heavy grazing pressure for over 6 years in association with the grass *Brachiaria humidicola* and formed good association with three other *Brachiaria* species (Lascano 1994). Possible reasons for the persistence of *Arachis* spp. include a prostrate stoloniferous habit similar to white clover even though it flowers but fails to set seeds under Sarawak conditions. Furthermore *A. pintoi* is easily propagated via vegetative stolons. It is shade tolerant, rapidly re-establishes its leaf area index after defoliation and can survive relatively long dry periods even though it loses its leaves and appears desiccated. An ability to acquire aluminum-bound phosphorus from acid soils may also be a factor in the superior persistence of *A. pintoi*. All the features listed above are consistent with the legume ideotype necessary for a persistent forage legume.

According to Peoples *et. al.* (1995) the amount of nitrogen fixed by *A. pintoi* is 4 to 30 kg/ha/annum. This figure is exceptionally low and may be due to no inoculation with rhizobium in infertile acid soils. *Arachis hypogaea* was reported to fix 37 to 206 kg/ha/annum (Peoples *et. al.* 1995).

5.5 Maintenance

Maintenance is done by farmers without payment as their contribution towards the project and to demonstrate their commitment to the project. Weedicides are provided for weeding to facilitate establishment of cover crops. Pesticides are provided as and when required, to keep pests and diseases under check. Fertililzers are applied according to schedule.

5.6 Recording

Records are kept on crop performance soon after planting. Plant height was recorded to establish a data base for subsequent growth rate assessment. At the same time mortality rate was recorded. Dead points were gap filled. Plant height recording was done every six months. When plants reached heights that became inconvenient to measure, girth records are kept. Subsequently data of first flowering and fruiting, yield and quality assessment will be carried out.

The National Park and Wildlife Division of SFD provided excellent support including Forest Guards and Forest Rangers from Headquarters and Ng. Ju Station who were involved in all aspects of the work. It is suggested that a permanent staff be posted to Ng. Bloh Station to assist in implementation, monitoring and enforcement work.

6.0 TRANSFER OF TECHNOLOGY

In order to ensure sustainability, transfer of technology was effected through dialogue sessions, *in situ* training and hands-on training of SFD staff and farmers (Figure 7). In addition, a manual on cultivation of indigenous crops was provided including translation of important sections into the Iban language for use by the participants (Appendices 5 and 6). Training course in the relevant crops with emphasis on agronomy and economics of production and utilisation is proposed for the development of LEWS, Phase III.

Field trips can also be organised for participants and staff to the on-farm trials and demonstration plots conducted by ITTO in LEWS, Phase II and those conducted by the SFD at BRC and Agriculture Departments at Agricultural Research Centre, Semongok, Layar Integrated Agricultural Station, Betong, Tarat Station and Sg Sibiew Station.

More active participation by the SFD counterpart (Forest Botanist) is required so that the project can be successfully continued after the consultancy period. It would be a good idea to recruit a fresh graduate with interest in community and conservation work to be the full-time counterpart and to undertake on MSc programme based on the project. The appointment of a Technical Officer to monitor the progress of the project is a useful stop-gap measure.

7.0 FINDINGS

7.1 Mortality

The success of crop establishment is assessed by means of the mortality rate. Establishment of fruits and rattan was good based on the mortality rate. (Table 5). The mean mortality rate of 10.1% (0 to 44.4%) is acceptable under farmers conditions.

The mortality rate for fruit tree demonstration plot in Ng. Bloh Station is 5.3% which is excellent.

The main causes of mortality were :

(i) Delayed planting and inadequate care of seedlings;
(ii) Water logging on heavy soils;
(iii) Weedicide damage; and
(iv) Mammalian pest damage.

7.2 Plant Height

Plant height was measured after planting (Table 6) and subsequently at six monthly interval. This will allow annual height increase assessment. Plant girth, date of first flowering and fruiting and yield and quality assessments shall be recorded. The above parameters will give an accurate assessment of the growth and yield performance of the indigenous crops.

7.3 Preliminary Economic Assessment

An estimation of the income that can be derived from 10 plants each of *isau, dabai* and *petai* (0.25 ha) is provided to give an idea of the economic potential of these three crops in improving the income generating capacity of the participants.

Based on yield, ex-farm price and seasonality of each fruit, a conservative estimation of the income is RM1,083 to RM1,875 per month (Table 7) which is 2.2 to 3.8 times the State's poverty line of RM495 per household of 5.1 persons. In LEWS, the sociologist reported that on average the household income in the vicinity of the LEWS was less than half the State's poverty line (ITTO, 1996).

The indigenous crops are to serve as a source of food and cash income. Table 8 shows the nutritional value of selected indigenous fruits collated from data of Anon (1992), Wong and Gan (1992) and Voon and Kueh (1998). *Dabai, nyekak* and *isu* are very nutritious with high values for energy (152 to 393 Kcal/100g), protein (2.6 to 3.8 g/100g) and potassium (362 to 810 mg/100g). In general, indigenous fruits in Sarawak are comparable to cultivated species except that they are low in Vitamin C compared to guava, papaya and citrus (28.0 to 152.0 μg/100 g) (Table 9). They are excellent sources of energy, protein, vitamins, minerals and fibre. Table 10 shows the nutrient composition of selected indigenous vegetables based on data of Bautista *et. al.* (1988), Anon (1992), Mertz (1997) and Voon and Kueh (1998). *Petai, lalis* and *daun sabong* are high in protein (3.7 to 6.0 g/100g), *kecala* and *tepus* are high in potassium (555 to 582 mg/100g), *pegaga* is high in iron (369 ug/100g) and *kecala* and *terong Dayak* high in Vitamin C (8.0 to 10.2 ug/100g). In general the nutritional value of indigenous vegetables are comparable to cultivated species (Table 11) with the added advantage that they are pesticide free. Studies on anti-nutritional factors such as arsenic, cyanide, lead, phytic acid, alkaloids and tannins showed that *lalis* contained alkaloids and *paku, miding* contained traces of arsenic, phytic acid, alkaloids and tannins but such levels were not detrimental to health (Voon and Kueh, 1998). Indigenous vegetables are nutritious and wholesome.

Mertz (1997) concluded that at the price of RM2.70/kg for cultivated *miding* (*Stenochlaena palustris*) the estimated annual income is RM5,000 to 10,000/ha. Effective production of *kecala* may potentially yield an annual income of RM10,000 to 15,000/ha provided there is sufficient demand for the shoots, flowers and fruits (Mertz 1997).

Table 5 Mortality rate of indigenous crops on-farm trial in Ulu Katibas and Ulu Mujok (%)

Indigenous crop	Participant											Mean
	Kallang ak Melamun	Ligon ak Umpang	Belasan ak Samin	Api ak Sanun	George ak Lumeng	Jana ak Tukau	Enggong ak Juing	Gerasi ak Kapi	Jawa ak Ribut	Mengiring ak Masil	Ingkau ak Entalai	
Isau (Dimocarpus longan var. *malesianus)*	10.0	30.0	0	40.0	10.0	10.0	0	-	10.0	20.0	30.0	16.0
abai (Canarium odontophyllum)	0	0	0	0	40.0	10.0	10.0	30.0	10.0	0	44.4	13.1
Petai (Parkia speciosa)	0	0	0	0	0	0	0	20.0	0	0	33.3	4.8
Others	0	12.5	5.0	0	14.3	33.3	0	0	0	0	37.5	9.3
Rotan manau (Calamus manan)	12.5	22.5	17.9		-	0	20.0	27.5	7.5	0	-	13.5
Rotan sega (Calamus caesius)	12.5	2.7	10.8	7.5	0	0	2.5	5.0	0	2.5	0	4.0
Mean	5.8	11.3	5.6	9.5	12.9	8.9	5.4	16.5	4.6	3.8	29.0	10.1

Table 6 Plant height of indigenous crops on-farm trial at planting (m)

Indigenous crop	Participant											Mean
	Kallang ak Melamun	Ligon ak Umpang	Belasan ak Samin	Api ak Sanun	George ak Lumeng	Jana ak Tukau	Enggong ak Juing	Gerasi ak Kapi	Jawa ak Ribut	Mengiring ak Masil	Ingkau ak Entalai	
Isau (Dimocarpus longan var. *malesianus)*	0.67	0.68	0.61	0.43	0.86	0.73	0.62	-	0.38	0.33	0.53	0.58
Dabai (Canarium odontophyllum)	0.47	0.35	0.45	0.35	0.32	0.42	0.36	0.62	0.45	0.54	0.54	0.44
Petai (Parkia speciosa)	0.69	0.61	0.75	0.49	0.71	0.80	0.76	0.69	0.61	0.66	0.47	0.66
Nyekak (Durio oblongus)	0.39	0.46	0.64	-	-	0.48	0.67	0.73	0.61	-	-	0.56
Rotan manau (Calamus manan)	0.34	0.51	0.35	-	-	0.64	0.60	0.37	0.73	0.82	-	0.55
Rotan sega (Calamus caesius)	0.29	0.36	0.29	0.30	0.32	0.37	0.28	0.37	0.42	0.48	0.41	0.35

Table 7 Economic potential of indigenous fruits

Fruit	Yield (kg/tree)	Ex-Farm price (RM/kg)	Income RM/tree	Income RM/10 trees	Income (RM/10trees/ annum)	Remarks
Isau (*Dimocarpus longan* var. *malesianus*)	300	3 - 8	900-2,400	9,000-24,000	3,000-8,000	Fruits once in 2 to 4 years
Dabai (*Canarium odontophyllum*)	300	2 - 5	600-1,500	6,000-15,000	3,000-7,500	Fruits once in 1 to 2 years
Petai (*Parkia speciosa*)	1000 pod	RM2/3 pod	700	7,000	7,000	Non seasonal with 1 to 2 peaks annually
Total / annum					13,000-22,500	
Total / month					1,083-1,875	

Table 8 Nutrient composition of selected indigenous fruits

Name of species	Energy (K/cal)	Moisture (%)	Protein (g) Fresh Weight	Protein (g) Dry Weight	Fat (g)	Carbo-hydrate (g)	Fibre (g)	Ash (g)	Phos-phorus (mg)	Potassium (mg)	Calcium (mg)	Magnesium (mg)	* Iron (ug)	* Manganese (ug)	* Copper (ug)	* Zinc (ug)	Vit C (ug)
	Nutrient composition per 100 g edible portion																
	Proximate composition								Minerals								
Dabai (Canarium odontophyllum)	393	41.3	3.8	6.5	26.2	22.1	4.3	2.3	65	810	200	106	13	8	7.0	4.7	NA*
Nyekak (Durio oblongus)	149	61.5	2.6	6.8	1.7	30.9	1.9	1.5	25	362	19	19	7	5	3.2	7.3	15.9
Isu (Durio graveolens)	152	66.7	2.6	7.7	6.2	21.5	2.0	1.0	43	529	10	27	6	4	7.0	5.9	10.4
Keranji (Dialium indum)	268	31.9	7.1	10.4	15.1	56.6	1.4	1.6	96	545	150	48	51	10	7.3	27.9	4.1
Terap (Artocarpus odoratissimus)	119	69.3	1.7	5.5	0.3	27.4	0.5	1.7	33	322	22	25	8	1	2.5	7.4	1.8
Engkala (Litsea garciae)	104	78.3	1.4	6.6	6.8	10.0	1.0	2.5	26	355	7	17	5	5	2.6	10.2	3.4
***Isau (Dimocarpus longan var. malesianus)*	-	78.8	1.2	-	-	-	0.7 %	0.6 %	-	-	52 ppm		2.5	-	-	-	2.9

