INTERNATIONAL TROPICAL TIMBER ORGANIZATION

ITTO

PROJECT DOCUMENT

TITLE	DEVELOPMENT OF LANJAK-ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA - PHASE III
SERIAL NUMBER	PD 16/99 Rev.2 (F)
COMMITTEE	REFORESTATION AND FOREST MANAGEMENT
SUBMITTED BY	GOVERNMENT OF MALAYSIA
ORIGINAL LANGUAGE	ENGLISH

SUMMARY

On the basis of the findings and recommendations from Phase II and the ITTO Borneo Biodiversity Expedition 1997, and in line with the Sarawak Government's goal on sustainable forest management, Phase III's outputs place emphasis on conservation through utilisation of timber and non-timber resources, and contribute towards developing the full potential of the Trans-boundary Bentuang Karimun Lanjak Entimau Biodiversity Conservation Area.

Main Outputs

1. Monitor and provide information on the phenology and agronomy of timber tree species in gene banks;
2. Provide technical and scientific training to the local communities in the development of sustainably produced resources;
3. Survey and collect information on the status of orangutan in the Trans-boundary Conservation Area including the Batang Ai National Park in Sarawak;
4. Conduct botanical studies relating to protection of critical habitats and endangered species, and on the potential of indigenous ornamental plants;
5. Provide and update management guidelines for the management of the Sanctuary as well as the Trans-boundary Conservation Area;
6 Provide training to young scientists and graduates to contribute to the future management need of the Sarawak Forest Department

EXECUTING AGENCY	FOREST DEPARTMENT, SARAWAK, MALAYSIA
COOPERATING GOVERNMENTS	---
DURATION	36 MONTHS
APPROXIMATE STARTING DATE	TO BE DETERMINED

BUDGET AND PROPOSED SOURCES OF FINANCE

Source	Contribution in US$	Local Currency Equivalent
ITTO	**743,775**	
Gov't of Malaysia	935,000	*RM3,553,000*
TOTAL	**1,678,775**	

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PART I : CONTEXT

A. RELEVANCE TO ITTO

1. Compliance with ITTO Objectives

This project proposal meets the following Objectives of Article 1 of the International Tropical Timber Agreement, 1994 (ITTA):-

(c) To contribute to the process of sustainable development (Output 1)

(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 (Outputs 1 and 2)

(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 (Output 2).

2. Compliance with ITTO Criteria

The project relates to four areas namely natural forest management, reforestation programmes, training of technical personnel and institutional framework, and national planning.

Activities that conform to ITTO criteria involve:

(a) Improvement of forest management through research into the natural forest ecosystems, species composition and gene banks of timber trees and their sustainable use (Output 1);

(b) Contribution to reforestation through protection and utilization of regenerating forests and abandoned shifting cultivation areas in the buffer zone with sustainable use of non-timber forest products (Outputs 1 and 2);

(c) Contribution to the development and strengthening of the Sarawak Forest Department, particularly its National Parks and Wildlife, and Forest Research Branches, through research and training to increase technical competence.

(d) Enhancing international cooperation with Indonesia through collaborative research and management programmes developed for the Bentuang Karimun-Lanjak Entimau Trans-boundary Conservation Area (Outputs 1 and 2).

3. Relationship to ITTO Action Plan and Priorities

Priorities in the ITTO's Libreville Action Plan are wholly or partially covered by the Project under the Committee on Reforestation and Forest Management. The Action Plan has set out the following specific goals:-

(a)Support activities to secure the tropical timber resource base;
(b) Improve the tropical timber resource base;
(c)Enhance technical, financial and human capacities to manage the tropical timber resource base;

The Project's outputs through research and development and community development activities will provide the supporting actions to achieve these goals.

B. RELEVANCE TO NATIONAL POLICIES

1. Relationship to Policies Affecting Tropical Timber

The Forest Policy of Sarawak, adopted in 1954 sets forth, *inter alia*, the following principles of forest management:-

(1) Reserve permanently for the benefit of the present and future inhabitants of the country forest land sufficient for the assurance of the sound climatic and physical condition of the country; safeguarding of soil fertility and water supplies for domestic and industrial use, irrigation and agricultural purposes; and the prevention of damage by flooding and erosion to rivers and to agricultural land.

(2) Foster the value of forest among the public by education and other public programmes.

Lanjak Entimau is not only an area of natural forest that is extremely rich in biodiversity but also encompasses three catchment areas to protect the soil fertility of, and supply water to four of the nine administrative Divisions in the State. The Sanctuary will be developed into a centre for scientific research, demonstration and training.

2. Institutional and Legal Framework

The Ministry of Resource and Management Planning is the authority on forestry and wildlife management in Sarawak. Ordinances relating to the state's wildlife are the recently passed Wild Life Protection Ordinance (1998) and National Parks and Nature Reserves Ordinance (1998). These ordinances provide for the active participation of the local communities through the formation of Special Park Committees and Special Wildlife Committees in all national parks and wildlife sanctuaries respectively. The Forests Ordinance (1994) (including all amendments) ensures protection of wildlife within the Permanent Forest Estates.

The Sarawak Forest Department, with its headquarters in Kuching, is the executing agency of the project.

PART II : THE PROJECT

1. ORIGIN

The project derives from a report by the ITTO Mission in Sarawak, 1989-1990, entitled "The Promotion of Sustainable Forest Management: A Case Study in Sarawak, Malaysia". The ITTO Commission concluded that the conservation of biological diversity in Sarawak was best served through the *in situ* preservation of the State's natural heritage. Measures recommended towards the accomplishment of this goal included preservation of :

(a) A complete series of representative widespread habitats (various forest types, for example) to be accomplished by insuring that a full range of soil types and altitudes is included;
(b) Examples of all unusual habitats or areas with rare or endemic species;
(c) Viable populations of animals, especially large mammals and birds which require large home ranges;
(d) Species which are naturally rare or endangered, or subject to intensive cropping, such as orchids.

These recommendations are consistent with the goal of the Sarawak Forest Department which is "to preserve areas of significant geological, biological or historical value for the benefit, education and enjoyment of present and future generations".

The conservation value of Lanjak Entimau had already been recognised as early as the 1980s. In 1983 it was gazetted as a Wildlife Sanctuary primarily for the protection of the Orangutan population in Sarawak. The Sarawak Forest Department is responsible for demarcating and maintaining the boundaries which are over 160 kilometres long.

The current project comprises three phases: Phase I included analysis and compilation of data derived from scientific surveys of the primates, birds, herpetofauna, forest ecology and socio-economy of the area; a detailed plan for protection of the area, plans for the extension and use of the area by local people; further research on the flora and fauna and recommendations on the locations of research centres and sub-centres, manpower needs with inclusion of a detailed financial plan.

Phase II project proposals have been based on the results and recommendations as laid out in the ITTO consultants' reports on research and community development. These reports include:-

(a) Research and Development
- Botanical inventory
- Ethnobotanical inventory
- Mycological inventory
- Establishment of gene banks
- Small mammal inventory

- Herpetofaunal inventory
- Fish inventory
- Entomological inventory

(b) Community Development
- Cultivation of indigenous crops
- Fish management (fish rearing)
- Game management

The main findings of these studies are given in Appendices I to X.

Findings from Phase II have revealed the need to :-

(a) conduct further studies on the Orangutan to gather information on its occurrence and migration pattern. Besides the Lanjak Entimau Wildlife Sanctuary (LEWS), this threatened primate also occurs in the Batang Ai N.P. also in Sarawak, and Bentuang Karimun National Park in Kalimantan (Indonesia). All these three TPAs are contiguous with each other (**see Map 1**). A policy for joint management under the Trans-boundary Conservation Area is necessary since the Orangutan is not bound by state or international boundaries. It has been proposed that Batang Ai N.P. be included into the Trans-boundary Conservation Area;

(b) conduct botanical inventory in selected areas including Batang Ai N.P.;

(c) establish special zoning areas for the protection of rare and important plant and animal species. And

(d) meet the development needs of the communities by alternative sources. This is to be done through a field demonstration programme of community development projects to equip them with the necessary knowledge and skills to embark on economic activities.

2. PROJECT OBJECTIVES

2.1 Development Objective

To develop the LEWS Totally Protected Area into a model for biodiversity conservation and management of genetic resources for forestry, community developments and research.

2.2 Specific Objective 1

To continue specific aspects of the biodiversity inventory to suit the management needs of the Sanctuary and the adjacent protected area of Batang Ai N.P.

2.3 Specific Objective 2

To encourage and support the development of economic activities by the local communities to enable them to share the benefits of the biological resources on a sustained level.

2.4 Specific Objective 3

To promote and integrate biodiversity conservation, research and management on a collaborative base in the Trans-boundary Conservation Area with Bentuang Karimun N.P. in Kalimantan and other institutions involved in research on tropical forest biodiversity.

3. PROJECT JUSTIFICATION

3.1 Problem to be Addressed

Protection of the Sanctuary continues to be a problem as the local communities are still very much dependent on its plant and animal resources. Commercial hunting is still rampant in some parts of the Sanctuary. Encroachment by the timber industry can still pose a threat where the boundaries between the licence areas and the Sanctuary are not demarcated clearly. Control is difficult due to the size and remoteness. The interior is largely accessible only by foot. Wherever possible, logging roads that are built close to the boundaries are used to provide quicker access to the Sanctuary.

The problem of encroachment and poaching would be partly overcome with the cutting of the Sanctuary's over 160-kilometre long boundaries has begun. The establishment of semi-permanent camping facilities for game rangers along strategic sections of the boundary will facilitate patrolling activities and protection in the more sensitive areas.

Although commercial hunting is expected to be gradually reduced with the implementation of the recently passed Wild Life Protection Ordinance (1998) which bans the sale of wild meat, subsistence hunting will continue to be practiced by the local residents. Alternate income sources will be necessary if the local people are to be discouraged from this activity. Findings from Phase II have shown that by providing training and guidance to seek alternative livelihood, it will be possible to reduce their dependence on the natural resources. The Forest Department is encouraging the active participation of the local communities in the Sanctuary's management with the proposal to form a Special Wildlife Committee comprising members from the Wildlife Office of the Department, ITTO consultants and the local residents.

3.2 Characteristics of the project area

3.2.1 Location and Status

The LEWS is located in an area of rugged topography in southwestern Sarawak between 111° 53' E to 112° 28 1/2' E and 1°19' N to 1° 51' N, in portions of the Kapit, Sarikei, Sibu and Sri Aman Divisions. Administratively, it lies within the Districts of Song, Kanowit, Julau, Lubok Antu and Sri Aman. The total area of the Reserve is approximately 187,172 hectares, including proposed extensions of 18,414 hectares. Added to this is the Batang Ai N.P. immediately south of the Sanctuary. This Park has an area of 24,000 hectares.

Besides the base camp in Ulu Engkari, there is a ranger station in Ulu Mujok and a temporary headquarters in the Ulu Katibas. The headquarters complex (stage one) in Ulu Katibas, a sub-ranger station in Ulu Mujok and a series of sub-camps along the boundary will be ready by 1999. The existing field facilities are manned by Wildlife Rangers and assistants recruited from the local communities.

3.2.2 Topography, Geology and Soils

Lanjak Entimau is composed principally of rugged, hilly terrain ranging from about 60-1200 metres above sea level, and forms the origin of the watersheds of the Lupar and Rajang rivers. Annual rainfall ranges from 2000-4000 millimetres.

Rocks in the Sanctuary are roughly between 40-60 million years old (Cretaceous to Upper Eocene), consisting mainly of sandstone, shales and slates. Soils are generally poor, and the majority (86%) are unsuitable for agriculture.

3.2.3 Flora

The complex biodiversity of Lanjak Entimau occurs in eight distinct forest types including secondary forests between 30 and 100 years old. The 30-year-old secondary forest and riparian forest were surveyed during the ITTO Borneo Biodiversity Expedition (IBBE) in 1997.

Already known from the Sanctuary are more than 1,075 species of trees attaining diameters of 10 cm and above, 791 species below 10 cm, 177 species of non-woody flora, and no less than 250 types of medicinal plants, wild fruits and vegetables. All the fertile botanical specimens collected are stored in the Forest Department Herbarium. Over 500 species of fungi have also been documented from the 1998 inventory. This includes 16 edible species and 14 of medicinal value 42 species of lichens are also known.

About 500 species of flowering plants were recorded from IBBE (1997) including many palms and orchids. There were also 68 species of lowland bryophytes.

3.2.4 Fauna

New information has been added to the six species of primates, 203 species of birds and 75 species of herpetofauna already known. Lanjak Entimau is also home to 45 species of small mammals, 82 species of fish including 12 possibly new to science, and 1,053 species of insects.

From the various studies on flora and fauna, a number of new conservation zones have been identified for the protection of important and rare species.

3.2.5 Socio-Economic Aspects

Of the estimated 12,400 Iban people residing in the periphery of the Sanctuary,

many are still dependent on the forest and its resources for building materials and food. Out-migration is becoming a common occurrence as many young people with basic education look for work in the towns.

Shifting cultivation, hunting and fishing are still being actively pursued by the older ones who prefer their traditional lifestyle.

In order to reduce their dependence on the Sanctuary's resources, cultivation of selected food plants and rearing fish of high economic value has been introduced to residents in four longhouses.

3.3 Other Relevant Aspects of the Pre-Project Situation

Scientific findings from the previous two phases and from IBBE (1997), have confirmed the importance of the Sanctuary as a Totally Protected Area and a component of the Trans-boundary Conservation Area.

The studies have also revealed the need to look into a number of issues relating to the Sanctuary's resource management. These issues are:-

(a) While the training needs of local counterparts and technical assistants from the Forest Department have been adequately met through active participation in the previous two Phases, there is still an acute shortage of qualified manpower for the Department. The training of more young scientists and students to meet the future management needs must be given priority;

(b) At the community level, training of the local residents is also necessary as they need to be given the responsibility of co-managing the resources.

(c) A very important socio-economic aspect is that there is presently very limited alternate income source for the local residents. Besides subsistence hunting, many of them are also reluctant to give up commercial hunting in spite of the Government's ban on the sale of wild meat as it is an important income source. Cash crops are not popular because they are relatively low in value and expensive to produce. The development of alternative livelihood needs to be further investigated.

3.4 Intended Situation After Completion of Phase III

At the end of Phase III, Lanjak Entimau will become a model TPA for biodiversity conservation and resource management through participatory community development and will possess:-

(a) information on phenology of major timber species;
(b) comprehensive database on all inventoried resources and their ecological characteristics;
(c) information on the occurrence and migration range of Orangutan in the Trans-boundary Conservation Area including the Batang Ai N.P.;
(d) a field demonstration centre to promote sustainable resource utilization through agro-forestry activities;

(e) general guidelines for collaborative research and management of the Trans-boundary Conservation Area with Bentuang Karimun N.P.in Kalimantan (Indonesia).

Research and development of the Sanctuary will be included in the Sarawak Government's 8th Malaysian Plan from year 2000 to 2005. The plan would give priority to the strengthening of the Forest Department's scientific expertise through the recruitment of more specialised officers to be trained to continue the work of the ITTO consultants in research and resource monitoring. Another aspect of the Plan would be to set up a Special Wildlife Committee as required under the revised Wild Life Protection Ordinance of 1998. The Committee is to incorporate the concept of co-management through direct local participation and would be responsible for resource protection and sustainable utilization through enforcement and agro-forestry projects. It would also be responsible for co-ordinating the co-management of the Trans-boundary Biodiversity Conservation Area.

3.5 **Target Beneficiaries**

The Sarawak Forest Department and local communities will be the target beneficiaries of this phase of the project:-

(a) Research and management of LEWS and other TPAs will be strengthened as forest research and wildlife staff of the Forest Department acquire the necessary scientific and technical skills and knowledge of co-management;

(b) The Forest Department will further benefit from the service of young graduates trained under the project;

(c) Reforestation programme will benefit from the availability of seeds from the gene banks;

(d) Opportunities will be given to the local communities to acquire the necessary knowledge and skills for starting and managing their own economic activities using the Sanctuary's resources;

(e) Greater opportunity for employment among the longhouse residents through direct participation in co-management and the Special Wildlife Committee formed under the Forest Department.

3.6 Project Strategy

3.6.1 Reasons for Selection

In 1994, ITTO initiated the establishment of the Trans-Boundary Conservation Area of LEWS in Sarawak (Malaysia) and Bentuang Karimun N.P. in Kalimantan (Indonesia). This Trans-boundary Reserve of nearly one million hectares is believed to be the largest in the tropical forest region. It reflected ITTO's commitment in biodiversity conservation and sustainable ultilization of the tropical forest. Dr Don A. Gilmour of International Union for the Conservation of Nature (IUCN) remarked in his report on the IBBE (1997) "Strategies for the Conservation Management of the Lanjak Entimau/Bentuang Karimun Trans-boundary Conservation Area" that "The collaborative efforts of both Governments that were essential in the successful functioning of the 1997 expedition will need to be continued if the trans-boundary initiative is to achieve its full potential and become one of the growing number of trans-boundary protected areas that is making serious contributions to enhancing biodiversity conservation across state borders."

Among the recommendations suggested by Dr Gilmour to enhance the achievement of the objectives of both the Trans-boundary Conservation Area and a broader conservation agenda are:

(a) Vigorously pursue an agenda of bio-conservation inside and outside protected areas with protected areas being expanded to contain a minimum of 10% of the State's forests in a representative network;
(b) Continue scientific studies in the Trans-boundary Conservation Area and link these studies to the needs of practical management and policy;
(c) Consider developing explicit linkages with the institutions where similar activities are taking place and where opportunities exist for mutual learning.

The first two recommendations reflect the need to strengthen co-operation with Bentuang Karimun N.P. Collaborative efforts should emphasize the development of a common goal in scientific research that will lead to the formulation of a management plan and policy for the Trans-boundary Conservation Area. With regard to the third recommendation, the LEWS programme will be linked to the Sarawak Biodiversity Centre (SBC) which is likely to play a key role in integrating the science, practice and policy of biodiversity conservation.

In Sarawak, the Batang Ai N.P. of 24,000 hectares is situated south of LEWS and shares a common boundary with it. This park is also contiguous with Bentuang Karimun N.P. in Kalimantan (**see Map 1**). Orangutans occur in all three TPAs and probably extend their migration ranges across both state and international boundaries. It is proposed that the Batang Ai N.P. should be included in the Trans-boundary Conservation Area.

Closely associated with LEWS and Batang Ai N.P. are the numerous Iban communities with a total population of approximately 15,000 people with their longhouses in the periphery. Many of these communities have rights and priviledges to hunt, fish and collect jungle produce in the two TPAs. Their impact is felt especially in areas where the communities are highly concentrated. The management on long-term strategy of the TPAs requires that they participate actively in the development of sustainably produced resources to enhance their socio-economic well-being.

The IBBE (1997) also recommended a joint eco-tourism development programme between Bentuang Karimun N.P. and Batang Ai N.P. as part of the strategy in the overall co-management of the Trans-boundary Conservation Area.

3.6.2 Lessons Drawn from Past Evaluation

Phase II studies have continued to reveal the extremely high biodiversity which must be adequately protected and managed to prevent any possible deterioration. Although long-term studies are needed to realize the full scientific and economic potentials of the Sanctuary, sufficient information has been collected to enable the Sanctuary's management needs to be assessed. For example, the plant and animal resources in the buffer and wilderness zones are especially vulnerable to continuing human exploitation so that special protection zones are necessary. It is also becoming quite clear that the local development needs of at least the present generation must be considered as a part of the management strategy.

3.6.3 Technical and Scientific Aspects

The approach places emphasis on continuing collaborative biological inventories with the sister project in Bentuang Karimun, while ensuring at the same time that some of the rich resources will be usefully exploited and developed for socio-economic advancement. Field inventories are an effective way of gathering baseline data for the Trans-boundary reserve of over one million hectares (including the Batang Ai N.P. in Sarawak). The technology applied during the previous studies will be adopted to ensure accurate surveys and data compilation. All the data will be stored in the Forestry Department's Geographic Information System and will be linked to the system in Bentuang Karimun to facilitate information exchange.

Community development projects will apply scientific knowledge and technology from the fields of horticulture, agronomy, animal husbandry and game management of indigenous species, while also drawing on the experience from Indonesia, particularly in the field of ethnobotany.

The training provided to the Forestry Department staff through active involvement in field activities will prepare them well in the handling and interpretation of field data and for participation in the joint management of the Trans-boundary Conservation Area in the future.

3.6.4 Economic Benefits

Forests have long been known to provide man's many needs for a variety of products and services. In recent years, we are constantly reminded of another important role of the tropical forests, that of carbon sequestration. However, the dollar benefits of the forest and its rich biodiversity cannot be fully understood without a study.

From the community activities implemented in Phase II, it has been possible to make a preliminary assessment of the socio-economic benefits derived from the cultivation of indigenous crops and rearing of fish **(Tables 1 & 2)**.

Table 1 : Economic potential of indigenous fruits
(Planting per household) (Amount in Malaysian Ringgit)

Fruit	Yield (kg/tree)	Ex-farm Price (RM/kg)	Income			Remarks
			RM/tree	RM/10 trees	RM/10trees/ Annum	
Isau (*Dimocarpus longan* var. *malesianus*)	300	3-8	900-2400	9000-24000	3000-8000	Fruits once in 2-4 years
Dabai (*Canarium odontophyllum*)	300	2-5	600-1500	6000-15000	3000-7500	Fruits once in 1-2 years
Petai (*Parkia speciosa*)	1000 pods	RM2/ 3 pods	700	7000	7000	Non-seasonal with 1-2 peak annually
Total / annum					13000-22500	
Total/ month					1083-1875	

Table 2 : Economic potential of indigenous fish species
(Amount in Malaysian Ringgit)

Tank Size	Initial Stocking	Mortality	Maturity Weight (kg)	Price per kg (RM)	Total Gross Income (RM)
253 m^3	2,280 tails	25%	1,710	50.00	85,500.00
76 m^3	650 tails	25%	488	50.00	24,400.00
235 m^3	2,115 tails	25%	1,586	50.00	79,300.00

The initial cost for fruit tree cultivation came mainly from transportation, weedicides and fertilizers, amounting to about RM500 (US$132) per household. For the fish, the initial cost was approximately RM12,800 (US$3,368). In another Agriculture Department-assisted rural fish breeding project, the income per harvest from five ponds and tanks with a total capacity of 280 m^3 is about RM100,000 (US$26,316). The initial cost of establishment was RM35,000 (US$9,211) (Jarum anak Rantai, pers. com.).

Besides fruit tree planting and fish breeding, research by the Forest Department has indicated that deer farming can also be beneficial, while wild boar can be bred and released in suitable jungle areas outside the buffer zone (J. Jawa, pers. com.). A pilot study is proposed.

The proposed centre for demonstration and training of agro-forestry activities will comprise:-

(a) For indigenous crop cultivation:-

- **(i) a nursery for indigenous species;**
- **(ii) demonstration plots for selected species and varieties of timber trees and non-tree crops;**
- **(iii) design of low input planting to reduce cost, increase profit and ensure sustainability through the use of cover crops for nitrogen fixing and preventing soil erosion;**
- **(iv) technical training programme on various aspects of agronomy, marketing strategy and entrepreunership;**

(b) For the fish rearing project:

- **(i) at least one concrete tank and one valley pond with appropriate features for maintaining the water chemistry;**
- **(ii) a nursery for breeding of fry for supply to participants;**
- **(iii) technical training in fish tank and pond construction and maintenance, and in ensuring healthy growth and productivity through proper care and feeding of fish stocks.**
- **(iv) Marketing and entrepreunership training**

For the wild boar releasing programme, a suitable secondary forest close to the centre will be selected. The released wild boar populations will be monitored by the Forest Department together with the local participants.

It is also proposed to incorporate facilities for eco-tourism training and activities for the Batang Ai National Park. The programme would involve nature education, local culture, tour guiding, tour organisation, safety, etc.

3.6.5 Social Aspects

Through regular contacts and dialogues, the local communities have gradually realized and accepted the need for the Totally Protected Area. Many have expressed satisfaction at the clean water and wildlife that are still readily available, whereas such benefits can rarely be enjoyed in areas affected by logging. Nevertheless, due to inherent social characteristics of the local people, the efforts to reduce the potential conflicts arising from the protection and use of the Sanctuary will take time. Many who do not have a regular cash income still find it necessary to hunt and fish for the purpose of selling them for quick cash. This problem can be partly solved through the introduction of agro-forestry programme.

Greater employment opportunities will be available from eco-tourism in the Batang Ai N.P. where a joint development programme has been proposed with Bentuang Karimun N.P.

Phase III project can also assist and collaborate in the conservation and nature education programme developed by the Forestry Department for the rural communities and schools.

3.6.6 Environmental Aspects

Lanjak Entimau's status as a Totally Protected Area has been strenghtened with the creation of the Trans-boundary Conservation Area. Together with the Batang Ai N.P., this conservation area plays a central role in the protection of Borneo's Orangutan, estimated to be 4,500 in number.

Lanjak Entimau and Batang Ai's function as an important catchment area straddling four administrative Divisions in Sarawak must continue to be recognised and safeguarded.

Implementation of Phase III activities will only have minimal effect on the TPA, mostly in the form of collection of research and planting materials and fish fry. Facilities for community-related development will be provided outside the TPA.

3.6.7 Managerial Aspects

In the management of the Sanctuary, the Forest Department is guided by management plan developed during Phase I. The Sarawak Government has realised the need for community participation in the management of its TPAs and biodiversity. Accordingly, the recently revised National Parks & Natural Reserves

Ordinance (1998) and Wild Life Protection Ordinance (1998) have made provisions for co-management involving the local communities. Already more than 4,500 honorary wildlife rangers have been appointed to assist the Government in wildlife protection statewide.

The local people's dependence on the Sanctuary will continue for at least another generation. The Government's conservation initiatives should recognise the need for them to be actively involved in the planning and management of resource use so that the benefits can be shared. The Special Wildlife Committee included in the Wild Life Protection Ordinance (1998) will provide the platform to strengthen interaction and co-operation.

The inclusion of Batang Ai N.P. to form a more complete intact ecological entity with Lanjak Entimau and Bentuang Karimun is to be regarded as a necessary step in the effort towards ensuring the survival of the Orangutan and numerous other plants and animal species.

3.7 Reasons for ITTO Support

3.7.1 ITTO Aspects

ITTO has established itself as an important forum to promote the conservation, management and sustainable development of tropical forests. It has helped created a platform for international co-operation between Malaysia and Indonesia through the newly formed Bentuang Karimun-Lanjak Entimau Trans-boundary Conservation Area. ITTO's system of multilateral funding is favourably accepted as an efficient system in the administration of funds. The experience and potential benefits that will be derived from sustainable resource utilization through the implementation of socio-economic development activities warrants continuous support from ITTO.

The activities proposed under Phase III are relevant to a number of priorities in the ITTO Action Plan.

3.7.2 Relationship to Relevant Actions Supported by Other Donors

As in the previous two phases, the present phase will be linked to the Sarawak Forest Department as the project's executing agency. Presently there is no other relevant research activity supported by other donors.

3.8 Risks

Due to their inherent cultural characteristics and long dependence on the Sanctuary's resources, many of the local people may find it slow to accept new ideas that would lead to a sudden change in their traditional lifestyle. Continuous support through education and training will be provided.

Mammalian pests can often pause a serious threat to food crops. Stricter control of hunting in the Sanctuary is likely to result in an increase in wild boar and monkey populations. Fish rearing could face the problem of disease and exceptionally high floods caused by heavy rain in the interior. Appropriate actions and preventive measures would need to be taken to mitigate these problems.

On the joint researeh and co-management of the Trans-boundary Biodiversity Conservation Area with Bentuang-Karimun National Park, a project proposal will be prepared by the agencies responsible for managing the TPAs. The schedule for implementation will be partly dependent on further administrative and political arrangements between the Indonesian and Malaysian Governments at the regional and national levels. A joint working committee should help expedite the process.

4. OUTPUTS

The following outputs will be expected:-

Output 1 **Research and Development**

1.1 Gene banks of timber species
1.2 Study on the occurrence and migration of Orangutan;
1.3 Botanical inventory in selected sites including species of ornamental value.