Source : Department of Agriculture, Sarawak, 1992

*ppm

** Wong and Gan, 1992

Table 9 Nutrient composition of common fruits

Name of species	Energy (K/cal)	Moisture (%)	Protein (g) Fresh Weight	Protein (g) Dry Weight	Fat (g)	Carbo-hydrate (g)	Fibre (g)	Ash (g)	Phos-phorus (mg)	Potassium (mg)	Calcium (mg)	Magnesium (mg)	Iron* (ug)	Manganese* (ug)	Copper* (ug)	Zinc* (ug)	Vit C (ug)
	Nutrient composition per 100 g edible portion																
	Proximate composition								Minerals								
Mangga *(Mangifera indica)*	83	79.5	10	-	1.8	15.6	1.4	0.7	13	187	9	2	0.4	-	-	-	23.0
Durian *(Durio zibethinus)*	153	64.1	2.7	-	3.4	27.9	0.9	1.0	44	70	40	40	1.9	-	-	-	23.3
Langsat *(Lansium domesticum)*	34	90.0	0.4	-	0	8.2	0.9	0.5	20	230	10	12	1.0	-	-	-	13.4
Rambutan *(Nephelium lappaceum)*	59	84.7	0.7	-	0.1	13.9	0.3	0.3	6	49	22	5	2.5	-	-	-	38.6
Limau manis *(Citrus reticulata)*	44	88.6	1.1	-	0.3	9.1	0.6	0.3	17	81	18	3	0.2	-	-	-	28.0
Belimbing manis *(Averrhoa carambola)*	24	92.0	0.7	-	0.1	5.0	1.8	0.4	12	8	5	6	0.3	-	-	-	25.8
Jambu air ** *(Syzygium equeum)*	17	95.0	0.8	-	0.1	3.3	0.6	0.2	-	-	25	-	1.1	-	-	-	16.7
Nanas *(Ananas comosus)*	45	87.8	0.5	-	0.1	10.6	0.6	0.4	6	97	24	31	1.4	-	-	-	15.2
Banana *(Musa sapientum)*	100	73.0	1.4	-	0.3	22.9	1.7	0.7	3	342	0	10	0.2	-	-	-	8.3
Papaya *(Carica papaya)*	59	64.4	1.0	-	0.1	13.5	0.5	0.5	17	337	31	2	0.6	-	-	-	69.3
Guava *(Psidium guajava)*	46	81.2	1.1	-	0.2	10.0	6.8	0.7	15	29	33	22	1.2	-	-	-	152.0
Water melon *(Citrullus vulgaris)*	28	92.6	0.6	-	0.2	6.0	0.2	0.4	11	78	6	4	0.2	-	-	-	5.5
Apple ** *(Pyrus malus)*	60	84.5	0.6	-	0.4	13.6	0.6	0.3	16	-	9	-	1.2	-	-	-	7.7

Source : Nutrient Composition of Malaysian Foods, National Sub-committee on Protein, 1988

*ppm

** Institute for Medical Research, Kuala Lumpur 1985

Table 10 Nutrient composition of selected indigenous vegetables

Name of species	Nutrient composition per 100 g edible portion																
	Proximate composition								Minerals								
	Energy (K/cal)	Moisture (%)	Protein (g) Fresh Weight	Protein (g) Dry Weight	Fat (g)	Carbo-hydrate (g)	Fibre (g)	Ash (g)	Phos-phorus (mg)	Potassium (mg)	Calcium (mg)	Magnesium (mg)	* Iron (ug)	* Manganese (ug)	* Copper (ug)	* Zinc (ug)	Vit C (ug)
Petai *(Parkia speciosa)*	91	76.0	6.0	25.0	1.6	13.2	2.0	1.2	115	341	108	29	22	42	36.7	8.2	-
Paku ikan *(Diplazium esculentum)*	24	92.5	2.7	36.4	0.5	2.2	0.8	1.2	84	410	14	19	18	3	1.9	0.6	0.0
Terong Dayak *(Solanum lasiocarpum)*	36	89.5	1.1	10.4	0.9	5.8	1.7	0.8	27	188	3	6	6	2	0.6	3.9	8.0
Kecala *(Etlingera elatior)*	94	74.4	2.6	10.3	3.0	14.0	2.6	3.4	56	582	90	123	78	298	3.1	1.5	10.2
Tepus *(Etlingera punicea)*	14	94.8	1.0	19.3	0.5	1.4	0.7	1.6	27	555	10	16	15	98	0.8	0.9	0.0
Pegaga *(Centella asiatica)*	53	83.9	1.9	11.7	1.2	8.7	1.9	2.5	40	479	289	40	369	43	0.0	30.0	0.6
Lalih *Plectocomiopsis geminiflora*	36	90.2	3.7	38.3	0.8	3.6	0.7	0.9	68	296	27	27	13	133	2.4	21.8	0.0
Pisang gentu *(Musa* spp.*)*	13	95.4	0.8	16.4	0.5	1.3	0.5	1.6	25	470	9	12	34	6	0.6	2.1	0.3
Daun sabong *(Gnetum gnemon)*	57	81.7	4.2	22.8	1.5	6.6	4.7	1.3	68	419	94	37	38	41	1.5	12.1	1.5

Source : Department of Agriculture, Sarawak, 1992

*ppm

Table 11 Nutrient composition of common vegetables

Name of species	Energy (K/cal)	Moisture (%)	Protein (g) Fresh Weight	Protein (g) Dry Weight	Fat (g)	Carbo-hydrate (g)	Fibre (g)	Ash (g)	Phos-phorus (mg)	Potassium (mg)	Calcium (mg)	Magnesium (mg)	* Iron (ug)	* Manganese (ug)	* Copper (ug)	* Zinc (ug)	Vit C (ug)
	Nutrient composition per 100 g edible portion																
	Proximate composition								Minerals								
Kacang soya *(Glycine max)*	404	12.4	40.2	-	18.5	19.2	5.0	4.7	440	397	198	-	6.0	-	-	-	7.5
Brinjal *(Solanum melongena)*	30	91.2	1.7	-	0.1	5.6	1.0	0.4	20	55	15	-	0.6	-	-	-	18.4
Sawi *(Brassica juncea)*	34	91.7	2.1	-	0.7	4.7	-	0.8	70	-	147	-	6.8	-	-	-	89.0
Carrot *(Daucus carota)*	35	89.5	1.0	-	0.1	7.5	1.1	0.8	27	136	138	-	0.8	-	-	-	9.5
Cucumber *(Cucumis sativus)*	16	95.0	0.5	-	0.0	3.4	0.6	0.5	21	76	14	-	0.2	-	-	-	9.7
Kangkong *(Ipomoea aquatica)*	29	90.9	3.1	-	0.2	3.6	1.0	1.2	9	78	88	-	5.2	-	-	-	48.5
Cekor manis *(Sauropus androgynus)*	74	79.8	7.6	-	1.8	6.9	1.9	2.0	64	2610	234	-	3.1	-	-	-	136.0
Lady's finger *(Hibiscus esculenta)*	31	90.5	1.7	-	0.1	5.9	1.0	0.8	32	80	77	-	1.5	-	-	-	19.3

Source : Institute for Medical Research, Kuala Lumpur 1985

*ppm

8.0 CONCLUSIONS

- Indigenous crops can be successfully cultivated by farmers in the LEWS Buffer Zone. It is not only technically possible but also economically viable. The inclusion of non-seasonal fruits and a low input package will improve viability and sustainability.

- Planting of indigenous crops will reduce poverty and malnutrition that is quite rampant in the area.

- Improving the livelihood of the inhabitants will reduce pressure on the TPA to facilitate conservation of the bio-resources.

- Planted on shifting cultivation land (young secondary forest) it will rehabilitate such degraded land.

- A significant number of indigenous crop species in the pilot planting and demonstration plots will form the nucleus of a more comprehensive collection for *ex situ* conservation of genetic resources.

9.0 RECOMMENDATIONS

- **Extension Project for Cultivation of Indigenous Fruits**

Based on the results of the pilot project which has been successfully implemented coupled with similar work carried out by the SAD's on–station and on-farm trials, an extension project is recommended. It should cover as many longhouses as possible in the vicinity of the Buffer Zone of LEWS which has comparatively better access. The sociological report showed that a total of 102 longhouses comprising 1,761 households with a population of 12,400 people reside in the periphery of the LEWS Buffer Zone. The project will uplift the living standard of the native Ibans who rely heavily on shifting cultivation of hill rice, collection of wild fruits and vegetables, hunting and fishing.

Besides indigenous fruits, the integrated fruit orchard must include short term non-seasonal commercial fruits such as papaya, banana and pineapple. For sustainability, a low input package using leguminous cover crops and NFTs must be used. It will also rehabilitate degraded shifting cultivation areas.

- **Community Forestry Based on Indigenous Timber Species in LEWS Buffer Zone**

The sociological report of LEWS Phase I demonstrated the common occurrence of poverty and malnutrition of the inhabitants.

A small holder forestry project based on technology generated by SFD and the management system developed by Model Forest Management Area (MFMA) of ITTO is recommended. Even though it will have a long gestation period, it will serve as a saving to provide a windfall at harvest.

Multipurpose trees such as *engkabang (Shorea* spp.), *durian* (*Durio* spp.), *kasai* (*Pometia pinnata*), *petai* (*Parkia speciosa*) and *kembayau (Dacryodes rostrata*) which yield fruits and useful timber are logical inclusions. Short term agro-forestry enterprises such as fruit trees, rattan, vegetables and indigenous fish to be included will provide a livelihood while waiting for the timber trees to reach maturity.

Planted on shifting cultivation areas it will also rehabilitate degraded land.

- ***Ex Situ* Conservation of Indigenous Fruits, Vegetables, Medicinal Plants and Rattan-Cum-Seed Garden in LEWS**

The proposed site is the LEWS Headquarters, Ng. Bloh with an area of 40 ha. An arboretum of at least 200 indigenous fruit species, indigenous vegetables of at least 100 species, medicinal plants of at least 150 species and rattan of at least 106 species (Dransfield 1992) is proposed. The *ex situ* conservation is a good genebank to facilitate research and serve as a seed garden and planting material source. Research on medicinal plants should be given priority as information on the bio-active compounds, efficacy, dosage, side effects must be studied before commercialisation can be attempted.

It can also be a site for eco-tourism where tourists can visit interesting collections in a single site. During the fruiting season of indigenous fruits, tourists will be able to appreciate the beauty and diversity of the fruits as demonstrated in the book Brunei Darussalam Fruits in Colour (Serudin Tinggal, 1992). Tourists can also pay to harvest and taste the fruits as is done in temperate countries for strawberry. With research on nutritive value, post harvest handling, product development and promotion, the indigenous fruits can be commercialised for sale in niche markets overseas. At the tourist outlet itself, sale of fresh fruit products e.g. fresh fruit drinks, cakes, ice creams with indigenous fruit flavours can be done as in the Tropical Fruit World in the Gold Coast of Australia.