Output 2 **Community Development**
The activities will meet the basic subsistence needs of local communities

2.1 Cultivation of indigenous crops;
2.2 Farming of indigenous fish;
2.3 Farming of indigenous game species

5. ACTIVITIES AND INPUTS

Activity	Man-month (m/m)
(a) Study on the phenology of timber species in gene banks	**36**
(b) Study on the occurrence and migration of Orangutan	12
(c) Botanical inventory	12
(d) Study of ornamental plant species	**12**
(e) Cultivation of indigenous crops	**24**
(f) Fish farming	**12**
(g) Indigenous game species farming	**12**

5.1 Inputs by ITTO:-

Staff	**m/m**	**'000US$**
Project Leader	36	252
Forest Ecologist	30	150
Horticulturist	18	108
Orangutan Specialist	**3**	15
Fish Management Specialist	**6**	**30**
Game Management Specialist	**3**	**15**
Support staff	36	**85**
Training		10
Meetings and staff exchange		10
Total	**132**	**675**

5.2 Inputs by Malaysian Government

Contributions by the Malaysian Government will include use of offices, counterparts, administrative officers and field staff, equipment and tools, subsistence allowances, transport and other operating costs.

Component	**Contribution ('000RM$)**
(a) Local counterparts	
(Project Co-Leader and counterparts)	**605**
(b) Research assistants and wildlife rangers	135
(c) Sanctuary Manager	72
(d) Travel Expenses	
(i) Air travel within Malaysia	36
(ii) Subsistence allowance	320
(iii) 4x4 landcruisers	**362**
Operating cost	**38**
(iv) Boats and motors	**100**
Operating cost	**100**
(e) Labour cost	300
(f) Equipment & tools	
(i) Generators **(x 3)**	**105**
(ii) Freezers & refrigerators (x4)	10
(iii) Backpack squadcall (x2)	30
(iv) ATUR phones with antenna stations (x4)	15
(v) Specimens dryers (x2)	5
(g) Land and infrastructure for community development programme	**1,250**
(h) Office expenses	70
Total	**3,553**

6 LOGICAL FRAMEWORK WORKSHEETS

Tables 3 and 4, and Figure 1 show the logical framework linkages between the various project components.

TABLE 3
JUSTIFICATION, LINKAGES AND BENEFITS OF RESEARCH AND COMMUNITY PROJECTS

PROJECT TITLE : DEVELOPMENT OF LANJAK ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA, PHASE III

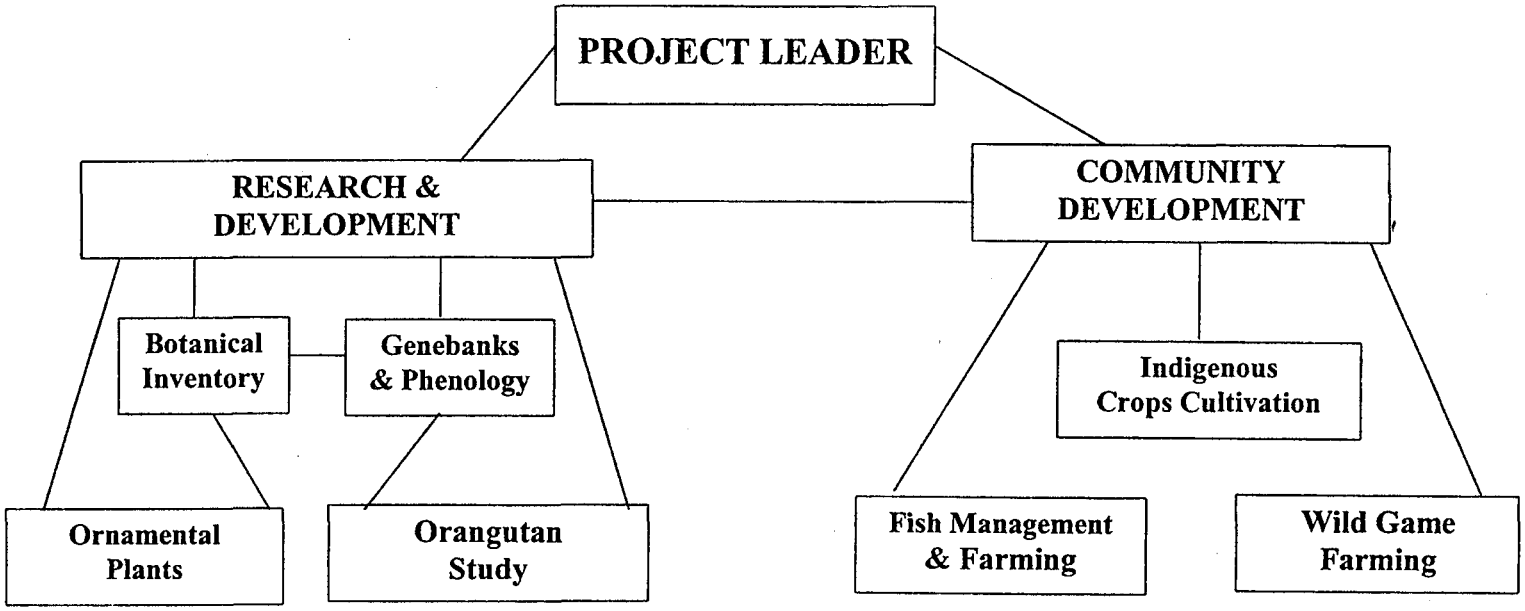
PROJECT	JUSTIFICATION	LINKAGE	BENEFITS
A1 Genebanks & Phenology	Contributing to reforestation and plantation programmes in the State	Sarawak Timber Association, MFMA, government and private nurseries and plantations	Increased availability of genetic materials for selection and provenance trials
A2 Orangutan Study	There is a need to identify orangutan habitat zones for efficient control and protection . The study will relate to food sources and hunting pressure	LEWS's linkage to BKNP in Kalimantan and Batang Ai N.P. in Sarawak will expand the area of orangutan sanctuary in Borneo to one million hectares	Collaborative research and management ensures survival of this threathened species
A3 Botanical Inventory	Studies in Batang Ai N.P. and sensitive areas will provide baseline data for protection of rare and important species and their habitats	Studies & development are linked to BKNP in Kalimantan, Sarawak Ministry of Tourism & Sarawak Biodiversity Centre	Discovery of new/rare and useful species. Provides guidelines for proper planning and development
A4 Ornamental Plant Species	Increasing local and overseas demand for ornamental plants	Sarawak Agriculture Department and local nurseries	Development of resources for economic benefits
A5 Indigenous Crops Cultivation	Providing alternative cash income through agro-forestry	Sarawak Agriculture Department & Farmers Organisation	Reduce impact on natural resource, directly benefits the local communities
A6 Indigenous Fish Farming	Over-fishing is threatening the survival of a number of valuable species	Sarawak Agriculture Department and Fishmart	Training and technology transfer to local residents. Increased income
A7 Indigenous Game Species Farming	LEWS's natural stocks are threatened by over-hunting. Ensure supply of sustainably-produced wild meat to meet local demand	Sarawak Agriculture Department, MFMA	Training & technology transfer to local residents. Increased income

TABLE 4 : ELEMENTS OF RESEARCH AND COMMUNITY DEVELOPMENT

PROJECT TITLE : DEVELOPMENT OF LANJAK ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA, PHASE III

PROJECT ELEMENTS	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTION
Development Objective To manage Lanjak Entimau Wildlife Sanctuary as a major centre for biodiversity and utilisation of sustainably produced resources	(i) Implementation based on completed Management Plan (ii) Development of cross-sectoral co-operation with the local communities and BKNP in Indonesia	(i) Management guidelines and standard training programmes developed Implementation schedule according to Management Plan	Strategies in line with Forest Department Policy on community participation in biodiversity conservation and utilisation
Specific Objective To contribute to the knowledge of resource management through community participation and international co-operation	(i) Results of project activities (ii) Scientific training, transfer of knowledge and technology (iii) List of valuable plants and animals used in community programme (iv) Information and staff exchanges with BKNP	(i) Reports on findings produced (ii) Field demonstration facilities established (iii) Collaborative research and management guidelines with BKNP drawn up	Research and community programme will contribute to socio-economic development and enhance co-operation with Indonesia

FIGURE 1 : LINKAGES BETWEEN COMPONENTS OF PHASE III PROJECT



7 WORK PLAN

The work plan is organised according to activities. Work schedules may be subject to modification due to the local weather patterns that can affect travel and field work. Studies on gene banks, Orangutan and indigenous crops cultivation are related to the flowering and fruiting seasons and field programmes will be planned acccordingly. The project will be completed within the duration of 36 months **(Figure 2)**

8 INSTITUTIONAL ARRANGEMENTS FOR EXECUTION AND OPERATION

8.1 Management Structure

The Sarawak Forest Department will be the executing agency and will involve the active participation of the National Parks and Wildlife and Forest Research Branches of the Department **(Figure 3)**. A new management tool of the Forest Department for the State's TPAs is to form special wildlife committees involving the participation of the local communities and, in the case of Lanjak-Entimau, also consultants from ITTO.

As the executing agency, the Forest Department will be responsible for providing all the logistic support to ensure smooth implementation, besides providing counterparts for each of the activities.

The project will be co-ordinated by the Project Co-ordinator appointed by the Director of Forests Department and ITTO.

8.2 Future Operation and Maintenance

The successful completion of Phase III will lay the ground work for the co-management of biodiversity through community participation. It will also enhance co-operation with Bentuang-Karimun National Park in the joint management of the BKNP-LEWS Trans-boundary Biodiversity Conservation Area. At the end of Phase III, the Forest Department will have a pool of trained botanists, wildlife officers and young graduates to serve the future management needs of the Sanctuary and other TPAs.

8.3 Key Staff

Key staff functions for Phase III are given below. Unlike the previous phases, all the consultants will be recruited locally.

Local Recruitment	Forest Department Counterpart
Project Leader	Assist, Director, National Parks & Wildlife Branch (NPWB)
Forest Ecologist	Botanist, Forest Research Branch (FRB)
Botanist /Taxonomist	Botanist, FRB
Community Development Specialist (Horticulturist)	Botanist, FRB
Orangutan Specialist	Wildlife Officer, NPWB
Fish Management Specialist	Wildlife Officer, NPWB
Game Management Specialist	Reforestation & Rehabilitation Branch (RRB)

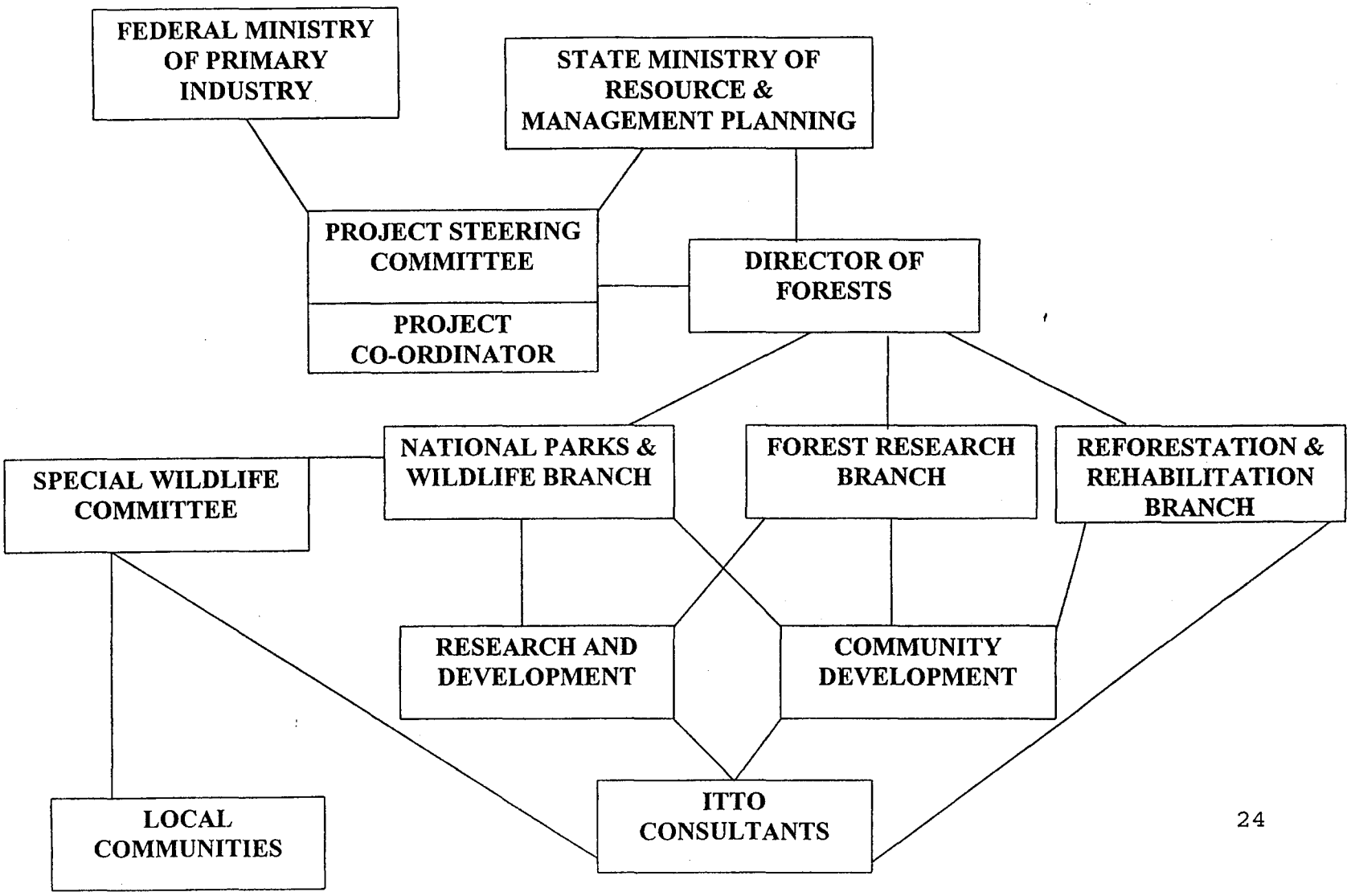
FIGURE 2 : WORK PLAN

OUTPUTS/ACTIVITIES	RESPONSIBLE PARTY	SCHEDULE (in months)
Output 1: Gene banks of timber species **Activities** 1.1 Planning & methodology 1.2 Tree identification for monitoring 1.3 Field work 1.4 Data analaysis & report writing	Forest Ecologist & counterpart	1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
Output 2: Orangutan study **Activities** : 2.1 Planning & methodology 2.2 Field work 2.3 Data analysis & report writing	Orangutan Specialist & counterpart	
Output 3 : Botanical Inventory **Activities**: 3.1 Planning & identification of study sites 3.2 Field inventory 3.3 Species identification 3.4 Report writing	Botanist & counterpart	
Output 4 : Study of ornamental plant species **Activities**: 4.1 Information gathering & planning 4.2 Collection of planting materials, nursery work, **trial planting** 4.3 Final report writing	Botanist & counterpart	

FIGURE 2 : WORK PLAN (Continued)

OUTPUTS/ACTIVITIES	RESPONSIBLE PARTY	SCHEDULE (in months)
Output 5 : Indigenous crop cultivation **Activities** 5.1 Needs assessment 5.2 Nursery & site preparation 5.3 Acquisition of planting stocks, & planting 5.4 Maintenance & monitoring 5.5 Final report writing	Horticulturist & counterpart	
Output 6 : Indigenous fish farming **Activities**: 6.1 Needs assessment & engineering plans for fish tanks 6.2 Tank construction 6.3 Fry collecting & stocking 6.4 Monitoring & report writing	Fish management specialist & counterpart	
Output 7 :Indigenous game farming **Activities**: 7.1 Needs assessment 7.2 Site selection & preparation 7.3 Acquisition of breeding stocks 7.4 Monitoring & final report writing	Game management specialist & counterpart	

FIGURE 3 : ORGANIZATION CHART FOR PHASE III – DEVELOPMENT OF LANJAK ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA



9 PRIOR OBLIGATIONS AND PREREQUISITES

Assuming the inputs listed in Part 5 are available prior to the start of the project.

10 POSSIBLE FUTURE ASSISTANCE

Upon review of the results in mid 2002, further assistance from international bodies may be sought in specific areas of research and resource development. Management of the Sanctuary will be enhanced through the Special Wildlilfe Committee which will apply the co-management concept.

PART III - MONITORING, REPORTING AND EVALUATION

1 MONITORING REVIEWS

Phase III of the project will be subject to review by ITTO and the Government of Sarawak according to their existing policies and procedures.

2 EVALUATION

ITTO and the State Government of Sarawak will evaluate the project in accordance with their existing policies and procedures. This evaluation shall take place within Year 3 of Phase III.

3 REPORTS

A report for each of the project activities will be prepared by the consultants at the end of the study. The implementing agency will produce a final report before the last day of the Phase III period to highlight the output achievements. The report will contain recommendations for follow-up actions necessary for the Sanctuary's effective management and provide guidelines for collaborative management of the Trans-boundary Conservation Area.

PART IV : BUDGET

Total and yearly budgets are given in the Phase III Financial Plan (below)

Timing and budget for the consultants are based on the Work Plan.

Exchange rate in November 1998 : US$1.00 = RM3.80 (Malaysian Ringgit)

FINANCIAL FLOW FOR PHASE III OF ITTO PROJECT : DEVELOPMENT OF LANJAK ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA

ITEM	YEAR 1	YEAR 2	YEAR 3	ITTO Contribution Requested (US$)	Contribution by Malaysia (RM)
A PERSONNEL - LOCAL					
Project Leader	84,000	84,000	84,000	252,000	
Local consultants	**100,000**	**120,000**	**98,000**	**318,000**	
Local support staff	**25,000**	30,000	30,000	**85,000**	
Training	4,000	4,000	2,000	10,000	
Government counterparts	**195,000**	**215,000**	**195,000**		**605,000**
Research & Wildlife assistants	45,000	45,000	45,000		135,000
Sanctuary Manager	24,000	24,000	24,000		72,000
Sub-total				**665,000**	**812,000**
B FIELD TRANSPORTATION/ DUTY TRAVEL					
Subsistence allowances for staff					320,000
Labour Cost					300,000
Boats, motors					**100,000**
Operating costs					**100,000**
4x4 Landcurisers					**362,000**
Operating costs					**38,000**
Sub-total					**1,220,000**
C CAPITAL ITEMS					
(i) Land acquisition					250,000
(ii) Infrastructure					**1,000,000**
(iii) Generators (x6)					**105,000**
(iv) Freezers & Refrigerators (x4)					10,000
(v) Backpack squadcall (x2)					30,000
(vi) ATUR with antenna stations (x4)					15,000
(vii) Specimens dryers					5,000
Sub-total					**1,415,000**
D AIR TRAVEL WITHIN MALAYSIA	12,000	12,000	12,000		36,000
E OFFICE EXPENSES					
HQ Office space					45,000
Supplies					15,000
Telephones & fax					10,000
Sub-total					70,000
F MISCELLANEOUS					
Meetings & Staff exchange	3,000	4,000	3,000	10,000	
G ITTO MONITORING, REVIEW & EVALUATION				15,000	
H REPORTS & TRANSLATIONS				**15,000**	
SUB-TOTAL : (A - H)				**705,000**	**3,553,000**
I ITTO PROGRAMME SUPPORT COST (5.5%)				**38,775**	
SUM OF ITTO & MALAYSIAN CONTRIBUTIONS (US$)				**743,775**	**3,553,000**

APPENDICES

3 DESCRIPTION OF THE LANJAK-ENTIMAU WILDLIFE SANCTUARY

Located between 111°51'E and 112°30'E, and 1°19'N and 1°51'N, the LEWS covers a total area of ca. 168,758 ha. Bounded by the Bentuang-Karimun Wildlife Sanctuary (Kalimantan) on the southeast and the Batang Ai National Park (Sarawak) on the south, the LEWS is drained by two of Sarawak's major river systems, the Batang Lupar and the 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, Ensireng, 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.between 111°51?E and 112°30?E, and 1°19?N and 1°51N,

The rugged topography of LEWS supports a variety of tropical moist vegetation along its elevational profile with the highest peak on Bukit Lanjak (1,280 m). This wide diversity of climax vegetation includes secondary forest of 50 to 100 years old, alluvial forest, gallery 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, LEWS 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 METHODOLOGY

Location

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, covering both primary and secondary forest 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.

Sampling techniques

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 a catapult or caught by hand by local people. Bananas and roasted coconut were the major bait types used. Where applicable, snares were set next to the cage traps. During visits to Ulu Skrang and Ulu Lubang Baya, liquid essence was used as attractant to lure the animals.

APPENDIX 1

SUMMARY REPORT ON SPECIES INVENTORY OF SMALL MAMMALS

Han Kwai Hin
Mammalogist

1 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 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 (ITTO, 1995). This recommendation is timely because inventory-taking is the first step towards studying biodiversity regardless 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 forms 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 on 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 of the socio-economic importance of the small mammals in terms of medicinal uses, food sources, host-parasite association and vectors.

2 OBJECTIVES

Because small mammals are important in providing insight into understanding the changes of community structure in various tropical forest, this project [No. PD 15/95 Rev.3(F)] intends to furnish an inventory for this animal group. Specifically, the objectives of this project 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 seed banks later, and
(iv) to assess the socio-economic importance of the small mammals.

(*Mus* sp; caught but escaped), one tree mouse (*Chiropodomys* sp.), one field rat (*Rattus tiomanicus*?), and one squirrel (*Sundasciurus tenuis*?). The moon-rat (a shrew) was reported (by Mr. Mabong) to be abundant near the last long house in Ulu Engkari, about two-hour walk from the boundary of Lanjak-Entimau. The flying squirrels (*Petionomys setosus*? and *Pteromyscus pulverulentus*?) were also said to be abundant in Ulu Engkari.

Altogether, currently there are 58 mammal species recorded from Lanjak-Entimau of which 48 are true small mammals, or approximately 36% of the known small mammals of Sarawak. Among these 48 mammals, 21% (10) are Bornean endemic. Stated differently, Lanjak-Entimau holds ca. 30% (10 out of 33) of the endemic small mammal species of Borneo. No true montane mammals were found, suggesting that Lanjak-Entimau may have long been isolated from other mountain range of Sarawak in the past.

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

			LEWS		
	Borneo	Sarawak	Present Study	Kavanagh (1982)	% (LEWS Sarawak)
Bats	92+1*	60	13	2	25%
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%
Shrews	8	5	-	1	20%
Total	175	132	40	8	36.4%

+1* : *Cynopterus minutus* found in Brunei (Kofron, 1977)
+1** : the potential new*Tupaia* sp. found in the present study

The non-volant mammals

The identity of one unusual tree shrew species (three specimens), provisionally denoted as *Tupaia* sp. remains unknown. This unusual tree shrew species closely resembles the montane tree shrew, *Tupaia montana* in terms of standard body measurements as well as external coloration. It possesses fine textured olive fur on its upper parts and its under parts are creamy white. In comparison, *T. montana* has coarser, more fluffy fur, and is generally restricted to habitats above 900 m elevation. Preliminary examination suggests that this unknown tree shrew is likely to be a new species although it can be confirmed only when other information such as skull, dental, and probably electrophoretic (allozyme) data is available.

Most bats were mist-netted. 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 ca. 0730 hour.

Preservation

With the exception of several specimens (mainly totally protected or protected species) which were released, 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. Soft tissues (heart, liver, kidney, and muscle) were also collected for some selected specimens and preserved either in 95% ethanol or liquid nitrogen for future study projects on population genetics and systematics. These tissues will be temporarily deposited with the Museum of Natural Sciences, Louisiana State University, USA.

Field data (e.g., locality, altitudes, reproductive condition) and body measurements of these specimens were recorded in field catalogue as well as in computer database (Microsoft Excel under the filename 'LEWS mammals') and kept in Sarawak Forest Department for reference. Both the wet and the dry preserved specimens have been deposited with the Sarawak Forest Department.

Identification of fruit types consumed by small mammals

Identifying fruit items directly from the stomach content of small mammals was difficult because majority of the food had already been digested. Fallen wild fruits were therefore collected from the forest ground in Ulu Katibas and Ulu Lubang Baya in vicinities where small mammals had been seen foraging. The local people helped to determine the Iban names of these fruits and if they were consumed by any (small) mammals. Fruit items were recorded only when a consistent answer was obtained from these local people. Botanical and zoological literature was also reviewed to identify plant species visited by mammals. A cross-check with the existing literature (Medway, 1977; Fujita, 1988; Whitmore, 1991; Payne, 1995) suggests that the information obtained in this manner is positively reliable.

5 SPECIES INVENTORY

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) recorded from Lanjak-Entimau in the present study, of which only 40 are true small mammals, or approximately 30% of the known small mammals of Sarawak (Table 1). This checklist is based mainly on specimens collected and by no means complete. Only 21.7% of the 60 Sarawak bat species are represented in this inventory, and certainly there are more to be found, particularly the ecolocating bats. Not shrews were trapped or sighted.

At least another seven species were sighted but failed to be identified positively, and therefore excluded from the present checklist. These unidentified species include three bats (*Eonycteris spelaea*?, *Hipposideros* sp., *Rhinolophus* sp.), one mouse

6 ECOLOGICAL ROLES OF SMALL MAMMALS

At least 75 fruit species representing 29 families of angiosperms are known to be consumed by (small) mammals. The Euphorbiaceae appeared to be the plant families most frequently visited by (small) mammals. Nonetheless, in a study by Fujita (1988), flying foxes were found to have visited as many as 59 plant families. Most of the families identified in the present study appear in Fujita's list except for Alangiaceae, Dilleniacea, Dipterocarpaceae, Fagaceae, Gnetaceae, Gonystylaceae, Melostamaceae, Myristaceae, and Zingiberaces, in which the scansorial mammals (excluding the pygmy squirrels which feed mainly on tree trunk moss) are probably the only mammalian consumers.

Pollination, seed dispersal, and secondary succession

The ecological interactions between plants and their pollinators and seed dispersers are mutualistic. Animals gain a source of nutrition (nectar, pollen, fruit pulp, and seeds) from plants, which in turn gain mobility for their pollen grains. The benefits gained by the plants from animal pollination include: reduced pollen waste as compared to alternate methods such as wind pollination, longer transport distances, higher pollination success at low plant densities, higher rates of outcrossing, and gene flow. Likewise, seed dispersal by animals provides the plants: escape from natural competitors (e.g., parents) and colonization of new habitats (Fleming, 1988).

Fruit bats (Pteropodidae) are perhaps the most important mammal pollinators. At least 306 plant species are known to have evolved adaptive morphological structures for bat pollination (Fujita, 1988). Among the fruit bats, *Macroglossus minimus* has long been known to feed on nectar and pollen from various plants, including banana, mango, and jambu flowers. The fruigivorous-nectarivorous *Cynopterus brachyotis* (the common short-nosed fruit bat) and the *Pteropus vampyrus* (the large flying fox) are known to pollinate durian and petai. Tree shrews (most likely *Tupaia minor*) have also been seen foraging banana flowers, and are probably just occasional pollen vectors (personal observation).

Mammals disperse the seeds by carrying the fruits away from the fruiting trees to their roosting sites when feeding the young or otherwise simply dispense the seeds along the way upon eating the flesh. The large flying fox (*P. vampyrus*), the short-nosed fruit bat (*C. brachyotis*), the dusky fruit bat (*Penthetor lucasii*), and the primates are well known for carrying fruits away from the fruit source. Bats can be particularly effective dispersal agents because they can carry seeds over long distances into areas that may otherwise not be reached. A small fruit bat is capable of dispersing seeds as far as 38 kilometers over one night (Start and Marshall, 1976).

Many tree squirrels, in particular the giant squirrel (*Ratufa affinis*), the Prevost's squirrel (*Callosciurus prevostii*), the plantain squirrel (C. notatus), and the horse-tailed squirrel (*Sundasciurus hippurus*) have been seen transporting fruits of various forms and sizes in Lanjak-Entimau. The red spiny rat *Maxomys surifer* has been

Strangely, the widely distributed lesser tree shrew, *T. minor* was not represented in the present collection even though this species has been reported to occur sympatrically with *T. tana* and *T. glis* in Sabah (Han, 1991). It is possible that *T. minor*, an arboreal species in most habitats studied thus far, may have simply been pushed to a higher canopy niche and failed to be caught.