- ***In Situ* Conservation of Indigenous Timber Species-Cum-Seed Garden in Bukit Sengayoh and Bukit Entimau**

The areas in Bukit Sengayoh and Bukit Entimau are relatively undisturbed and contain a wide range of eco-types which can provide seeds of indigenous timber species of economic importance especially dipterocarp species. Its location is strategic being adjacent to the LEWS Buffer Zone where the community forestry project is proposed. It will serve as a centre for environmental protection and *in situ* conservation of bio-resources. It will supply the community forestry project area with seedlings. Research on seed production, nursery practices, provenance trials can be carried out to support the community project and general application elsewhere.

- **Community Fish Culture Based on Indigenous Species**

The longhouse dwellers depend on fish as a source of protein which is continually depleted by over fishing and pollution. Based on SADs success in breeding indigenous fish in captivity and successful culturing of indigenous fish in ponds and cages using high quality feed, a community project on indigenous fish culture should be included. The success is to be confirmed by the pilot project on fish culture by

LEWS Phase II. A low input package using natural fish feeds is advocated. Being of extremely high market value e.g. *semah* (*Tor douronensis*), *empurau* (*T. tambroides*) and *tengadak* (*Puntius schwanenfeldii*), it will bring significant financial benefit to the community. A recent survey showed that the prices of these species of fish in the vicinity of LEWS Buffer Zone are RM30 to RM130/kg.

- **Pilot Apicultural Project Based on Apis cerana and A. dorsata**

Wild honey is commonly harvested by the local community for sale from two species of bees *Apis cerana* and *A. dorsata*. The method of harvest is destructive often involving burning of the hives.

The SAD and Sabah have successfully carried out bee keeping research to explore its potential. In Sarawak, *A. cerana* has been successfully domesticated in an intensive system using box hives in coconut (*Cocos nucifera)* and *Acacia mangium* plantations. In Sabah, community apiculture based on *A. cerana* and *A. dorsata* in natural forests has been developed and commercialised in a low input system using simple coconut trunk trapping hives (*gelodog*). Queen rearing to supply bee stock to farmers has been successfully done in both Sabah and Sarawak.

Apiculture has great potential for development in community projects as the demand for natural honey is great and the price is good (RM30/kg). In addition to honey, the potential of other apicultural products such as bees-wax, bee pollen, royal jelly and propolis can be explored.

Initially a pilot project is proposed in LEWS Buffer Zone.

The above proposals are projects aimed at community development to raise their living standard by providing food and generating cash income to eradicate the twin scourges of poverty and malnutrition in rural communities. It will significantly reduce pressure on LEWS as a TPA.

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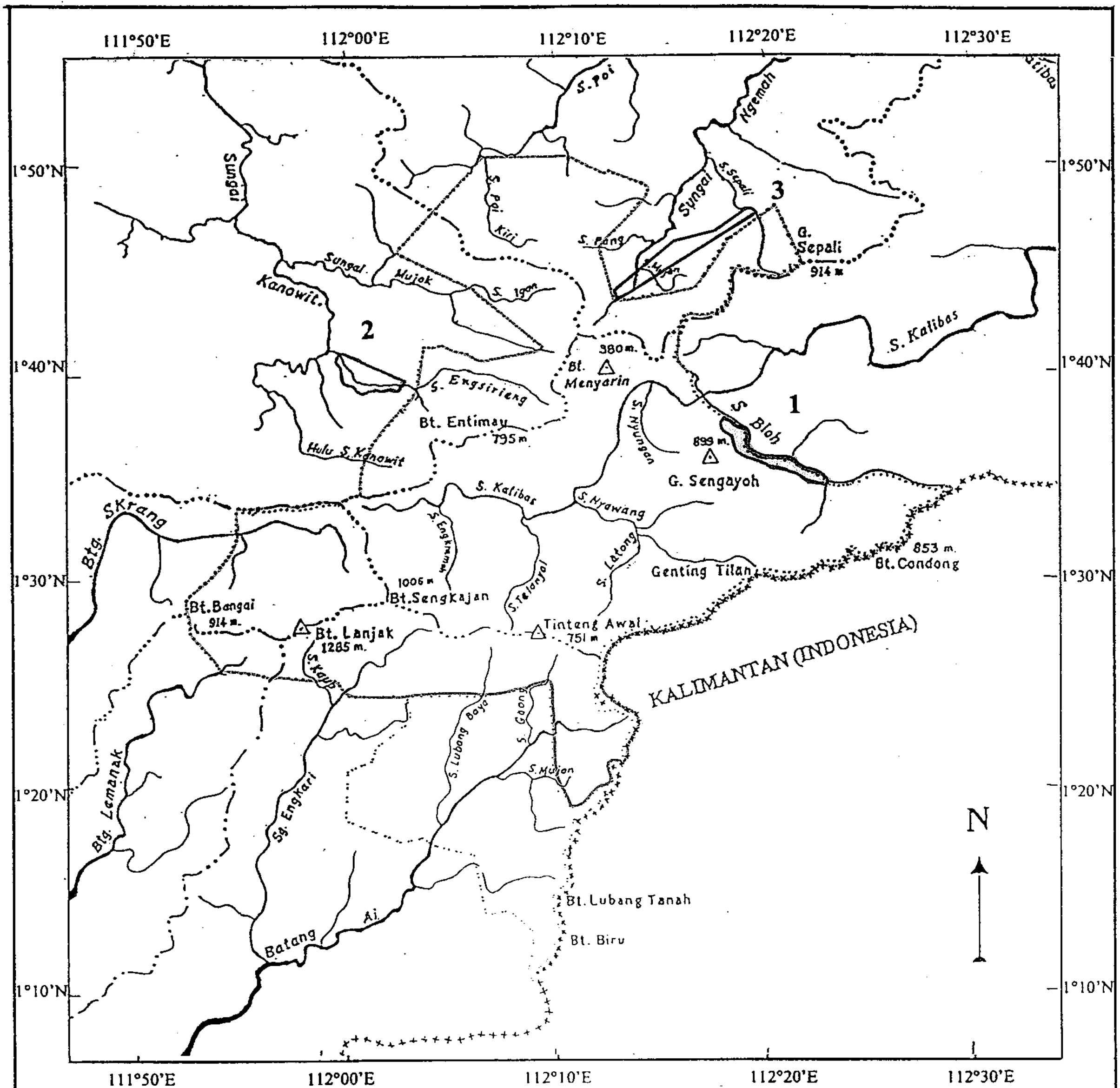

Figure 1 : GAZETTED AREAS FOR SUSTAINABLE COLLECTION OF FOREST PRODUCE

Legend

Lanjak-Entimau W/S ....

Batang Ai N/P.......................

International boundary..............

0 ——— 20 KM

Scale 1 : 625,000

Areas for local people to collect forest produce for their own use at :-

Ulu Katibas (1,174 Hectares) ... 1

Ulu Kanowit (918 Hecatres).. 2

Ulu Ngemah (1,722 Hectares) .. 3

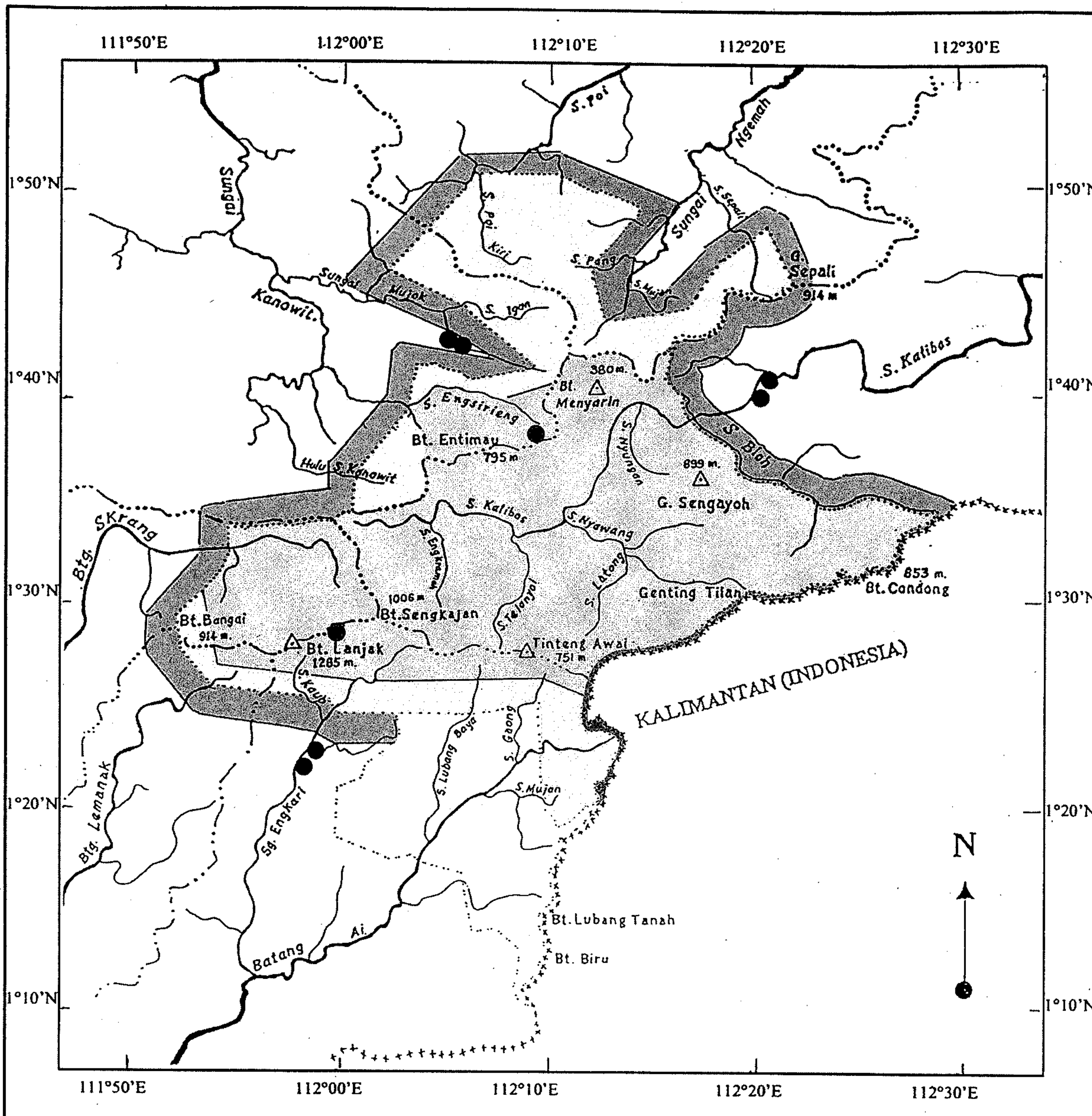

Figure 2 : ZONATIOIN OF LANJAK-ENTIMAU WILDLIFE SANCTUARY FOR BIODIVERSITY MANAGEMENT

Legend

Lanjak-Entimau W/S ....

Batang Ai National Park....................

International boundary....................