The unexpected record of plantain squirrel (*Callosciurus notatus*) in Ulu Engkari and Ulu Katibas may represent an extension of known range of this species because *C. notatus* was thought to be found largely in the western parts of Sarawak and absent from tall forest (Payne *et. al.*, 1985). The recent range expansion of *C. notatus* has occurred possibly because this species is capable of propagating well in monoculture plantations (e.g. oil palm and tapioca) 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 collection of the present study is equally represented by members of the sibling pair of *Maxomys surifer* and *Maxomys rajah*, and includes a good sample of the common *Leopoldamys sabanus* and *Sundamys muelleri*. Both *M. surifer* and *M. rajah* are relatively abundant in Lanjak-Entimau, a situation unparalleled in most other areas in Malayxsis especially when these two species were faily well demarcated by elevation with *M. surifer* occurring above 350 m and *M. rajah* below 400 m. Equally important, Lanjak-Entimau forests contain all the Bornean lowland *Maxomys* rats. Also, Lanjak-Entimau houses all the three Bornean porcupines in abundance, a situation so far unmatched in other places of Borneo. A local man (Mr. Anjan Ngelabong) confessed that he had killed as many as 100 porcupines (mainly the common *Hystrix brachyura*) in the past few years in Ulu Skrang. The present study shows that this animal can be easily lured, and hence snared, using mild essence with flavor of peach, pineapple, and mango. Incidentally, the short-tailed mongoose was also attracted to the essence, particularly the strong essence.

Volant mammals (the bats)

In general, the composition of bat species netted was similar in various parts of Lanjak-Entimau, i.e. in Ulu Engkari, Ulu Katibas and Ulu Skrang. There appears to be a substantial amount of morphological variation among the geographic populations in different parts of Lanjak-Entimau.

Elevational effect

Elevational effect in a relatively more refine scale appears to be significant only among closely related species, particularly those within a genus, as exemplified by the *Maxomys* rats. *M. surifer* was generally more abundant at 400 m elevation and above, whereas its sibling species, *M. rajah* occurred at a lower elevation. Such distinct elevational zonation was also found between *Tupaia montana* and *T. tana* in Sabah but at a higher elevation (1,000 m) and was thought to be the result of ancient (mid-Oligocene or Tertiary; 30 - 20 mya) cyclic sea level changes (Han, 1991; Han *et al.*, in review; see 5.4 of Appendix 5 for scientific interest).

7 SUMMARY OF FINDINGS

1. Currently, there are 48 small mammal species recorded in Lanjak-Entimau, including 15 bat species. Another five species, not small mammals by definition, were also recorded.
2. One potential new tree shrew, believed to be Bornean endemic and tentatively designated *Tupaia* sp., was found in lowland of Lanjak-Entimau.
3. The plantain squirrel *Callosciurus notatus* was found to have an extended distribution range from the west and central regions of Sarawak into Lanjak-Entimau.
4. The small mammal diversity of Lanjak-Entimau, though only moderately rich, is unique, with all three Bornean porcupine species, and both *Maxomys rajah* and *Maxomys surifer* occurring in relatively abundance.
5. The porcupines were found to be easily lured with liquid essence with flavors such as peach, mango, and pineapple.
6. The geographic populations of some mammal small species (*Callosciurus prevostii* and *Tadarida plicata*) in Lanjak-Entimau showed substantial intraspecific variation; whereas the distribution of the *Maxomys* genus displayed a somewhat prominent elevational effect.
7. At least 75 plant species representing 29 families of angiosperms in Lanjak-Entimau are known to be consumed by small mammals.
8. The important functional roles of small mammals in forest ecosystems include: pollinating flowers and dispersing seeds, controlling insect population and hence reducing the loss of primary production, enhancing successful seed germination via burrowing activities, and providing important source of nutrients via defecation.
9. Because pollinators help pertpetuation of plants through making their sexual reproduction a success and hence enhancing their individual fitness, conservation of pollinators should therefore be viewed as conservation of plants species.
10. The small mammals of Lanjak-Entimau are of significant scientific importance and should be preserved and be included in long-term research on tropical forest dynamics.

8 CONCLUSION

Because the organization of biological communities are shaped by interspecific interactions and preserving habitat is fundamental to faunal conservation, an integration of both ecosystem and species/population approaches has thus been recommended in this research program to better frame the problems of faunal conservation in Sarawak. Priorities for conservation of biodiversity are primarily given to species and ecosystem: maintenance of species diversity and ecosystem functions, and retention of genetic variation within populations.

reported to store fallen fruits in its nest for the young, and the common porcupine *Hystrix brahcyura* disperses the seeds of Borneo ironwood (Payne *et al.*, 1985). In West Malaysia, the long-tailed giant rat *Leopoldamys sabanus* feeds on the fruit of *Ryparosa kunstleri*; the common porcupine consumes the fruit of *Lithorcarpus lucidus*, and *Knema hookeriana* is a common fruit item for the long-tailed porcupine (*Trichys fasciuclata*), the red spiny rat, and the long-tailed giant rat (Miura *et al.*, 1997). Tree shrews in Danum Valley and Poring (Sabah) were seen feeding on wild figs (*Ficus* spp.) and spitting out their seeds (Emmons, personal communication). The large tree shrew (*Tupaia tana*) and the three striped squirrel, *Lariscus insignis*, were seen visiting the blooming *Rafflesia* flower in Bukit Gading National Park, Lundu, Sarawak (personal observation). Seeds, particularly the tiny and undigestable seeds, are also dispersed through mammal feces. In the present study, feces of the civets, notably the binturong, the barking deer, and the porcupines, the wild boars were found to contain various kinds of unidentifiable whole seeds, as well as broken seeds.

Bats and birds play an important role in the colonization of disturbed habitats by pioneer plants. Numerous studies (Uhl and Clark, 1983; Swaine and Hall, 1983), including studies of the composition of soil seed banks, seed rain, and the dynamics of secondary succession in the Old and New World tropics indicate the small seeds of fleshy-fruited plants dominate tropical soil seed banks. These seeds are often the most important source of early colonists of newly disturbed habitats (Swaine and Hall, 1983).

Other ecological roles

Mammals, particularly the insectivorous bats, play another equally important role in forest ecosystem, i.e. controlling the population of insects. The consumption of invertebrate herbivores and the destruction of large part of larval population may positively affect the primary production of forest ecosystem by reducing plant losses due to invertebrate grazing. The naked bat (*Cheiromeles torquatus*), the free-tailed bat (*Tadarida mops*), the wrinkle-lipped bat (*Tadarida plicata*), and the Javan pipistrelle (*Pipistrellus javanicus*) collected in this study feed on insects only. It has been estimated that a pipistrelle can eat around 30,000 mosquito-sized insects a night (Hill and Smith, 1984).

Shrews and tree shrews are known to eat earthworms, termites, arthropods, and the larvae of beetles. By turning over leaf litter and topsoil and/or burrowing in search of insects, these mammals may enhance successful germination of seeds. Frequently, rats, porcupines, flying squirrels, and bats inhabit trees with holes or rotten, hollow trunk. The waste product of these animals thus forms an important source of nutrients to many forest trees, particularly, due to their high metabolic rate, the small mammals can process food into nutrients rapidly. More importantly, the free ranging droppings of small mammals will make these nutrients available in various parts of the forest (R. Stuebing, per. com.).

In order to revitalize the ever-deteriorating interest in the natural history of small mammals, a series of research activities have been recommended for prioritization, an undertaking should be taken up by the newly established Sarawak Biodiversity Center through a long-term committed effort and a highly active role in producing quality research. These activities include: systematic and periodic field surveys, collection, taxidermy, the construction of an electronic database, publications, and integration of study with parasitology and medical entomology. Apart from the conventional specimen collection (skin and wet), two other types of collection are recommended: soft tissues preserved in 95% ethanol and red blood cells in 10% potassium-EDTA. Any findings from this research program should be attempted for publication in international scientific journals, as a sort of incentive for producing quality research, which hopefully would evolve into a local culture.

In conjunction to the priortization of research activities, two facilities are recommended for installation: (1) a mini research canopy walk for surveying arboreal species, and (2) an allozyme electrophoresis unit, which will be used to assay genetic parameters for indexing threats to biodiversity. With respect to genetic tool, the establishment of a research group in molecular taxonomy and conservation genetics should be views as a long-term commited effort, with at least five to seven years' gestation in preparation and training. Given the intensification of research activities, more staff need to be recruited and trained, an undertaking should be taken up the newly established Biodiversity Center.

Finally, the most important result expected to be gained from this research program is hopeful, a shift of conservation emphasis from focusing on just a few species to giving equal importance to all species.

The Sanctuary lies in close proximity to the Kapuas Basin in Central Borneo where the early Sunda River originated. There are a total of 36 common fish species out of the total of 127 species recorded from both regions, including many endemic fish species. Although the forest along the rivers in the Sanctuary are fairly consistent, there are many micro-habitats such as torrents, waterfalls and slow moving side pools that provide for a large diversity of fish species. The prolonged dry and wet season in the year produce many adaptive environment for the fauna.

Fish species are prone to habitat change, either natural or man-made. Some species such as the cyprinids and balitorids need good clean water to breed. Others need torrential flows to disperse their youngs. The Sanctuary offers long term protection of its diverse habitats and the large pool of fish genetic resources present within the protected area. The co-existence of many local longhouse inhabitants at the buffer zone of the Sanctuary provides great challenges in the management of fish resources in the protected area.

2 OBJECTIVES

2.1 Objectives of fish fauna inventory survey project.

The objectives of the present study are:-

i) to conduct field work at designated field sites at Katibas/Ulu Skrang/Engkari, in the project area to produce an inventory of fish found in the Sanctuary;
ii) to prepare voucher specimens of all species of fish collected and to deposit reference collection in the Sarawak Biodiversity Centre;
iii) to train junior scientist and field assistants in fish identification, taxonomy, fish preservation and curation techniques; and,
iv) to acquire information on the relevant habitat data and socio-economic importance of fish fauna to the local communities.

3 SURVEY METHODOLOGY

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 S. Nyungan, LEWS as a comparative study on the effectiveness of the method as compared to the elecrofisher. Immediately after capture, all fish specimens were 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 specimens were transferred into 70% ethanol for permanent preservation and storage.

SUMMARY REPORT ON FISH FAUNA INVENTORY

Charles M. U. Leh
Ichthyologist

1 BACKGROUND

1.1 The Freshwater Fish Fauna Of Sarawak and Borneo.

The early specimens collected by the naturalists G. Doria and O. Beccari were reported by Gunther (1868). 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 International Borneo Biodiversity Expedition 1997 compared fish fauna in Bentuang-Karimun (Indonesia) with Lanjak-Entimau.

Other small collections of freshwater fish were made by Cramphorn (1978), Watson and Balon (1984), Parenti (1986, 1993) and Brown and Brown (1987). In recent years, some additional collections of fish were made by Kottelat and Lim (1993), Lim and Kottelat (1995), Ng and Lim (1993), 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.

1.2 The significance of Lanjak-Entimau Wildlife Sanctuary for ichthyofauna conservation

The habitats of Lanjak-Entimau Wildlife Sanctuary (LEWS) had been adequately discussed in the earlier management plan (Steubing, 1994). The Sanctuary is large, comprising 167,758 hectares of tropical rain forest. The core area consists of mixed dipterocarp forest while its periphery has regenerated dipterocarp forest of 50 to 100 years arising from previous settlements along its rivers. The Sanctuary is an important catchment area of major drainages such as the Lupar and Rajang rivers. As such, it is naturally diverse in fish fauna in its rain forest rivers and streams.

collected only twice in the Bloh river system. The fish species distribution, occurrence and abundance in Ulu Engkari, Katibas and Ulu Skrang were recorded. 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*, *Parhomaloptera 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.

A number of potential new species are listed as follows :
(a) *Clarias* sp. (1 species)
(b) *Hemibagrus* cf. *nemurus* (1 species)
(c) *Gastromyzon* spp (3 species)
(d) *Leiocassis* sp. (1 species)
(e) *Glaniopsis* spp. (2 species)
(f) *Lebcheilus* sp. (1 species)

4.1 Fish species diversity, occurrence and abundance.

A total of 28 aquatic systems comprising main streams and tributaries in Lanjak-Entimau were studied during the project. These included of 4 stations in Engkari, 12 in Katibas, 6 in Bloh and 6 in Ulu Skrang. A range of sizes of the rivers' width were sampled. The fish species diversity, evenness and richness of each of the river system is given in Table 1.

Fish species diversity in the Engkari river and the Kaup rivers are high. The Engkari Ulu has a higher fish species diversity and richness even though there are 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 has 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 has been the most intensively sampled during the study. This system is separated by a high mountain range from the Kapuas system in Indonesia. Fish species similarity between the two conservation areas is less than 30%. Species diversity varied with the width and elevation of the stream except for Sg. Melinau which was suspected to be poisoned earlier during the dry season according to local reports.

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 Bogoriense and the Sarawak Museum. The larger fish specimens were dissected and their gonad maturity stages noted.

Fish species diversity indices, 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'.

$H' = {}^{s}E\ Pi \log Pi$ where Pi = ni/N. ni is the number of individuals of Species i and 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_{max} = ln S and
S = no 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 is the number of species and N is the number of individuals.

4 FISH SPECIES INVENTORY OF LEWS.

82 species belonging to 31 genera of 8 families were recorded from the field collections. A total of 3668 specimens were collected from the 77 fishing stations. 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. Stuebing (1994) noted that 31% of the known terrestrial herpetofauna in Sarawak are found in the Lanjak-Entimau Wildlife Sanctuary. 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

proposed similar 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 have 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 (*Dipterocarpus oblongifolius*) and engkabang (*Shorea macrophylla*) 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 rocks and riffles for the balitorid fishes. Lower light intensity also discourages 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. We have observed that species of *Osteochilus*, *Lobochilus* and *Gastromyzons* feed actively over the surfaces of rock boulders where there is 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* sp.) 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 specimens collected from the rapids. We also noted the importance of feeding areas along rivers and streams in the Sanctuary. 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 which 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.

Table 1. Fish species diversity (H'), species evenness (J) and species richness (D) of The rivers sampled in Lanjak-Entimau Wildlife Sanctuary (S. = sungai or river, 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
S. Kaup, Engkari	22	276	1.1571	0.3743	8.6033
S. Engkaramoh, Engkari	12	71	0.5166	0.2079	5.9419
S. Menyarin, Katibas	31	397	1.2202	0.3553	11.5438
S. Ulu Katibas	26	299	1.2044	0.3696	10.0983
S. Pasir, Katibas	11	74	1.0990	0.4583	5.3498
S. Kulit Kayu I, Katibas	14	84	0.8133	0.3082	6.7558
S. Kulit Kayu II, Katibas	6	12	0.6685	0.3731	4.6331
S. Gindi, Katibas	6	26	0.5336	0.2978	3.5336
S. Bedawak, Katibas	21	232	1.0356	0.3401	8.4549
S. Melinau, Katibas	3	5	0.4582	0.4171	2.8613
S. Engkabang, Katibas	4	41	0.4341	0.3131	1.8601
S. Begua, Katibas	12	31	0.9126	0.3672	7.3758
S. Nyungan, Katibas	21	125	1.0990	0.3609	9.5378
S. Kelimau Mit, Katibas	19	142	1.0359	0.3518	8.3632
S. Bloh	11	94	0.8515	0.3551	5.0680
S. Joh, Bloh	43	654	1.3464	0.3579	14.9170
S. Joh Paraka, Bloh	28	208	1.1858	0.3558	11.6476
S. Joh Ibau, Bloh	10	26	0.8921	0.3874	6.3605
S. Merating, Bloh	29	237	1.2189	0.3620	11.7907
S. Layak, Bloh	8	50	0.5958	0.2865	4.1201
S. Gerugu Rintong, Ulu Skrang	22	243	0.8891	0.2876	8.8028
S. Berkiat, Ulu Skrang	20	234	0.9497	0.3170	8.0195
S. Serembuang, Ulu Skrang	20	255	0.9366	0.3126	7.8951
S. Jelian, Ulu Skrang	5	11	0.5936	0.3688	3.8410
S. Sirik (merah), Ulu Skrang	8	92	0.5579	0.2683	3.5645
S. Ulu Skrang	16	86	0.9808	0.3537	7.7539

4.2 Critical areas for the conservation of ichthyofauna.

The central catchment area of Lanjak-Entimau which was 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* sp.) and kulong (*Lobochilus* sp.). The forest outside the boundary of Lanjak-Entimau is already being utilised for other secondary activities beyond the control of the management. Such areas have been proposed as recovery and sustainable use zone, as well as multiple use and buffer zone. Meredith (1995) also

6.0 FUTURE RESEARCH

6.1 Overview

Fish either from the wild or cultured are usually consumed by the people in Sarawak. It is a cheap and essential source of protein for the rural communities. The introduction of non-indigenous fish species into water bodies near to totally protected areas poses a threat to the local fish fauna in terms of food availability, niche competition and displacement. Totally protected areas offer safe opportunities for fish to breed. It is necessary for the authorities to assess fish stocks in totally protected areas through inventory projects before long term management plans could be drawn up.

6.2 Further scientific research

The current study only provides the baseline inventory data of ichthyofauna found in the Sanctuary. There are many other aspects that require further assessment. The species population dynamics and growth rates of valuable commercial species have to be studied over a minimum period of 1 year in order to observe breeding patterns during the dry and wet seasons. This can be undertaken in subsequent projects of ITTO. Basic fishery biology of selected riverine fish species have to be documented before suitable management of the species can be implemented. At present, information is not available, and hence it is not appropriate to propose any suitable management plans for the fishery. This study can be undertaken by officers of the National Parks and Wildlife Office as post graduate programmes. Any basic fishery assessment of the Sanctuary should not cause excessive mortality of breeding adults so that recruitment of young fish into the population is sustainable in the long term. There is a need to document the occurrence of disease and parasites on the ichthyofauna of the Sanctuary. This study could be short term of six months and suitably undertaken by a fish parasitologist from local university. This is necessary because fish parasites pose a health hazard to the local communities who depend on it as a protein supplement.

6.3 Proposed Field Centers

In the first phase of ITTO, one of the location for the field centre had been proposed at Nanga Segerak, Ulu Engkari. In addition, the other research centres may be sited at Nanga Bloh, Katibas. These are ideal sites as they are located at the periphery of the Sanctuary where access into the surrounding habitats could be facilitated with ease. The Field centres can be used to cater for biodiversity-related research projects that have a direct bearing on the management of the Sanctuary under the Forestry Department. It is important that the core zone of the Sanctuary be left undisturbed by any future research studies.

5 RECOMMENDATIONS FOR THE MANAGEMENT AND DEVELOPMENT OF ICHTHYOFAUNA.

5.1 Objectives

The primary objective of the management of ichthyofauna in the Sanctuary is to preserve fish genetic resources and to replenish downstream fish stocks naturally. Other objectives are listed below.

1. To ensure that the Sanctuary remains in its pristine state for the conservation of biological resources.

2. To promote and support scientific research in ichthyofauna.

3. Propose educational programmes to conserve fish resources in the Sanctuary.

4. To monitor and regulate the use of ichthyofauna in the Sanctuary.

5.2 Protection

5.2.1 Protection of Wildlife Sanctuary

The Wildlife Sanctuary can be adequately protected by the establishment of additional ranger post in 1998 along Nanga Mujok and Nanga Bloh. Protection of the Sanctuary from encroachment of local indigenous communities and outsiders can be checked by the NPWO staff at each ranger post. Boundary markers must be well maintained and checked regularly by staff stationed at each post. The rangers can also monitor and where possible reduce fishing activities in the wilderness zone in the Sanctuary. Fishing activities should be limited to the buffer zone of the protected area. The presence of a ranger post at each of the entry points would discourage further subsistence activities such as shifting cultivation over new forest and the collection of wild game.

5.2.2 Fish management

One of the prime objectives of the fish inventory project is to collect species and site data on the distribution of ichthyofauna in the Sanctuary. Then the next step would be measures taken to protect critical areas and buffers. Hence, fish species can be managed in a sustainable method once the species distribution is identified. It is natural to manage a fish species by protecting its breeding habitats from destruction and breeding adults from over fishing. It is also necessary to monitor any other activities that cause the fish population to decline. Co-operation of the longhouse communities near to the Sanctuary must be sought to work out a management system on fish so that they can have sufficient protein for subsistence.

5.2.3 Conservation management zones

The ITTO Commission (Anon, 1990) has recommended a minimum three zones of protected areas culminating in the core area for the management of the Sanctuary. The proposed zones in the earlier ITTO report (ITTO, 1996) is followed in this report. The core area is insulated by the wilderness zone while the outer zone is the area of sustained use and buffered by the multiple-use zone.

4 INSECT FAUNA

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, damseflies-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 specialised, 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.

5. METHOLOGY

Moths were collected using a UV (ultra-violet) light tube, TOKI F20T10BLB made in Japan, powered by a portable generator. The light-trapping hours were from 7 p.m. to 10 p.m., the peak hours of moth activity. All moths attracted to the UV light illuminating a 1 metre square white sheet were caught in killing bottles charged with ethyl acetate, papered and labelled. A minimum of 3 sampling nights was conducted at each site, except at Bukit Lanjak summit where only 1 night was sampled using a less powerful French-made gas lamp Superlumogaz PZ206, as dictated by circumstances.

Butterflies, dragonflies and damselflies were collected using nets mainly on river banks. Bees were attracted with dilute honey solution sprayed onto the understorey vegetation at around 9 a.m.

Termites were surveyed systematically using 5 circular plots of 5 meters radius in each of the forest types. Beetles, cicadas and other insects were collected alongside the light-trap for moths.

5a Moths

Altogether 17 families with 790 species and 3185 individuals were sampled. Holloway (1993) estimated a total of 3429 species in Borneo, and the present samples comprise 23 %, or about a quarter of the Bornean species.
The geometrid subfamily Ennominae has the highest number of species (172) and individuals (1077). The noctuid subfamily Ophiderinae has the second highest species (123) with relatively few individuals (259), while the arctiid

SUMMARY REPORT ON THE INSECT FAUNA

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Entomologist

1 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 & Sarawak Forest Department, 31 March 1996. According to the appendix, 5927 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.

2 OBJECTIVES

The objectives of the entomology component under Phase II of the project are listed as follows:

(i) To investigate the richness of the insect fauna at the different ecosystems present in LEWS such as alluvial, lowland as well as montane forests;
(ii) To quantify insect diversity indicative of the different ecological environments;
(iii) To provide training for the staff of the Sarawak Forest Department (Forest Research Centre) on insect survey and sampling methods, taxonomy, curation techniques, as well as data analysis on biodiversity.

3 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 dipterocarp forest (300-400 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 (1270 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.

Also, several endemic species, e.g. *Ixias undatus* Butler, are found in the upper reaches of Sungai Engkari (including Sungai Segerak, Sungai Jela).

5c Dragonflies & Damselflies

25 species (out of a Bornean total of 259) with 256 specimens were sampled.

The most striking result is the almost total absence of the dragonflies and damselflies along the Sungai Bloh sites (BL, LY) where logging is 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 is 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 also produced the most number of species, a result similar to that of butterflies.

5d Bees

10 species were sampled, consisting of 8 stingless bees (*Trigona* spp.), and 2 honey bees (*Apis* spp.). Bornean bee fauna is made up of more than 30 species.

Generally the bees appeared to be more abundant around 11 a.m. The two most widespread species were *Trigona atripes* sp. *collina* Smith and *Apis cerana*.

Surprisingly relatively few bees were sampled in the deep forest understorey sites, except one site where the honey-bait was purposely sprayed onto the foliage of a sapling about 5 m away from a group of stingless bees always seen scavenging near the Ubah Ribu camp site. Honey-baited plants about 100 m and even 50 m away from the camp site failed to attract any bees. This suggests that the bees have limited foraging range within the forest understorey. The fact that many of them are scavengers also reduces 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* 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.

Most bees were collected along riverbanks, which may be used by the bees as navigation corridors.

5e Termites

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)

subfamily Lithosiinae has 69 species out of a relatively high number of 378 individuals. These 3 groups are the more generally distributed moths in LEWS.

Comparisons of the different forest types show that the hill dipterocarp forest at Ubah Ribu (700 m a.s.l.), is the most diverse in moth fauna. This may be attributed to the overlap of lowland and montane elements. The area is also rich in Myrtaceae (Chai 1995), which is known to support a diverse moth fauna. There are also species, including endemics, restricted to the habitat. The alluvial forest samples (pooled for the first 3 nights to enable fair comparison) at Nanga Joh (150 m a.s.l.), on the other hand, yielded the lowest diversity, as the tree density in the habitat was reported to be low (Chai 1995), and also its plants may possess alkaloid defences repugnant to moths. Endemism at the alluvial sites is also low. The Bukit Lanjak summit (1270 m a.s.l.) sample, despite its small size, produced the highest endemism. Diversity *per se* may not be high at the summit, but the quality of its diversity, here referring to the degree of endemism, is good. The lowland dipterocarp forest sites L (300 m a.s.l.), D (325 m a.s.l.), and F (410 m a.s.l.) showed higher endemism and diversity at 410m.

5b Butterflies

Altogether 8 families with 104 species and 450 individuals were sampled. The species made up about 1/9 of those found in Borneo (910 spp. in total).

The upper reaches of Sungai Jela gave the highest number of individuals (80) and species (25). The species count for each sample generally ranges between 10 and 20.

Ubah Ribu (UR) 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 is the abundance of the Rajah Brooke's Birdwing butterfly *Troides brookiana brookiana* Wallace in the Nanga Joh area. 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.

7 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 Mit & Besai). 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.

Table 1 : Total numbers of insect individuals (N) and sorted species (S) In LEWS Project Phase II

	LEWS		**Borneo**
Group	N	S	S
Moths (Lepidoptera)	3185	790	3429
Butterflies (Lepidoptera)	450	104	910
Dragonflies/Damselflies (Odonata)	256	25	259
Bees (Hymenoptera: Apidae)	760	10	33
Termites (Isoptera)*	139	40	103
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	1240		
Total	6176	1053	

*For termites, N is number of vials. Termite species in Borneo based on Sabah (Thapa, 1981)

listed only 103 species in Sabah, but that figure may not adequately represent the total number of species found in Borneo.

Most of the taxonomically interesting species, however, are 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 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.

Several termite species are notorious forest pests, particularly in plantation monocultures (Chey, 1996), but in the undisturbed natural forest habitats of LEWS, these pest termites appeared to be scarce and 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 (plot A4) in the entire survey.

5f Beetles, Cicadas, & Other Insects

As many as 12 species of cicadas were collected from the various forest habitats of LEWS. Moulton (1923) reported that 73 species were found in Borneo. These creatures certainly make their presence felt by producing loud noises through the male tymbal organs. The forest of LEWS is more often a furious symphony of the cicadas.

The beetles appeared to be more diverse between 400 and 700 m a.s.l. in LEWS as shown by their relatively higher abundance and richness at two sites. 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.

6 OVERALL SAMPLES

This 6-month study yielded 6176 individuals with 1053 sorted species from 58 families out of 8 insect orders. The data are summarised in Table 1. The specimens are lodged in the Entomology Unit of the Sarawak Forest Research Centre in Kuching.

(d) Specimens were sorted out, described, numbered, and labelled for herbarium record; for any unknown species, a spore-print was obtained;
(e) All collections were either 'smoke-dry' or preserved in ZnSO4 (Zinc suphate) solution;
(f) The dried specimens were placed in sealed plastic bags or mounted on herbarium sheets;
(g) In the laboratory, examination started with the study of the macroscopic features visible to the unaided eye, using hand lens (X10 - X20), dissecting microscope (X20 - X80), and microscope (X100 -X 600) for details;
(h) All notes, photographs and microscopic preparations relevant to particular collections were kept in the herbarium.

Besides the permanent record and dried reference samples, a living culture was also maintained for further studies.

4 STUDY SITES

Within the six - month duration (April - October 1998), three field trips were organised. The first trip was conducted in May via Song to Ulu Katibas, While the second and third trips were made in July & August respectively via Lubok Antu to Ulu Engkari.

5 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 in 111 genera of 45 families). A very large percentage of macrofungi in the Sanctuary were recorded in mixed dipterocarp forest (63.0%) and riparian / alluvial forest (32.0%). The Polyporaceae (11 genera) and Tricholomataceae (8 genera) are the most dominant families.

(i) Alluvial forest : -

So many species of macrofungi flourish in a wide variety of habitats. They are fleshy, attractive and conspicuous because of their colourful fruit bodies. The great majority of these fungi belong to the families of Basidiomycetes and Ascomycetes. Some familiar species, e.g. the gill fungi (*Russula* spp, *Tricholoma* spp. and *Lentinus* spp.), coral fungi (*Clavaria* spp. and *Ramaria* spp.), bird's nest fungi (*Cyathus* spp.), Cup fungi *(Cookeina* spp.) and earth-stars (*Geastrum* spp.), were common in the forest. They were found on a wide variety of substrata, growing on rotten tree trunks, dead branches or fallen twigs, leaf litter, soil and other forms of organic matter.