0 20 KM

Scale 1 : 625,000

Core Zone	
Wilderness Zone	
Buffer Zone	
Genebanks	●
Culture	●

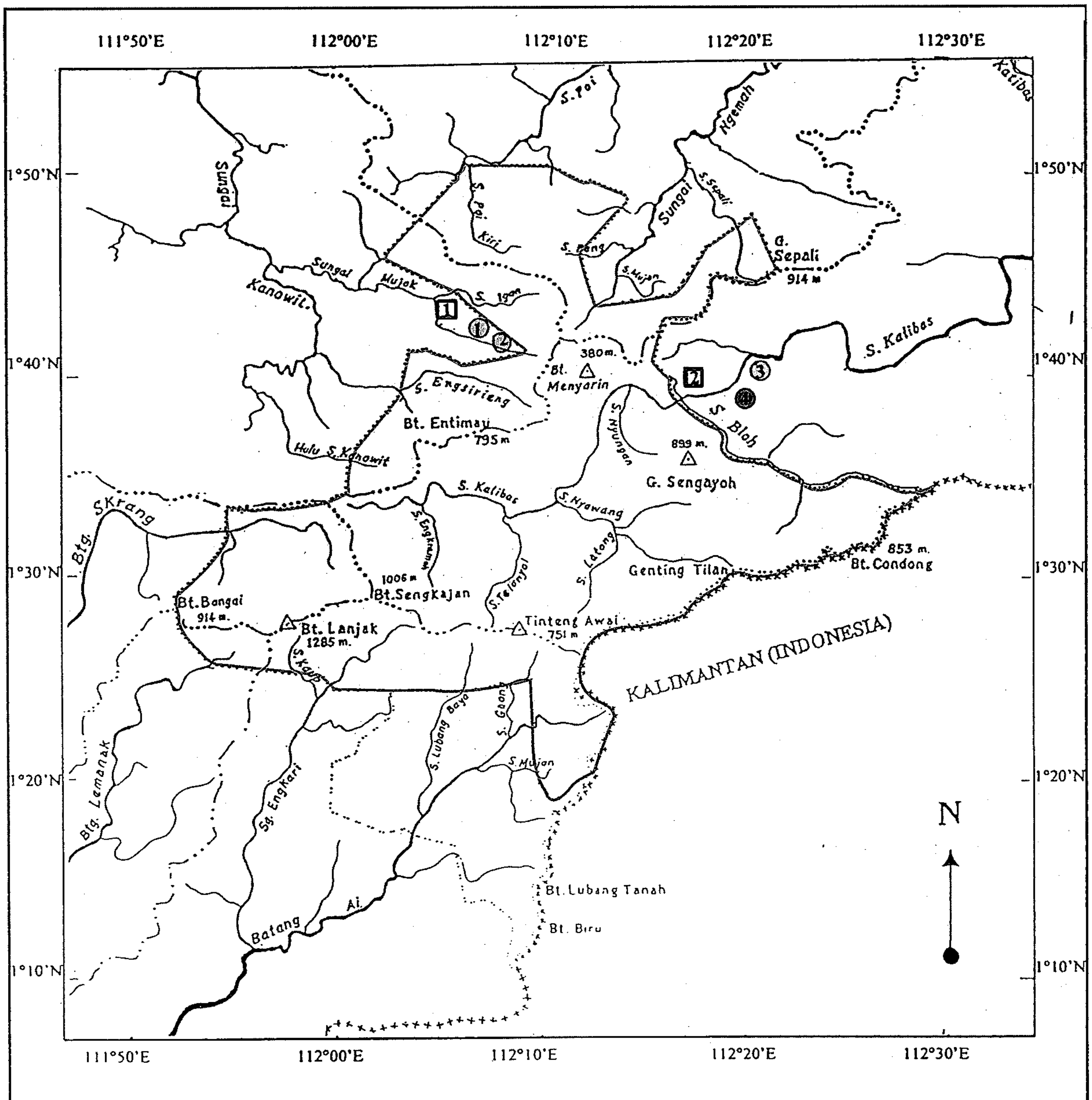

Figure 3 : LOCATION OF INDIGIENOUS CROPS PILOT PROJECT AND DEMONSTRATION PLOTS

Legend

Lanjak-Entimau W/S ....

Batang Ai N/P......................

International boundary............ +++++

0 ——— 20 KM

Scale 1 : 625,000

Indigenous Crops Pilot Project	Demonstration Plots
① Rumah Gerasi	1 Nanga Ju Station
② Rumah Mengiring	2 Nanga Bloh Station
③ Rumah Api	
④ Rumah Enggong	

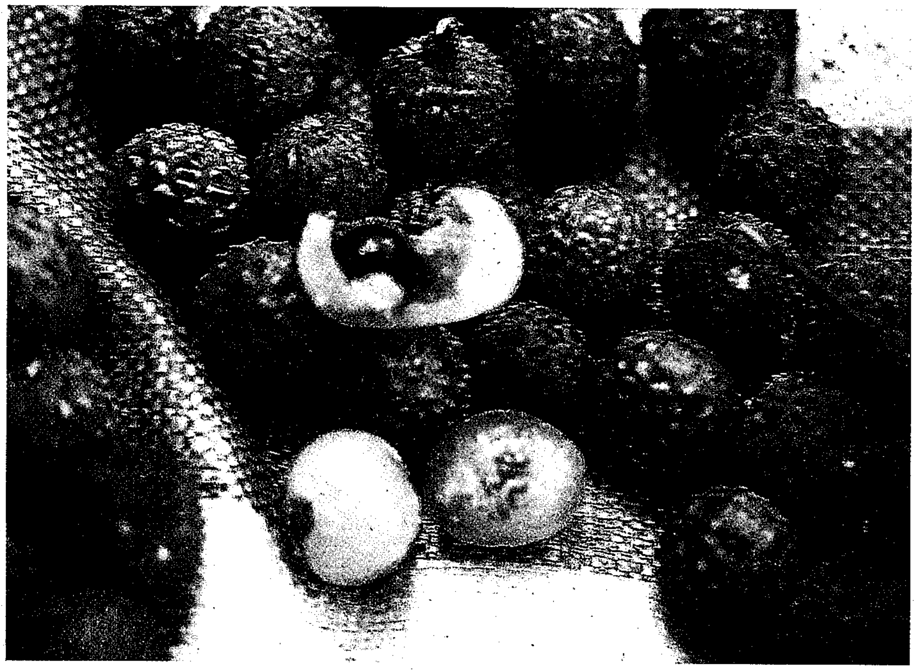

Figure 4 : Among four types of longan indigenous to Sarawak, *isau* (*Dimocarpus longan* var. *malesianus)* has the greatest potential for commercialisation.

Figure 5 : *Kecala (Hornstedtia magnifica)* a very popular wild ginger with the potential to surpass ginger as a condiment

Figure 6: *Dabai (Canarium odontophyllum),* planted following ITTO's recommendation of using leguminous cover crop (*Arachis pintoi)*

Figure 7 : Hands-on training on indigenous frùit tree planting tò ensure effective transfer of technology

Appendix 1 Fruits with commercial potential planted by farmers

	Botanical name	Local name	Commercial potential
1	*Durio oblongus*	*Nyekak*	Fruits with thick quality pulp in demand
2	*Durio graveolens*	*Isu*	Pulp with unique taste and flavour. Quality fruits with thick pulp in demand
3	*Durio zibethinus*	*Durian*	Very aromatic and tasty. A fruit known as King of fruits. Eaten fresh or processed. Unripe fruit cooked as vegetable
4	*Mangifera pajang*	*Mawang*	Fruits with thick yellow fibreless sweet pulp in Batang Rajang in great demand
5	*Mangifera indica*	*Mangga*	Popular commercial fruit used fresh or processed
6	*Canarium odontophyllum*	*Dabai*	Popular domesticated fruit in Sibu and Kapit Divisions. Thick fleshed, good quality fruits in great demand. Kernel used as almond.
7	*Dimocarpus longan* var. *malesianus*	*Isau*	Isau with thick sweet pulp is very popular compared to the thin fleshed kakus, sau and guring. Domesticated in Kapit and Sibu Divisions
8	*Artocarpus odoratissimus*	*Terap*	Aromatic sweet pulp popular. Seeds make an excellent titbit when fried
9	*Dialium indum*	*Keranji*	Popular fruit that can be stored for several months
10	*Litsea garciae*	*Engkala*	Popular fruit that has been domesticated in some areas. Pulp tastes like avocado.
11	*Pentaspadon motleyi*	*Pelajau*	Fried or boiled the kernal gives a nutty taste
12	*Lansium domesticum*	*Langsat*	Popular domesticated fresh fruit
13	*Nephelium lappaceum*	*Rambutan*	Popular domesticated fruit eaten fresh or canned
14	*Citrus reticulata*	*Limau manis*	Popular commercial fruit
15	*Averrhoa carambola*	*Belimbing manis*	Popular commercial fruit
16	*Syzygium aqueum*	*Jambu air*	Domesticated fruit actively promoted in local market
17	*Ananas comosus*	*Nanas*	Popular commercial fruit eaten fresh and processed Seasonality can be overcome by use of flower inductants

Appendix 2 List of commercial rattan species in Sarawak

	Local name	Botanical name
1	*Rotan sega*	*Calamus caesius*
2	*Rotan semambu*	*Calamus scipionum*
3	*Rotan sega*	*Calamus optimus*
4	*Rotan irit*	*Calamus trachycoleus*
5	*Rotan jelayan*	*Calamus ornatus*
6	*Rotan manau*	*Calamus manan*

Appendix 3 Indigenous vegetable species planted at Ng Bloh Station and on-farm trials

	Botanical name	Local name	Parts eaten	Commercial value
1	*Diplezium esculentum*	*Paku ikan*	Young fronds fried or boiled	Commonly sold in jungle produce markets. Popular in eating places
2	*Solanum lasiocarpum*	*Terong Dayak*	Fruits cooked in soups or fried	Intercropped with hill paddy and widely sold in jungle produce markets. Downstream processing into drinks, dry and wet preserve by Department of Agriculture
3	*Etlingera fimbriobractecta*	*Tepus*	Heart of young shoots, flower buds and fruits used as vegetable and condiment	Found in jungle produce markets. Commonly used by both rural and urban communities
4	*Hornsteadtia magnifica*	*Kecala*	Heart of young shoots, flower buds and fruits used as vegetable and condiment	Found in jungle produce markets. Commonly used by both rural and urban communities.
5	*Brassica juncea*	*Ensabi*	Whole aerial part	Widely sold in jungle produce markets. Popular salted vegetable
6	*Centella asiatica*	*Pegaga*	Leaves used in *ulam* or cooked	Sold in jungle produce markets. Commonly served in eating places
7	*Plectocomiopsis geminiflora*	*Lalis*	Rattan heart is cooked or roasted	Commonly sold in jungle produce markets
8	*Parkia speciosa*	*Petai*	Seeds eaten young or mature, as *ulam,* cooked or roasted	Commonly sold in jungle produce markets. Sometimes served in eating places
9	*Musa spp.*	*Pisang gentu & pisang lengki*	Heart of pseudostem and inflorescence used as *ulam*, cooked or roasted	Sold in jungle produce markets
10	*Gnetum gnemon*	*Sabong*	Young leaves and fruits cooked or fried mixed with other vegetables, meat, fish, Kernals made into a *keropok*	Commonly sold in jungle produce markets