Species of *Marasmius* and *Mycena* are common, growing mainly on leaf litter, and twigs. They are small, delicate looking and fragile. Some *Mycena* species (kulat jalai malam) exhibit brilliant blue- white luminescence at night.

APPENDIX 4

SUMMARY REPORT ON MYCOLOGY INVENTORY IN THE LANJAK-ENTIMAU WILDLIFE SANCTUARY

Chin Fook Hon
Mycologist

1 BACKGROUND

Forest fungi grow abundantly in the tropics and provide an excellent opportunity for study. To-date, no comprehensive study of the fungal flora in Malaysia has been carried out. The total number of fungi species and their distribution in the Malaysian forests are still not known.

Prior to World War II, only a small number of fungi were recorded in Sarawak. In 1959, Johnston conducted a preliminary study of some macrofungi. Turner (1971) studied fungal diseases of Sarawak; and mentioned about 237 species in 165 genera. However, only a few of the macrofungi (in Basidiomycetes) were collected. In 1974, Corner described 20 species of *Boletus* and *Phylloporus*.

Systematic surveys began in Sarawak in 1976 with the establishment of a Forest Pathology Unit in the Sarawak Forest Department. Since then up to 4,600 species from different areas and forest types have been collected. The Lanjak-Entimau Wildlife Sanctuary however was not covered in the study.

2 OBJECTIVE

(i) To conduct a general survey of the non-vascular plants (fungi and other lower plants) of the Sanctuary
(ii) In collaboration with the ethnobotanist and local traditional medicine practitioners produce a list of fungi of economic potential;
(iii) Enter all relevant data into the Project GIS data base
(iv) Produce a final report on the findings

3 METHODOLOGY

For fungal sample collections, the following procedures were adopted : -

(a) Collections were carried out in different habitat types of forest e.g. in riparian/alluvial forest, lowland dipterocarp forest and old secondary forest;
(b) In each forest type, collection was made along the jungle trails, examining different habitats such as rotten woods, roots, tree trunks for fungal species;
(c) Depending on the fruit bodies available, between 1 to 4 specimens of each species were collected;

6 THE IMPORTANCE OF LEWS AS A HABITAT FOR FOREST FUNGI

From the present study, more than 500 species belonging to 71 genera of 39 families were collected. The number of fungi species made up some 11.0% of the known forest fungi species in Sarawak. A very large percentage of macrofungi in the Sanctuary was encountered in the mixed dipterocarp forest (63.0%) and riparian / alluvial forests (32.0 %). The Polyporaceae (11 genera) and Tricholomataceae (8 genera) are the most dominant families.

Tricholomataceae is a large family of mostly fleshy species, usually growing on the ground and fairly study in stature. 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 typical woody, bracket fungi is Ganodermataceae. They are the destructive parasites in lowland dipterocarp forest, e.g. *Amauroderma* sp. found on living 'resak' tree (*Cotylelobium* spp.), *Ganoderma* spp. on 'menggris' (*Koompassia malaccensis*) and 'kapur' (*Dryobalanops* sp.). These fungi are not only well known to our foresters as the wood-destroying pathogens, their medical properties are also known to the longhouse communities, especially in the Ulu Katibas area. About 6 of the 16 species for medicinal purposes or other uses belong to this family.

Field data also indicated that more than half of the edible fungi and medicinal species were present in the lowland dipterocarp forest, and fewer in alluvial forest. Hill dipterocarp forest is a poor habitat for fungi.

The distribution and occurrence of fungi in submontane forest and montane mossy forest are comparatively fewer than in other vegetations types. Some *Ramaria* sp., *Clavaria* sp., (Clavariaceae), *Amauroderma* sp. (Ganodermataceae), *Auricularia auricula - judae* (Auriculariaceae), and *Cantharellus* sp. (Cantharellaceae) were recorded in submontane forest; while only 3 fungi species - *Polyporus* sp. (Polyporaceae), *Peziza* sp. (Pezizaceae) and *Stereum* sp. (Stereaceae) occured in montane mossy forest.

7 LICHENS

Lichens are abundant and widely distributed in the riparian / alluvial and lowland dipterocarp forests. Lichen fungi nearly all belong to the group called 'Ascomycetes' which are characterised by producing their spores in special sac-like cells called 'asci'. There are a few, mainly tropical lichen fungi that belong to quite a different group, the 'Basidiomycetes'. 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) : -

2 poisonous, 8 edible and 10 medicinal species were found here. Some edible species, e.g. *Pleurotus ostreatus* (oyster mushroom), *Auricularia auricula-judae* (kulat bibir), *Lentinus sajor-caju* (k. jelutong), and *Calostoma* sp. (k. mata babi) are commonly sold as food at local markets.

(ii) Old secondary forest : -

Collection was made at elevations from 400-550 m. a. s. l. Although the result was not very 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.

(iii) Lowland dipterocarp forest : -

This was the richest habitat for fungi. Many species were encountered between 300 m and 500 m a. s. l. Besides the common saprophytic species e.g. *Xylaria* sp., *Lenzites* sp., *Panellus* sp., *Mycena* sp., some bracket fungi parasitic on living trees were encountered, such as *Fomes* sp. (Polyporaceae) on living 'meranti majau' (*Shorea leptoclados*) and *Phellinus* sp. (Hymenochaetaceae) on living 'kumpang pali' (Myristicaceae).

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

Species of *Boletus, Amanita, Thelephora, Cortinarius*, and *Tricholoma* were among the common groups uncountered. Many of these may form mycorrhizal roots with the forest trees.

(iv) Hill dipterocarp forest : -

The second trip to Ulu Engkari was made in August. Collecting sites included the hill dipterocarp forest around the camp. In this forest type there are fewer timber trees species present, but palms, herbs and small trees were more common. Larger fungi found in this forest occurred mostly on soil or rotten wood. They included the simple saprophytes and a few parasitic species.

(v) Submontane and Montane forests : -

Sampling in submontane mossy and montane mossy forests was undertaken on Bukit Lanjak (with a height of 1,270 m. a. s. l .). The occurrence of macrofungi in these vegetations types indicated a decrease in species and abundance. Many species were short-lived with small to medium - sized fruit bodies, tough, leathery or even corky.

8 THE ROLES OF THE FUNGI AND LICHENS IN THE ECOSYSTEM:-

The great majority of the thousands species of fungi that inhabit the forest are saprophytes which obtain their food by decomposing dead leaves, twigs, flowers fruits, fallen trunks and animal remains and wastes. They are not directly injurious to living plants, although their activities may promote the growth of certain fungi that cause disease. Saprophytic fungi play an essential role in the forest through the conversion of forest debris into humus, an important constituent of the forest soil and a prime source of chemical nutrients, for plant growth.

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 position 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 rock by penetrating its structure physically with rhizones 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 water erosion, even if the scrub cover dies during drought periods. The carpet of lichens on arid soils contains at least one species cable of fixing nitrogen - *Collema coccophorum* (Filson, 1979) and provides a habitat for numerous other nitrogen - fixing blue-green algae, thus enriching the nitrogen reserves in forest soil.

9 CLASSIFICATION OF FOREST FUNGI ACCORDING TO THE BIOLOGICAL CHARACTERISTICS AND USES :-

Since our study relies heavily on the knowledge of local people in the supply of information, especially on medicinal fungi, short stays at peripheral longhouses were arranged. According to the biological characteristics and uses, our collections were classified as shown in Table 1.

1. Crustose lichens : - the thallus tightly appressed to the substrate. Sometimes they are completely immersed in the rock or bark. The thallus is like a crust and usually lacks distinct lobes. Most lichen species in LEWS belong to this class, e.g. *Graphis* sp. & *Opegrapha* sp.

2. Fruticose lichens : - thallus erect or pendulous 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.

3. Foliose lichens : - they are leaflike and prostrate but not so firmly attached to the substratum. It is normally attached rather loosely to the substratum by means of root - like thread. Often the whole plant is rosette - like with the young growing lobes at the margin. *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 Myristicaceae, Myrtaceae (*Eugenia* spp.) and Leguminosae (*Koompassia malaccensis*). The whole thallus is closely attached to the tree trunk and it is often difficult to separate it from the host plant.

"Foliose lichens" are also common in occurrence. Parmeliaceae (*Parmelia* sp. - the broader - lobed leafy lichen) on Sapotaceae, and Physciaceae (*Physcia* sp.) - the narrow-lobed leafy lichen) on an unidentified small tree are found.

Riparian and alluvial forests have a higher number of crustose lichen species than the lowland dipterocarp forest in general. They were found on the leaves of Dipterocarpaceae (*Vatica* sp.), Palmae, Euphorbiaceae (*Cleistanthus* sp.), Leguminosae, Myrtaceae (*Eugeria* sp.) and Zingiberaceae. Many species were also observed on the stem (or bark) of Myrtaceae, Annonaceae, Polygalaceae, Euphorbiaceae and Dipterocarpaceae. In the riparian forest along Sg. Joh (Ulu Katibas) and Sg. Jela (Ulu Engkari), they occur on exposed rocks. Their growth on bare rocks initiates the weathering process of such rocks.

Opegrapha sp. (Opegraphaceae) is distinguished by its small ascocarps (the fruiting structures) - about 0.2 - 0.3 mm. They are often bent, forked, in groups and immersed in the greyish brown thallus.

Lichens are less commonly found in hill dipterocarp forest and rarely encountered in submontane and montane forests.

Temperature and moisture are important determining factors for fungal growth. With little or no rainfall, very few fruit bodies may appear. In the Sanctuary area, the rainfall is high and fairly uniformly distributed. The distribution of rainfall is also important for the timing of the burning of fields which usual takes place in the second half of July or in August. Some varieties of forest fungi are associated in a relatively direct sense with hill-rice agriculture. The appearance of certain fungi in newly fired fields is a sign of ideal conditions for planting of annual crops. Their occurrence indicates an optimum rainfall for crop growth. Some short-lived fungi, e.g. 'kulat amau' (*Neurospora* sp.) and 'k. buah' (*Hygrophorus* sp.) are exhibited as signs of soil fertility and the success of farmland fired. They appear on burnt-over ground usually a few days after firing.

Gathering edible mushrooms and other wild foodstuffs is one of the field activities of women. The older women usually have good practical knowledge of fungi, especially on the fungi for medicinal and other uses.

Lanjak-Entimau Wildlife Sanctuary has at least 37 species that are edible. However compared to other foodstuffs, the mushrooms contribute a little to Iban diet and are of minor importance in their pharmacology.

12 RECOMMENDATIONS

Based on the results of the findings in the Sanctuary, the following recommendations are made : -

(a) Further inventory to the Reserve is needed to discover more specie of socio-economic importance, to increase the 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) Initiating a pilot project on mushroom cultivation to help raise the living standard of the local residents while at the same time 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 created a great diversity of flora and fauna. However, insufficient study has been carried out on the lichens. Future inventories should include this group of non-vascular plant.

(d) Most fungi collectors have little knowledge of the biology of fungi. They have simply gathered just the common edible species, trampling and destroying all other types, even quite edible ones. The consequence of this is obvious; the local fungi flora has suffered and of course it has meant less food for the local population in future. The ITTO study has to convince the local communities to avoid collecting any immature fruit bodies and also to refrain from indiscriminate collecting.

Table 1. 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 Others uses	16	14

Note : Specimens recorded from 08 May 1998 to 07 October 1998.

10 SPECIES OF SOCIO-ECONOMIC IMPORTANCE

10.1 FOOD (VALUES) AND MEDICINE : -

In fact, the food value of fungi is not great, approximately the same as that of green vegetables. A young fruit body is more nutritious than an old one, and the cap more nutritious than the stem.

Generally, mushrooms are an agreeable addition to the diet, with a delicate flavour and pleasant consistency. However, poisoning by fungi can be fatal, or they can produce only a mild gastrointestinal disturbance or the symptoms of mild allergy.

Compared to other forms of flora, fungi contribute very little to Iban diet and are of only minor importance in Iban pharmacology.

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. Properties include releasing 'wind' from the stomach, anti-tumour activity, treatment of inflammed eyes and reducing body temperature.

11 DISCUSSION

A total of 521 fungi species belonging to 71 genera of 39 families collected from the forests in LEWS. A very large percentage of macrofungi were collected in mixed dipterocarp forest and alluvial forest.

(iii)to analyse the data to obtain as complete a list as possible of the plant species present in LEWS, their habits, habitats, distribution and rarity, and

(iv)to recommend ways to conserve and manage the plant biodiversity of LEWS for the future.

3 METHODOLOGY

Three collection trips, each lasting. c. 21 days, were made during this project. All seven forest types represented in the TPS were sampled and two areas of particular botanical interest (Bukit Lanjak, the highest peak in the TPA, and Bukit Entimau) were visited. A total of 765 fertile (flowering and/or fruiting) vascular plant specimens were collected and processed according to standard herbarium specimen collection procedures. At the Sarawak Forest Department Herbarium c. 500 of these specimens and c. 920 other specimens recently collected in LEWS were identified to species by comparison with specimens in the Herbarium and with reference to relevant literature. The specimens represent collections from three areas of LEWS, namely Katibas (NE), Engkari (including Bukit Lanjak) (SW) and Mujok (W).

A database was established to store data on specimens from the TPA. Fields in the database included reference number, family, genus, species, habit, forest type, altitude, location and other relevant collection data. Data for each of the specimens collected during this project, together with those previously collected in the TPA and identified during this project have been entered into the database.

4 FINDINGS

A total of 661 species, representing 89 plant families (excluding ferns) have been identified so far. This number includes species of still uncertain status and those unmatched in SFD Herbarium. The final number of species for the TPA, after some specimens (particularly orchids) have been examined, is estimated to be 700 species. To this will be added data from the 1974 SFD collection and 1993 orchid collection.

The specimens represent a wide range of vascular plant types including trees (timber, non-timber, wild fruit trees and understory trees), palms, herbs, climbers, epiphytes, parasites and saphrophytes.

Species of particular interest met with during the study include:

(i) rare or uncommon species, defined here as taxa represented by only one or two specimens (whether in SFD Herbarium or reported in the literature),

(ii) plants not previously recorded as occurring in Sarawak or Borneo (New Records), and

(iii)potential new species not matching a named taxon in SFD herbarium, and given a letter code (sp. A, B, C etc.)