Botanical name	Local name	Parts eaten	Commercial value
11 *Psophocarpus tetragonolobus*	*Kacang ceper*	Young pods eaten as vegetables boiled, Fried or fresh as *ulam*. Tubers eaten as in potato (95% protein)	Commonly sold in markets in urban and rural areas
12 *Blechnum orientale*	*Paku kelindang*	Young fronds eaten, cooked fried or as *ulam*	Occasionally sold in jungle produce markets
13 *Pycnarrhena tumetacta*	*Daun tubu*	Leaves of all ages is added to cooked food to enhance taste and flavour much like monosodium glutamate	Occasionally sold in jungle produce markets
14 *Eugenia* sp.	*Bungkang*	Young leaves added to meat and fish dishes cooked in bamboo containers to enhance taste and flavour	Occasionally sold in jungle produce markets
15 *Cucumis sativus*	*Timun Dayak*	Leaves, young shoots and fruits cooked in various ways. Raw fruits eaten as *ulam*	Sold in jungle produce markets
16 *Pseuderanthemum borneense*	*Gelabak*	Young or older leaves as spinach	Popular with rural populations but seldom sold in jungle produce markets. Potential for domestication and commercialisation

Appendix 4 Plant species with potential for medicinal use planted at Ng Bloh Station

	Botanical name	Local name	Medicinal use
1	*Calophyllum lanigerum* var. *austrocoriaceum* and *C. teysmannii* var. *inophylloide*	*Bintangor*	Anti-AIDS property
2	*Oldenlandia diffusa*	*Lidah ular*	Treatment of hepatitis and cancer
3	*Xanthophyllum amoenum*	*Langgir*	Shampoo and hair conditioner
4	*Goniothalamus* spp.	*Selukai*	Bark used as a mosquito repellent
5	*Parkia speciosa*	*Petai*	Treatment of hypertension and diabetes
6	*Centella asiatica*	*Pegaga*	Treatment of diarrhoea, leprosy, cold and tonsilitis Tetripenodus in pegaga used in cosmetics and skincare products
7	*Cassia alata*	*Serugam*	Treating ringworm and white spots
8	*Melastoma malabathricum*	*Kemunting*	Treating of cuts and wounds
9	*Clerodendrum villosum*	*Empahit*	Treating skin irritation, lice, diarrhoea, cracked feet
10	*Spatholobus ferrugineus*	*Akar kemedu*	Stop bleeding
11	*Tetracera akara*	*Empelas*	Treating coughs
12	*Leonurus sibiricus*	*Ka-chang-ma*	Treating body pain after delivery, hypertension, nephritis dropsy, reduction of uric acid
13	*Elephantopus scaber*	*Tutup bumi*	Relief of headache
14	*Eurycoma longifolia*	*Tongkat Ali*	Aphrodisiac, hypertension, anti-malaria
15	*Derris elliptica*	*Tuba*	Treating boils and skin diseases, a natural insecticide and fish poison
16	*Blechnum orientale*	*Paku kelindang*	Treating of mouth ulcer, fever and boils
17	*Blumea balsamifera*	*Mambong*	Treating stomach-ache and fever. Also used as a health bath for women in confinement

Appendix 5 Manual for cultivation of indigenous fruits, commercial fruits and rattan (An example with translation into the Iban language)

Source : Kueh Hong Siong (1995)
Malaysian Fruit Industry Director (1989)
PROSEA Plant Resources of S.E. Asia 8, Vegetables

LONGAN

Local Name : *Isau, Mata Kuching Masak Hijau*
Scientific Name : *Dimocarpus longan* var.*malesianus* Lour.

Recommended Clones:
In 1996, the Sarawak Agriculture Department recommended Is7 for planting based on high yield anf fruit quality characterised by thick arilloid, high value vitamin C, calcium and iron content (Wong, 1994)

Soil and Climatic Requirement
Isau trees grow best on well drained, deep, fertile loamy alluvial soils found along river banks. Terrain should be flat or only gently sloping. The trees fruit faster and more consistently in areas with a more pronounced dry weather.

Propagation
Obtain inarched or marcotted plants from trees that bear heavily and have fruits that are large with thick, crispy, sweet flesh and small seeds.

Planting Distance and Density
9 m x 9 m (123 plants/ha).

Fertilizer Application

Year	Time of application	Type of fertilizer	Rate (kg/plant)	Rate/ application (kg)
0	At planting At planting At planting	Rock Phosphate Dolomite Organic manure	0.20 0.10 5 to10	0.20 0.10 5 to10
1	Every 3 months	15:15:15	0.50	0.13
2	Every 3 months	15:15:15	1.00	0.25
3	Every 3 months	12:12:17:2+TE	1.50	0.38
4	Every 4 months	12:12:17:2+TE	2.00	0.67
5	Every 4 months	12:12:17:2+TE	2.50	0.83
6	Every 4 months	12:12:17:2+TE	3.00	1.00
7	Every 4 months	12:12:17:2+TE	4.00	1.33
8 onwards	Every 4 months	12:12:17:2+TE	6.00	2.00

In addition, an application of organic manure at 10 to 40 kg/plant/annum is recommended.

Weed Control
Establishing cover crop is recommended to control weeds and conserve the soil.

Pruning
Vegetative propagated plants require only slight pruning to obtain spherical canopy.

Vegetative Period
5 to 6 years

Economic Life
30 to 40 years.

Yield
30 - 100 kg in younger plants. Mature plants can yield up to 300 kg.
Fruiting occurs once in 1 to 4 years depending on weather conditions.

Economic Aspects
At ex-farm price of RM3 to RM8/kg, the income that can be obtained is RM900 to RM2,400 per tree per season

Uses
Fresh consumption

Appendix 6

LONGAN

Nama Asal : *Isau, Mata Kuching Mansau Gadong*

Nama Saintifik : *Dimocarpus longan* var.*malesianus* Lour.

Paong Tiru:
Opis Betanam Betupi kemandar bangsa Is7.

Tanah sereta gaya penyelap/pengangat ka diguna
Kayu Isau tumboh enggau manah ba tanah ka cukup parit ka dalam, pemakai ka mayoh enggau tanah ka liat, bisi di temu ba tebing sungai. Endor manam mesti rata tau ka landai mimit. Kayu ka di tanam ba endor ka rangkai dika ngeluar ka buah lebih jampat sereta enda berubah.

Cara ngulih ka paong
Paong diambi ari kayu ka udah di *marcotted.* Kayu ka dipili udah bisi ngeluar ka buah ti lebat lalu buah ti cukup besai, tebal, manis isi enggau leka ti mit.

Penyarang nanam enggau pemayoh pun
9 m x 9 m (123 pun/ha).

Cara meri baja

Taun	Maya meri	Bangsa baja	Penyampau (kg/pun)	Pemyampau/ Diberi (kg)
0	Musim nanam	Rock Phosphate	0.20	0.20
	Musim nanam	Dolomite	0.10	0.10
	Musim nanam	Organic manure	5-10	5-10
1	Tiap 3 bulan	15:15:15	0.50	0.13
2	Tiap 3 bulan	15:15:15	1.00	0.25
3	Tiap 3 bulan	12:12:17:2+TE	1.50	0.38
4	Tiap 4 bulan	12:12:17:2+TE	2.00	0.67
5	Tiap 4 bulan	12:12:17:2+TE	2.50	0.83
6	Tiap 4 bulan	12:12:17:2+TE	3.00	1.00
7	Tiap 4 bulan	12:12:17:2+TE	4.00	1.33
8 ke atas	Tiap 4 bulan	12:12:17:2+TE	6.00	2.00

Kena nambah, *organic manure* tau meh di beri kira 10-40 kg ha siti pun sekali setaun

Nagang rumput ngambi ka enda tumboh
cover crop tau di tanam ngambika rumput bakai enda tumboh sereta ngetan ka tanah lak ka enda tusor.

Ngempat ujong dan/batang
Kayu ka tumboh ari *vegetative propagation* dan tau batang ka enda manah patut di kempat ngambika pucok ia segala.

Pengelama alai ia cukop besai/mansang
5 - 6 taun

Pengelama ia olih bebuah
30 - 40 taun.

Pemayoh buah
30 - 100 kg enti kayu nya agi biak. Tang enti kayu udah tuai olih ngeluar ka asil sampai ngagai 300 kg.

Mansik sereta ngira penguntong tau ka pengerugi

Cara makai
Diempa leboh buah ia baru di ambi tau ka agi manah.

DISCUSSIONS

Haryadi

What are the roles of the local communities in the choice of species?

Kueh Hong Siong

What we did was we proposed to them certain species of fruit trees and obtained their feedback. They responded very positively to *dabai* (*Canarium odontophyllum*) and *isau* (*Dimocarpus longan* var. *malesianus* Lour.). They were not keen to grow indigenous vegetables because they could not bring the vegetables to the market and they can find the indigenous vegetables very easily. The response to plant medicinal plants was negative because modern medicine is readily available even in the village shops. We also consulted them whether the cultivation of indigenous crops should be on community or individual basis. They preferred it on individual basis as it has advantages such as better land, more enthusiasm and the work could be organised more easily. In other words, the local communities were consulted before we embarked on the activity.

Dr. Soepadmo

Why was *engkabang* not included in your trial farming as *engkabang* is a multi-purpose tree?

Kueh Hong Siong

Firstly, *engkabang* is a timber tree rather than a fruit crop. Secondly, it takes a much longer time to mature. Thirdly, the Sarawak Forest Department has already embarked on planting of *engkabang*. Of course in the community forestry project, *engkabang* would be one of the main tree species to be inter-cropped with other agricultural crops.

Ernest Chai

Can you elaborate on how you propose to rehabilitate some of the shifting cultivation areas through the small holder forestry project.

Kueh Hong Siong

I think what we would do is to select some participants and a suitable site for the planting of these indigenous timber species such as *engkabang*, *durian*, etc. in the small holder forestry project. In addition we should provide them with short term crops, fruit trees, vegetables and may be fish rearing so that they can make a living while waiting for the trees to mature. Once the trees mature, it will be a windfall for them.

Perception of the Local Community towards the Lanjak Entimau Wildlife Sanctuary (LEWS)

by
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Abstract

Well before the establishment of the Lanjak Entimau Wild Life Sanctuary as a Totally Protected Area, several longhouses of the Iban community were already in existence in the neighbouring areas. The management of the Sanctuary, therefore, represents a new set of circumstances, which put some pressure on their traditional practices and landuse, and thus, may undermine the incentives for sustainable use of the invaluable resources. Various experiences have shown the needs for the local communities to play an active role in the conservation of the resources.

With their dependence on the nearby forests, it is essential to examine the perception of the local community towards the management and protection of the Sanctuary. Therefore, the main objective of this paper is to provide the background and rationale for incorporating socio-economic component into the management and development plan of the Sancutary. The paper also attempts to highlight the perception of the local community towards the conservation and management of the Sanctuary. The determination of their perception is largely based on the findings of a preliminary assessment of the Project, which was done as part of the monitoring exercise, as well as, the community consultation process.

The findings would be useful for charting future strategies and in designing a required intervention approach that accomodates the needs and aspirations of the community for sustainable development of the Sanctuary. The communities are also encouraged to participate in the formulation of their own solutions that will not be in conflict with their traditional values and beliefs. It is believed that only by involving the communities from the onset will the development plan aiming to protect the Sanctuary to help the local communities to improve their socio-economic status be succesful.

1.0 INTRODUCTION

From a socio-economic study of the Lanjak Entimau Wild Life Sanctuary (LEWS) carried out in 1994 several longhouses were found to be located within the periphery of the Sanctuary. Of all the longhouses, only the last few located in the upper reaches of the respective rivers were found to have direct access to the areas, and are expected to be directly affected by or having direct impact on the Sanctuary. Subsequently, a number of project activities have been implemented in these longhouses during Phase II of the project implementation.

A brief survey of these few long houses was undertaken in the second week of September 1999 as part of the monitoring exercise. The main objective was to undertake a preliminary evaluation of the projects, as well as to determine the perception of the community towards the present project. This paper presents the findings of the study, particularly, to highlight the perception of the neighbouring community towards the Sanctuary.

2.0 SOCIO-ECONOMIC BACKGROUND OF THE COMMUNITIES

2.1 Longhouse community

As stipulated in the Project Document, one of its overiding objectives is the development of Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area (TPA) for nature conservation. However, in trying to achieve this objective, one cannot afford to disregard the communities living adjacent to the areas for many generations, and who are presently dependent on the forestry resources for their livelihood. It is, therefore, imperative to sustain the present situation for the mutual benefits of the Sanctuary and the local communities.

A total of 102 Iban longhouses with an estimated population of 12,400 were found to be living at the periphery of the Sanctuary (Sidu, 1994) (See Table 1). The longhouses were located mainly along the four major tributaries leading to the areas (see Table 1). With difficult and costly transport, only the last few longhouses closest to the areas have direct access to the Sanctuary.

Understanding their needs, the government have legally granted rights to the villagers from 35 neighbouring longhouses to collect jungle produce from the area for their own consumption under the Lanjak Entimau Wild Life Sanctuary Order 1983. As per the *Second Schedule* of the aforesaid Order, these include, 13 longhouses in Ulu Ngemah area, 12 in Ulu Kanowit area and 10 in Ulu Katibas Area (none in Ulu Engkari, Lubok Antu).

Presently, the exploitation of the resources for their own use is under control. However, with the changing environment, encroachment into the Sanctuary could become a threat in the foreseeable future if no appropriate measures are taken right from the beginning. This is particularly so in view of its vastness, which makes enforcement extremely difficult. The best alternative is to establish a good rapport and co-operation of the neighbouring communities. For these reasons, the socio-economic components of the project are essential, and should be directed at improving the socio-economic status of the local community, as well as encouraging their greater participation in the management of the Sanctuary.

Table 1 - Number of Longhouses and Population in the periphery of the LEWS

AREA (River system) (District)	No. of onghouse (Villages)	Total households	Total population
Upper Kanowit River (Julau District)	26	559	3,268
Upper Ngemah River (Kanowit District)	51	747	5,530
Upper Katibas River (Song District)	22	415	3,350
Upper Engkari River (Lubok Antu District)	3	40	250
Total	102	1,761	12,398

Source: Socio-economic Survey of Lanjak-Entimau Wild Life Sanctuary, July 1994.

2.2 Major Agricultural Activities of the Community

2.2.1 Hill padi farming

The needs for socio-economic improvement are necessary as the people are basically subsistence farmers, planting hill padi as their main activity. From the earlier socio-economic study, majority of them planted hill padi (See Table 2) with an average farm size of about 2.0 hectares per household. In areas with low population density and few other resources except land, such traditional practice of farming can be regarded as rational because it is economically the best method for them, requiring almost no cash inputs and limited labour. Partly for these reasons, the return from padi farming has been very low (much lower than the average yield of 464 to 590 kg/ha for the Districts), which results in more than half of the households having inadequate supply of rice to meet their own needs until the next harvest.

In spite of its low return and being the main source of staple and security food for them, hill *padi* planting is expected to continue in the future but the size may be getting smaller. This is expected as there is increasing trend of the rural-urban migration among the communities which drastically reduces the available manpower.

Table 2 - Percentage of households planting hill rice

Planting	Upper Kanowit		Upper Ngemah		Upper Katibas		Upper Engkari		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Planting	78	93	67	93	59	95	12	100	218	94
Not Planting	6	7	5	7	3	5	0	0	14	6
Total	84		72		62		12		230	

Source: Socio-economic Survey of Lanjak-Entimau Wild Life Sanctuary, July 1994.

2.2.2 Other agricultural activities

Besides hill *padi* farming, the major use of their land was the cultivation of cash crops, which include mainly rubber, pepper, cocoa and fruit trees. However, due to various constraints, the cultivation of these crops had not been successfully undertaken, and therefore, did not contribute much to the general economy of the households in the areas. Other activities, such as fish rearing is still minimal while livestock rearing is mainly done for their own consumption. For these reasons, some of them have worked elsewhere leaving their gardens and crops neglected.

3.0 UTILISATION ON FORESTRY RESOURCES

Like any other communities whose lives are closely associated with forest, hunting, fishing and collection of jungle produce are important to the local communities. Although no detailed study has been done on their exploitation of the forest resources, there are indications that the Iban communities in the respective areas are dependent on the forests for their livelihood.

3.1 Hunting

Being close to the forests, the majority of the households in the neighbouring areas are still involved in hunting the wild animals commonly found either in the *temuda* (secondary forest) or in the primary forest. Overall, being more prolific, wild boar is still the most popularly hunted animal, while the rest of the animals like deers and other smaller animals were less frequently caught. The percentage of people involved in hunting these animals are much less if compared with the survey findings in 1994. This could be due to the fewer number of capable males still left behind in the long houses as many of them were working for wages elsewhere. The reduced intensity of hunting could also be due to the fact that the animals are getting less, and therefore, harder to hunt now (See Table 3).

Table 3 - Percentage of households involved in hunting

Wild Animals	Percentage involved	Availability Status (Percent)
Wild boar *(Sus barbatus)*	38%	Getting less - 56% Remain unchanged - 22% Getting more - 22%
Rusa (*Cervus unicolor*)	13%	Getting less - 100%
Kijang (muntiacus spp.)	13%	Getting less - 67% Remain the same - 33%
Others (including mousedeer, porcupine, ant-eater and other smaller animals)	13%	Getting less - 67% Remain the same - 33%

3.2 Fishing

Like hunting, fishing is also an important activity of the longhouse communities in the neighbouring areas. Various types of local fish are caught, but the major ones are *baong, semah, tengadak, bantak, kulong* and *enseluai* (See Table 4). These fish are considered indigenous to the areas as some of them are not found in other rivers, especially in respect of the high-value fish like *semah* and *tengadak*. .

Table 4 - Percentage of households involved in fishing

Fish	Percent involved	Availability Status (Percent)
Baong (*Mystus* spp.)	54%	Getting less - 77% Getting more - 23%
Semah (*Tor duronensis)*	46%	Getting less - 73% Getting more - 27%
Tengadak (Puntius schwanenfeldii)	13%	Getting less - 67% Remain unchanged - 33%
Others (including *bantak, kulong* and *enseluai*)	50%	Getting less - 75% Remain unchanged - 25%

With their longhouses scattered along the major rivers, their fishing activities are confined mainly to rivers along their respective longhouses, and it is not uncommon for them to go fishing almost daily for their immediate consumption. Being aware of the needs to ensure continuous supply of fish, and to ensure that their rivers are safe for human use, there was strict control on fish poisoning, and most of them use the traditional fishing gears, such as hooks and nets.

Like the wild animals, most of the villagers feel that there is much less fish now compared to ten years ago (See Table 3). Rapid decline of fish in most rivers has been partly due to over-fishing and increasing pollution. In view of this, aquaculture development would be useful to sustain the supply of fish both for local consumption and for cash income.

3.3 Collection of Non-timber Forest Produce

Another important activity through which most of the households supplement their income and food supply is the collection of non-timber forest produce. With their intimate knowledge of the forests, most of the "wild products" in the jungles that are edible and medicinally useful are practically known to them. As such, all kinds of wild fruits and vegetables, including rattan and edible fungi are collected but mainly for their own consumption. Being far from the major towns, most of their building and constructional materials are also derived from the neighbouring forest either from the secondary or primary jungles. However, extraction of timber for construction and repair of longhouses and for making longboats is only done occasionally as the need arises.

4.0 LEVEL OF HOUSEHOLD INCOME

With limited opportunities to earn cash income, it is not surprising to note the level of income among the local community has been extremely low. From the detailed socio-economic study conducted in 1994, an average income of the survey households was estimated at RM1,100 per annum or an equivalent of RM92 per month per household. Most of the surveyed households were within the income level of less than RM1,000 per annum. Substantial income was derived from their wage employment as it constituted about 20 to 40% of their household income.

Compared to the State Poverty Line Income of RM5,940 per annum for a household of 5.1 persons (1993), there were definitely high incidence of poverty among the communities. The majority of the households were earning a cash income of less than RM5,000 per annum and only 3% earned a cash income of more than RM5,000 p.a. Actually a high proportion of the households earned a total cash income of about RM1,000 per annum (See Table 5).

The prevalence of poverty among them could be the main factor for a relatively high incidence of malnutrition among their pre-school going children. The problem had also an adverse impact on them as with limited cash they had difficulties sending their children to schools, especially to secondary schools, thus affecting their level of education. It is obvious that the main constraint to the socio-economic development of the communities living adjacent to the Sanctuary is their remoteness, resulting in their isolation.

Table 5 Estimated household cash income for the year 1993

Income Level	Upper Kanowit		Upper Ngemah		Upper Katibas		Upper Engkari		Overall	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Nil	1	1	8	11	1	2	0	0	10	4
500	30	36	33	46	22	35	8	67	93	40
1000	24	29	18	25	9	15	3	25	54	23
1500	9	11	5	7	9	15	0	0	23	10
2000	5	6	3	4	5	8	1	8	14	6
2500	5	6	1	1	6	10	0	0	12	5
3000	2	2	0	0	3	5	0	0	5	2
3500	1	1	1	1	1	2	0	0	3	1
4000	3	4	1	1	1	2	0	0	5	2
4500	1	1	2	3	1	2	0	0	4	2
5000	0	0	0	0	1	2	0	0	1	0
Over 5000	3	4	0	0	3	5	0	0	6	3
Total	84	100	72	100	62	100	12	100	230	100
Average	1180		800		1534		462		1130	
Minimum	120		23		60		60		23	
Maximum	5824		4380		8360		1524		8360	

Source: Socio-economic Survey of Lanjak-Entimau Wild Life Sanctuary, July 1994.

Note:

1. Household income includes the imputed values of hill rice (average price of 0.60 cents/Kg.), gross sales of farm and jungle products (rattan, wild vegetables & fruits) and those derived from the sales of wild animals and freshwater fish and cash remittances from the family members who worked elsewhere.
2. The State Poverty Line Income (1993) was estimated at RM5,940 p.a. or RM495 p.m. for a household of 5.1 persons (State Planning Unit).

In the context of the management and conservation of the Sanctuary, the problem of poverty among the local community is one of the critical areas that needs to be viewed seriously by the Project management. Presently, it may not pose much problem but its future ramifications can be a threat to the Sanctuary. The longhouse communities in the respective areas will be poverty-driven to look for any possible alternatives to earn their living. As such, there is a need to incorporate various measures in the development plan of the Sanctuary in order to tackle the related social problems.

5.0 IMPACTS OF THE PROJECT UPON THE LOCAL COMMUNITIES

Being part and parcel of their livelihood system, forest and its resources contribute considerably to the welfare and economic well-being of the rural people. It is well-documented that the range of uses and functions of forests in rural setting are enormous. The LEWS are no exception as the longhouse communities living nearby have been and will continue to be dependent on the forest for their living. Under the existing situation, the dependency of the local population upon the forests can, in fact, be seen from many angles, be that in cash terms (cash income), in dietary terms (amount of food or nutritional importance), in seasonal terms (importance in bad weather or drought) and gendered or age specific terms.

However, with the objective to manage the LEWS as a TPA, it inevitably means that alternative land use have to be forgone, and therefore, a cost to the communities. Under the circumstances, any effort to develop and manage the LEWS would definitely affect the local communities either directly or indirectly. However, the actual impacts of the Sanctuary on the local communities will depend on the various restrictions imposed by the Project. Nevertheless, based on the preliminary study the following are some of the benefits and negative points of the Project.

5.1 Project Benefits

5.1.1 Management and enhancement of natural resources and environment

With the conservation and management of the Sanctuary as a TPA, the existing environment will be maintained in its natural and pristine state. Besides its ecological and hydrological benefits, the whole biomass in general is the total wealth to the State, and to the local communities, in particular. Unfortunately, the whole values of the forest have often been overlooked as its contributions are only seen in terms of its direct values, and thus discounting its intangible values. With its undisturbed environment, forests provide excellent cover for wild life, while indiscreet felling and environmental destruction will definitely affect the natural habitat of the available wild animals and wild plants, including endangered species. Another important point is that with its catchment remaining intact, there will be minimal pollution of rivers within the Sanctuary, which serve as a good breeding ground for indigenous fish. All these are direct benefits, which the communities living nearby the Sanctuary will continue to enjoy so long as the environment is under control and properly managed.

On the other hand, the impact may be especially negative if natural forests are cleared to make way for other forms of development. Such development as plantations will contribute to the loss of watershed, soil fertility and biodiversity. Biological diversity in natural forests is crucial as it confers resilience and stability and provides multiple benefits for local people, particularly in times of seasonal shortages and occasional catastrophe.

The Sanctuary's boundary configuration may have partly affected their adjacent land, but has not really taken their land out of food production, neither were the villages dislocated nor their rights to collect jungle products from the forests ignored. Therefore, the effort to conserve the Sanctuary would definitely be beneficial to the local communities both in the immediate and long-term.

5.1.2 Provision of opportunity for employment and income generation

Another direct benefit of LEWS to the local communities will be the creation of opportunities for their employment. It is expected that various development activities of the Sanctuary will definitely require some manpower, which could be recruited from the neighbouring villages. In fact, some of the capable males from the nearby longhouses were already employed and engaged as casual labourers at the two Ranger Stations of Ng Ju in Ulu Mujok and Ng Bloh in Ulu Katibas. Although the project may not be able to provide enough jobs for all the economically active persons available, substantial job and other business opportunities will be generated in future, especially when the Sanctuary is fully developed.

In addition, opportunities and facilities for skill development and training in activities related to forestry would be organised for the local communities. This is an added incentive that would make them more involved in the development of any projects in the area. The local communities will also directly benefit from the various socio-economic projects implemented in their respective longhouses. The implementation of these projects should be continued as it is not only to encourage greater participation in the protection of the Sanctuary, but most importantly, to help cushion the pressure on the existing resources. It is expected that, with the opportunities, their cash income and socio-economic status will be slowly improved, and thereby reducing pressure on the Sanctuary.

5.2 Negative Points

5.2.1 Restriction on the Traditional Activities

In any development projects, there are certainly some negative views that are unavoidable. Based on the general feelings and observation, it is unlikely that the development of the LEWS will cause any adverse social impacts to the local communities. Nevertheless, being dependent on farming, hunting, fishing, and collection of jungle produce for their living, one of the most distinct issues raised is in respect of the "restrictions" to these traditional activities through the enforcement of the relevant Laws and Regulations.

(a) Shifting cultivation

As a Totally Protected Area, the local communities will be prohibited from further clearing of the primary forest within the Sanctuary. Control and restriction of their customary land use practices will to a certain extent affect their present lifestyle. However, the practice of shifting cultivation is becoming less popular among the new generation as it has been found to be less productive. There is also increasing trend of urban migration among them to work for wages elsewhere, which results in less number of capable males available in the villages. With a very low population density, there is no pressure on their existing *temuda* (secondary forest). Therefore, this is not really a problem to the Sanctuary.

(b) Hunting, fishing and collection of jungle produce

Strict enforcement of the Regulations relating to these forest-related activities, especially the ban on the sale of wild meat, will have some effect on those who have been depending on the activities for their living. For example, such measure will limit the opportunity for them to earn meager cash income to support their families, whereas previously, they could sell the wild meat more openly.

But all these restrictions are a blessing in disguise to the communities as the intention is towards proper control on the exploitation of wild life, which in the long run will ensure continuous supply of wild meat for their own consumption. After all, the local people are already experiencing difficulties in hunting and fishing within the neighbouring areas. It is, therefore timely to conserve the LEWS and to enforce the ban on the sale of wild meat. Otherwise, the problem will be further aggravated and may instead cause hardship to the communities concerned.

6.0 PERCEPTION TOWARDS CONSERVATION AND PROTECTION OF THE SANCTUARY

Parks and nature reserves have long been thought of as the best way of preserving wild life. Following the Earth Summit in Rio de Janeiro in 1992, and the ratification of the Biodiversity Convention, many countries are seeking to transform as much land as possible to strictly protected regimes. The central concept has been conserving the natural state of pristine environments. This implies trying to keep nature as they are, but they can never remain unchanged for a number of factors, particularly with increasing human population and economic development. Moreover, the creation of most of the protected areas involved the local communities, who are often excluded by the project management. It is well recognised that the rural and subsistence communities depend on the wild resources for their livelihood. For this reason, if wild habitats are lost, these resources will no longer be available, and those who will suffer most are the poorest.

Consequently, conflicts between the conservation effort and the local people is a key issue since without local involvement in the management of protected areas, adequate protection can only be achieved if the Implementation Agency has the authority and ability to enforce regulations. This is both undesirable and often unattainable, and this realisation represents a major shift in practical conservation philosophy. From various experiences, forest protection and exclusion through policing has not proved sustainable and has resulted in considerable local resistance. It is, therefore increasingly being recognised that wild life conservation must operate hand in hand with sustainable use by local communities.

Incentives for wild life management are only effective if the communities have a long-term vested interest in managing the wild life resources for their economic gain. Managing wild life as wild food resources is an important step towards sustainable use and management of the Sanctuary. This is because unless they are made available to local communities, commitment to manage the resources will remain limited. Wild food is a part of their diets not only during period of shortages, but also on a daily basis. Developing effective institutions for common property resource management represents a major challenge for policy makers.

Presently, the Sanctuary is fortunate as the population remain sparse and status quo. Nevetheless, the local people will be faced with a new sets of circumstances and regulations with the development of the Sanctuary. It is, therefore, not unusual for any Project to encounter initial resistance especially when the local people are not properly consulted and well-informed about the project. Considering their close proximity to the Project areas, it is, therefore, essential to find out ways in which their perceptions and needs may best be taken into account to achieve sustainable management.

Being in the interior part of the region, forests are crucial to the Iban people. As traditional shifting cultivators, forests provide them the very condition for this form of agriculture. Forest resources have also been gathered freely to meet their basic needs. However, as the resources have declined overtime, primarily as a result of land clearance for agricultural production, the communities have now recognised the importance of having a natural and virgin forest near their villages to provide the goods and services central to their livelihood system. They will continue to be dependent on the forest for their food and supplementary income.

Overall, the local communities are positive and receptive towards the conservation and protection the Sanctuary. As indicated in Table 6, an overwhelming majority or 92% of the survey households agreed that the development of the LEWS would bring the benefits to them. Practically, none of the respondents showed their disagreement, while only the remaining 8% was uncertain whether the Sanctuary would benefit them.

Table 6 Percentage of households who agreed that the LEWS would bring benefits

LEWS are beneficial to local Community	Percentage (%)
Agreed	92
Disagreed	0
Not sure	8
Total	100

With judicious exploitation by the locals, the management and protection of the Sanctuary will, in the long run, ensure them a continuous supply of food and other valuable produce. The benefits of having a constant supply of wild animals, like wild boar and deer, and fish are being experienced by those living closest to the Sanctuary. In view of these, the neighbouring villagers were unaware that they have exercised their informal control over the immediate areas in an effort to ensure continuous supply of food and other jungle produce for themselves. They have in fact served as an effective watchdog for any possible encroachment into the Sanctuary, especially from the outsiders or villagers downriver.

6.1 Ban on hunting and trade on wild meat

Legislative bans on threatening activities have been widely implemented in many countries to safeguard certain species. However, a ban is, in practice, like any legislation, only effective if the enforcement is effective. Some conservationists argue that bans can only be a short-term measure, but a long-lasting protection can only be envisaged if the people can be persuaded or convinced of the noble objectives.

A desire of the local communities to conserve the existing resources, particularly the wild life, was further supported by the fact that about 75% of the surveyed households agreed with the ban on the sale of wild meat (See Table 7). They have slowly realised that the ban will certainly help to conserve the wild animals, thereby ensuring continuous supply of food themselves. Those who disagreed felt that the ban has put some restriction upon them from earning supplementary cash income like before.

Table 7 Percentage of households agreed with the ban on sale of wild meat

Agreed with the ban	Percentage (%)
Agreed	75
Disagreed	17
Not sure	8
Total	100

Again, from the survey results, 63% of the households agreed with strict enforcement of the regulations (See Table 8). This includes a complete ban on any logging activities adjacent to the areas as the activity could adversely affect the environment, particularly pollution of inland waters in the catchment areas.

Table 8 Percentage of households agreed with the strict enforcement of Regulations

Agreed with Strict Enforcement of Regulations	Percentage (%)
Agreed	63
Disagreed	33
Not sure	4
Total	100

Among those who agreed with a more stringent enforcement of the Regulations, 67% would still want the Forest Department to be the lead agency as well as being the Implementing Agency (See Table 9). Currently, they realise that the stations are not managed and utilised properly in view of inadequate staff. The remaining 33% suggested that the community leaders and the local people should be given the mandate to enforce the necessary regulations as they are at the grass-root and always around. This implies that in order to be effective, the Forest Department should as far as possible get the support and co-operation of the local villagers, particularly their headmen (Tuai Rumah).

Table 9 Suggestion on who should enforce the Regulations

Responsible agency	Percentage (%)
Forest Department	67
Community leaders	21
Local people	12
Total	100

With the exception of their sceptism on the possible restrictions on their traditional activities, all these perceptions clearly indicated that the local communities value the Sanctuary, particularly its rich natural resources. They appreciated the great potential that can be derived from the effort to manage and conserve the Sanctuary. They were willing to co-operate with the government agency in the management and protection of the Sanctuary provided that they could derive benefits from it in the future.

7.0 RECOMMENDATIONS AND CONCLUSION

7.1 Socio-economic Development

Socio-economic projects, which are aimed at improving the socio-economic status of the communities, should be continued and intensified in view of the high incidence of poverty in the rural areas. The communities are also in the process of transition and adjustment to the new circumstances. It is felt that only through such development can the pressure on the Sanctuary be minimised in the near future.

Based on the felt needs of the local communities, the following projects are recommended for implementation in order to improve their socio-economic status:-

(i) Development of freshwater fisheries
(ii) Livestock rearing and domestication of wild animals
(iii) Integration of indigenous fruit production with apiculture
(iv) Development and promotion of eco-tourism

For greater impact and sustainability, the projects should be properly planned and implemented on a relatively larger scale to benefit a greater number of the villagers. Implementation of both the individual and community projects is recommended in order to have wider coverage, and at the same time, encourage their participation and instill the spirit of co-operation among the longhouse communities. The project management at both the official and community levels is important, while the existing institutional leadership structure should be utilised to marshall the support and co-operation of the villagers.

7.2 Establish Good Rapport with the Local Communities

The project management should establish and maintain a good rapport with the local people in order to encourage their involvement and participation in management. Continuous consultation will avoid future conflicts with them, and thus attention must be given to the human aspect of development. A proper machinery is required to undertake the task of community development and consultation, which should be continuously carried out by the Implementing Agency. Apart from the creation of awareness on the needs for forest management this will also provide important feedback for successful implementation of any development programme.

In terms of future employment, with their experiences and knowledge of the areas, the local people can be an asset to the project. As such, priority would be given to the nearby villages whenever opportunity for employment arises.

7.3 Conclusion

With their reliance on the immediate environment for their sustenance, the local communities have a far greater awareness on the importance of conservation than anyone else. It is in their interest not to damage it because to destroy the environment would be to threaten their own survival. Overall, therefore, despite some restrictions on their traditional activities, the project would certainly be beneficial and socially acceptable as well as to the pristine environment, both in its immediate term and long-term development. The challenge is to maintain the co-existence of the local communities and natural forest for the mutual benefits and sustainable development of the Sanctuary.

REFERENCE

1. Sidu, J. (1994) A Socio-Economic Study of the community living adjacent to the Lanjak-Entimau Wild Life Santuary (Unpublished Report)

DISCUSSIONS

Runi Sylvester Pungga

What is the educational status of the children in the area?

Jiram Sidu

This study did not look into the educational status of the children living in the area. However during Phase I of the project, the study on the socio-economic aspects covered the educational level of the children. Generally the level of education is low among the school children because of lack of facilities and the remoteness of the longhouses.

Jayl Langub

I have some suggestions. The best way to channel community projects to the longhouses is through the Village Development and Security Committee. If the longhouses at LEWS do not have their respective committees, they should seek the advice of their District Officers to set up one. This is to avoid a situation in which the Tuai Rumah would be responsible to all the community projects. An article by Clifford Sather, an anthropologist on "Trees and Tree Tenure in Paku Iban Society", which discussed indigenous management of resources in the Spaoh Sub-district, would provide a good guide in agro-forestry activities. Other references such as the Sarawak Gazette, Annual Report of District Office, Sarawak Musuem Journal, and the History of Kanowit could provide some useful information on secondary forest and migration.

Joseph Jawa Kendawang

During the socio-economic survey in 1994, the majority of the longhouses preferred some of the nearby forests to be constituted as communal forest. May I have the opinion of the Speaker?

Jiram Sidu

A communal forest in the periphery of LEWS can serve as an additional buffer zone to reduce encroachment into the deeper part of the Sanctuary and as a source of forest produce to the local communities.

Penguang Manggil

The Departrment has proposed that the forest areas around LEWS be constituted as protected forest. It is being demarcated on the ground. We feel that there is no need to constitute a communal forest as the protected forest serves the same purpose as the communal forest. Under Section 65 of the Forests Ordinance any inhabitant of Sarawak may without licence or permit cut and remove from state land which is not a Forest Reserve any timber or other forest produce for his own domestic use.

Haryadi

Do the local communities have indigenous right in the area?

Jiram Sidu

When Lanjak Entimau Wildlife Sanctuary was constituted in 1983, thirty-five longhouses were granted rights to collect forest produce in the designated areas within the Sanctuary. However it is the few longhouses that are close to the Sanctuary have direct access to the areas because the other longhouses are constraint by the high cost of transportation. Rules pertaining to the management of a wildlife sanctuary are contained in the Wildlife Protection Ordinance, 1998. The Forest Department has also appointed Wildlife Rangers to enforce the Wildlife Rules and Regulations.

WORKSHOP RECOMMENDATIONS

Recognising the importance of Lanjak Entimau Wildlife Sanctuary as one of the major areas for conservation of tropical forest biodiversity in the world and in acknowledging the financial and technical contributions made by ITTO as well as the amount of scientific endeavours carried out so far by the Sarawak Research Team, it is recommended that:

(1) the scientific work to inventorise the extent and magnitude of plant and animal biological diversity in the Sanctuary be continued and extended to cover a wider groups of organisms (keystone species) directly relevant to the current and future management plans of the Sanctuary.

(2) to facilitate the smooth implementation of the management plans for the Sanctuary, forest types (habitats) occurring in the Sanctuary should be accurately mapped using the latest available technologies, eg. GIS, Remote Sensing, Satellite Imageries, etc.

(3) the definitions of genebank be expanded to include a collection of non-timber non-tree species of ethnobotanical values and to establish an *ex-situ* herbal garden.

(4) to promote the use of the indigenous technical knowledge and traditional forestry related knowledge to study the numerous plant resources and to develop strategies to conserve such resources and to protect Intellectual Property Rights.

(5) detailed studies on the plant-animal interaction and on the roles of the critical groups of animals in pollination and seed disposal and the reproduction biology of forest trees.

(6) the Sarawak Forest Department shall undertake the studies of orangutan and flora diversity and the resulted fund saving be utilised to promote bilateral collaboration between Betung Kerihun NP and Lanjak Entimau Wildlife Sanctuary.

(7) fishing guidelines be formulated to regulate fishing in LEWS and in the designated areas of the Sanctuary to ensure the fish stock is sustained.

(8) entry into the Sanctuary be strictly regulated and enforced to ensure that the area is developed into a totally protected area.

(9) scientific training and conservation education be intensified.

(10) the local communities be given roles in the management of LEWS as provided for under the Wildlife Protection Ordinance, 1998.

(11) the population of wild game animals and their reproduction biology be ascertained with a view to regulate seasonal hunting.

CLOSING ADDRESS

Closing Remarks

By Mr. Penguang Manggil, ITTO Projects Coordinator, Sarawak

Mr. Penguang Manggil, the ITTO Projects Coordinator for Sarawak, in his closing remarks, reiterated that the Workshop does not only served as a forum for discussing the achievement and the scientific results of the project, but more so as platform for sharing of experience and information and the formation of a networking among the array of professionals attending the Workshop. He acknowledged that the ensuing discussions during the Workshop has been very constructive and lively, for the subject matters which could have been extremely technical and "dry". He commended all the paper presenters for their dedication and hardwork and enormous time they have spent in preparing for the Workshop.

Mr. Penguang also recognised and commended the three Session Chairmen namely Dr. Efransjah of ITTO Secretariat Japan, Mr. Patrick Andau from the Wildlife Department, Sabah and Dr. Nengah from WWF, Indonesia, for their professionalism and the manner they have guided the discussions to the standard that every one of us had witnessed during the last 2 days. He assured all participants that their contributions have been dully recorded by the rapporteurs and that the recommendations emanating from the Workshop would either be used to enhance the quality of the final report or be tabled in the coming PSC meeting to be used as a guideline in mapping out the activities for the next phase (i.e. Phase III) of the Lanjak Entimau Wildlife Sanctuary Project.

Finally, he said, as ITTO Projects Coordinator and on behalf of the Director of Forests who is away on official duty in Australia, he would like to extend his thanks and appreciation to Dr. Efransjah, ITTO Projects Manager for the Asian-Pacific Region, for his understanding, enthusiasm, support and cooperation over the years. He also thanks all participants, particularly those from Indonesia, Peninsular Malaysia and Sabah for their support and contributions and to the Organising Committee led by Dr. Paul Chai, the Project Leader, for their untiring efforts in ensuring the smooth running of the Workshop.

APPENDICES

APPENDIX 1 GLOSSARY

a.s.l.	:	above sea level
Batang	:	main river
bomoh/mamang	:	traditional medicine man
bubu	:	fish trap
Bt, Bukit	:	Hill
°c	:	degrees celsius
c.	:	of approximately
cm	:	centimetre
E	:	East
emping	:	cracker made from the nuts of *Gnetum gnemon*
g	:	gram
GPS	:	global positioning system
ha	:	hectare
hilir	:	lower, down river
kg	:	kilogram
km	:	kilometre
kuali	:	wok, frying pan
kulat	:	fungi
LNK	:	a pepper, a high yield and disease resistance variety
m	:	metre
mm	:	millimetre
miring	:	a ritual to offer sacrifice
N	:	North
NP	:	National Park
Ng, Nanga	:	Mouth of a stream
p.a.	:	per annum
padi	:	unhasked rice
ppm	:	parts per million
Rh, Rumah	:	village, house
RM, Ringgit	:	Malaysian currency, Ringgit Malaysia (US$1.00 = RM3.80)
Rotan	:	Rattan
S, Sg, Sungai	:	river, stream
t	:	tonne
tamu	:	market
temuda	:	young forest, secondary forest
Tintieng	:	ridge
Tuai Rumah	:	head of village or longhouse
Ulu, Hulu	:	interior, upper reaches of river
umbut	:	young shoot

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Official opening & Workshop Organisation

Chairman	:	Mr. Julaihi Abdullah
Members	:	Mr. Kho Seng Yaw
	:	Mr. Jet Kaliang
	:	Mr. Kenny Chew
	:	Mr. Jemree Sabli
	:	Mr. Joseph Yap

Protocol/Reception

Chairperson	:	Ms. Runi Sylvester Pungga
	:	Miss Angelia Muri
	:	Ms. Jumiah Ludoh
	:	Miss Lilian Vivine Malo
	:	Ms. Rainih Hassan
	:	Ms. Chiang Boi Hua

Transport/Accomodation

Chairman	:	Mr. Johnny Poh
	:	Mr. Azman Hipni
	:	Mr. Francis Dihom
	:	Mr. Voon Voo Joon
	:	Mr. Lu Yaw Yun
	:	Mr. Fernandos Douglas

Publicity

Chairman	:	Mr. Shahbudin Bin. Hj. Sabki
	:	Mr. Voon Joon Hee
	:	Mr. Jainal Abidin Bin. Hj. Rosli

Registration

Chairperson	:	Miss Chiang Moi Sien
	:	Miss Angelia Muri
	:	Miss Fauziah Bt. Hassan
	:	Miss Jong Pei Yung
	:	Ms. Chiang Boi Hua

Dinner

Chairman	:	Mr. Kueh Juan Hian
	:	Mr. Kho Seng Yaw