SUMMARY REPORT ON FLORISTIC INVENTORY

Kit Pearce
Botanist

1 BACKGROUND

The flora of Borneo is known to be extremely rich and has been conservatively estimated to comprise 12,000 - 15,000 species of vascular plants (Merrill, 1950). Most areas of Sarawak have been well-sampled by plant collectors, chiefly from the Botany Unit, Sarawak Forest Department (SFD), but also from overseas, and as of 1997 more than 76,000 collections had been made by SFD. However, there are still many species to be discovered and described in Sarawak, especially in more remote areas, as is apparent from the existence of many unmatched specimens from a wide range of families in Sarawak Forest Department Herbarium. Three new species from Lanjak-Entimau Wildlife Sanctuary have recently been described.

Lanjak-Entimau Wildlife Sanctuary, gazetted as a Totally Protected Area (TPA) in 1976, and c. 200,000 ha in extent, is located in south Sarawak and is relatively remote. Plant specimens were first collected in the area in March 1974, (391 specimens collected by Sarawak Forest Department). No further collections were made in the TPA until 1993, when c. 570 specimens were collected by botanists working on the Tree Flora of Sabah and Sarawak Project and 366 specimens, including 233 orchid specimens, by visiting orchid taxonomists. In 1994, a further c. 400 specimens were collected by SFD staff. The International Borneo Biodiversity Expedition 1997 (IBBE 97) added a further c. 900 collections to the total for the TPA. However, the total number of existing collections (c. 2627) is still low, and many areas in the TPA have still not yet been visited for plant collection. Till now, the Lanjak-Entimau area has been relatively under-collected compared to most other areas of Sarawak.

2 RATIONALE & OBJECTIVES

The Lanjak-Entimau Wildlife Sanctuary is the single largest Totally Protected Area for the *in situ* conservation of biodiversity in Sarawak. Seven different forest types occur in the TPA, which protects a significant proportion of the State's remaining virgin forest. However, baseline data regarding the families, genera and species of plants present, their habits, habitats and rarity has not yet been assembled. The objectives of the floristic inventory are

(i) to obtain as much baseline data as possible by collecting specimens from each of the seven forest types found in the area and from areas not yet visited for plant collection, and identifying these, together with existing collections from the TPA.

(ii) to store this data in a database to facilitate its retrieval and analysis,

5 DISCUSSION

1. The number of families and species so far recorded from the TPA indicate its botanical richness. However, the richness of the area has not yet been adequately sampled because

   i. not all areas in the TPA have been visited for collection
   ii. not all forest types are adequately represented by the specimens so far collected (e.g. summit ridge forest is very poorly represented except for orchid collections)
   iii. periodicity in flowering and fruiting means that many species could have been missed because they were not fertile when a particular area was visited.

   The botanical richness is not yet fully understood because:

   i. As many as 127 species recognised as distinct during the identification process were not able to be matched in SFD Herbarium. These may represent:

      a) species yet to be recognised in our Herbarium, (in many cases matching specimens are among the unidentified specimens already inserted in the Herbarium), or
      b) species not yet recorded for Sarawak, or
      c) species new to science.

   ii. Some specimens, particularly orchids, have yet to be identified.

2. Many rare and interesting plants have been encountered, as well as plants with potential as ornamentals (palms, gesneriads, orchids, begonias etc.) and others which are useful (e.g. rattans) or would be of interest to ecotourists (*Nepenthes*, orchids, cauliflorous trees in the TPA, *Rafflesia* just outside it).

3. The rare and interesting species identified during this project are by no means confined to particular habitats but occur in many different locations and forest types in the TPA. This has two implications:
   - further collection should be carried out in all areas of the TPA including old secondary forest, and not be restricted to mountain peaks or virgin forest,
   - protection has to be extended to all parts of the TPA.

4. The orchid flora is rich and diverse and although orchids are particularly common in riparian and montane habitats they are not limited to any particular forest type.

Table 1: Families richest in genera and species

Plant family	Notes
Annonaceae	9 genera
Begoniaceae	12 species of *Begonia*
Euphorbiaceae	15 genera
Gesneriaceae	*Cyrtandra* is represented by 19 species
Melastomataceae	14 genera
Myrtaceae	*Eugenia* is represented by 30 species
Orchidaceae	at least 26 genera
Palmae	12 genera
Rubiaceae	28 genera and a specimen unmatched to genus
Zingiberaceae	12 genera

Table 2: Rare species and species newly recorded for Sarawak or Borneo

Family	**Species**	**Status (N.R. = New Record)**
Anacardiaceae	Semecarpus sandakanus	N.R. Sarawak, endemic, rare
	Swintonia schwenkii	Rare
Araceae	Phymatarum borneensis	Genus endemic to Sarawak
Bombacaceae	Neesia pilulifera	Rare
Burseraceae	Canarium sarawakanum	Rare
	Dacryodes rubiginosa	Rare
	Santiria impressinervia	Rare
	Santiria sarawakana	Rare
Euphorbiaceae	Agrostistachys sessilifolia var. graciliflora	Rare
Gesneriaceae	Cyrtandra minuta	Rare
	Cyrtandra papyracea	Rare
	Didydmocarpus murutorum	Rare
Guttiferae	Calophyllum mukunense	N.R. Sarawak
	Garcinia bancana var. curtisii	N.R. Sarawak
	Garcinia dumosa	N.R. Sarawak
Melastomataceae	Driessenia attenuata	Rare
	Medinilla allantocalyx	Rare
	Memecylon fruticosum	Rare
Myrtaceae	Eugenia argyrocalyx	Rare
	Eugenia burkilliana	N.R. Sarawak
Palmae	Iguanura chaiana	Rare
	Pinanga brevipes	Endemic
	Pinanga pilosa	Rare
Polygalaceae	Xanthophyllum monticolum	N.R. Sarawak
Rubiaceae	Urophyllum sessiliflorum	N.R. Borneo
	Xanthophytum alopecurum	Rare

- **Preservation zones.** Such zones would be given absolute protection (zero disturbance with no rintising, camping or collection of plants permitted). Bukit Lanjak, Bukit Peninjau and Bukit Lanjak Mit, the only area in the TPA supporting montane mossy forest, should be given preservation zone status. Bukit Lanjak summit has already been damaged by the construction of a trig point and camping activities.
- **Conservation zones.** Areas accorded priority for conservation would include existing genebank areas and other areas rich in dipterocarp species, such as Bukit Sengayuh, ulu Katibas, where further genebanks may be established in the future, as well as areas from which materials for other projects e.g. ornamental plant projects, might be obtained.
- **Wilderness zones.** The remainder of the TPA.

iii. Semi-permanent camp structures of belian could be set up in the preservation and conservation zones to prevent the damage to the forest caused by periodic camp-making. Camping would not be allowed in the most sensitive areas.

iv. Local involvement in the protection and patrolling of the area, escorting legitimate visitors to the area, and monitoring sensitive species or habitats from time to time could be achieved if members of the local communities were given suitable training.

4. The rich and diverse orchid flora of the TPA needs special study due to the complexity of orchid taxonomy.

5. Species with potential as ornamentals (e.g. orchids, palms, pitcher plants, gingers, gesneriads and begonias) could be investigated with a view to local community involvement in their propagation etc. as an economic activity outside the TPA area.

6. Ecotourism outside the TPA boundary is a potential economic activity for the local community. The data from the floristic inventory could be used to a) identify species occurring in the TPA which would be of interest to ecotourists, which could then be established in gardens outside the TPA, and b) habitats with a high proportion of interesting species to help in the choice of ecotourism destinations outside LEWS.

5. Elements of training for members of the team involved in the project included exposure to:
   i. the practice of collecting ginger and orchid flowers and delicate specimens such as *Burmannia* in bottles of spirit. Such material is more effectively preserved for later identification when collected this way.
   ii. the types of data to be noted in the field for particular groups (e.g. palms, gingers, melastomataceae, aroids etc.). Such data facilitates identification of herbarium material and has been collated for future use.

6. A method of printing herbarium specimen labels using data directly from the database has been introduced and could result in considerable time savings if used in future work involving plant collection in the TPA.

6 RECOMMENDATIONS

1. The taxonomic richness and diversity of the TPA could be better understood if:
   i. specimens are collected from areas not yet visited, forest types not yet well collected (e.g. summit ridge forest) or plant groups of particular interest (orchids, palms, plants with potential as ornamentals),
   ii. remaining unidentified specimens from the TPA are identified,
   iii. taxonomic reference material presently unavailable in SFD Herbarium (including some literature & photos of type material of species described from Sarawak but not available in the Herbarium) are obtained and used,
   iv. problematic material (especially the many unmatched species) is referred to specialists,
   v. new species are described.

2. A checklist of the plants occurring in the TPA is needed. This would be a list of plants arranged by family, genus and species. For each species a brief description, its habit, habitat range, distribution, rarity and local (LEWS) vernacular name would be provided and an index of vernacular names included. Such a checklist would be of use both to the scientist and for educational and training purposes. It could be largely generated from the existing database of plants of the TPA once the necessary taxonomic work (see Recommendation 1 above) is completed.

3. Resource management of the biodiversity in the TPA needs to incorporate:
   i. protection of all areas of the TPA from disturbance as rare species are not limited to particular forest types or locations.

   ii. zonation of the TPS into different zones, based on the extent of particular forest types, habitat sensitivity to disturbance, and presence of species of particular interest. Each zone would be accorded a different level of protection:

2 OBJECTIVES

The objectives of the Phase II study are:-

(a) to continue and expand the study begun in Phase I;
(b) to collaborate with the horticulturist and local communities on the development of gardens of indigenous fruit trees, vegetables and medicinal plant species;
(c) Together with the mycologist, to compile a full taxonomic list of plants of potential medicinal and other values.

3 METHODOLOGY

The methodology used during Phase I was adopted. This involved visits to longhouses and identifying older residents who still had a good knowledge of the forest plants. These were then employed as informants and guides during the collecting trips. For each plant collected the following information was recorded:-

(a) Locality and habitat;
(b) Vernacular and scientific names;
(c) Description of the plant;
(d) Uses and, method of preparation;
(e) Voucher specimens of the species collected whenever necessary.

The survey covered parts of the ulu Kanowit area which could not be studied during Phase I, as well as a new Iban community in the Skrang region also south-west of the LEWS between the Kanowit and Engkari Rivers. Skrang represents one of the earliest settlements of the Iban people. The Iban communities now living in the Rajang watersheds originally migrated from there more than 200 years ago.

4 FINDINGS

The rich cultural traditions of the Iban people are reflected in their knowledge of numerous plant species for a variety of uses which are classified below:-

4.1 Food plants;
4.2 Medicines;
4.3 Buildings and handicrafts and other uses;
4.4 Rituals and ceremonies.

These uses are fully described in the final report.

4.1 Food Plants

Food plants are classified into four categories (Table 1). The young leaves are generally referred to as "kantok", but a number of more specific terms are also known. "Taruk daun" refers to the very young terminal leaves that have just opened, but are called "daun muda" when these young leaves are fully expanded. "Paku" refers specifically to the fern group. These are all eaten as vegetables.

SUMMARY REPORT ON ETHNOBOTANY

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1 BACKGROUND

Many native tribes of Sarawak are known to use the forest plants for food, medicine, rituals and ceremonies, and as materials for construction and handicrafts. This knowledge of the plants and their uses have been passed down from generation to generation, the medicinal plants through traditional healers called "dukun" or "manang". Village carpenters and handicraft makers are able to select the best materials from timber, rattan, bark and leaves to suit their many needs.

Although such knowledge has been known for many generations, studies and documentation of the plant species used did not begin until the early 1970s. In 1989, a Forest Department report containing 289 species of native medicinal plants and their uses was produced (Chai *et. al.*). The Forest Department's Botany Unit is still continuing with the study and to-date, an estimated 600 species have been documented. Another ethnobotanical survey among two Kelabit & Iban communities was undertaken in 1997 (H. Christensen).

In Lanjak Entimau the study was initiated during Phase I of the project in 1993, and covered areas in the ulu Mujok and ulu Engkari in the north-west and south-west respectively. Two other ethnic communities provided information on medicinal uses apart from the Ibans who live in the periphery of the Sanctuary. The Kedayan identified 67 species, the Lun Bawang 38 species, while 42 species were from the Iban.

Another category of plants recorded were fruits and vegetables which numbered 114 and 36 species respectively from the ulu Kanowit region in the north-west where there is a concentration of many Iban longhouses.

These initial findings have revealed the potential value of the Sanctuary as a gene pool of numerous plant species of ethnobotanical uses, and reflected the need for more study to be carried out. Collection of the forest products by the local residents can have varying degrees of impact on the natural resources. In the case of fruiting trees, the branches may be cut off to get to the fruits. Collection of palm cabbages often requires that the plants are cut down. There is less impact on the medicinal plants since modern medicines have almost totally replaced traditional remedies. Therein also lies the danger of the information being gradually lost as the younger generations have little interest in acquiring the knowledge from their elders. The study is continued in Phase II to gather more information from other areas of the Sanctuary in order to build up a more complete database of this group of plants.

(iii) Euphorbiaceae e.g. *Baccaurea angulata* (uchong)
B. motleyana (rambai)
B. macrocarpa(puak)

(iv) Flacourtiaceae e.g. *Pangium edule* (kepayang)

(v) Moraceae e.g. *Artocarpus anisophyllus* (bintawak)
A. integer (cempedak)
A. heterophyllus (nangka)
A. kemando (pudau)

4.1.2 Edible Young Leaves (Kantok and Paku)

The number of species recorded from ulu Kanowit and ulu Skrang were 38 and 26 respectively.Among the 12 species being common to both areas are the midin fern *Stenochlaena palustris*, paku kubuh (*Nephrolepis biserrata)*, and a number of palms including rattans. Uses of many of the leafy vegetables and the ways they are prepared are very similar among all the communities.

The main sources of these jungle vegetables include trees, climbers and herbs. The most well known of these is probably the midin fern (family Blechnaceae). This wild vegetable has found its way into most restaurants in Sarawak. Its popularity is partly due to its natural origin which makes it free from any pesticides.

Young leaves of many species may be eaten raw as a salad or ulam sometimes with sambal, a pounded mixture of prawn paste, dried prawns or fish and chillies. Leaves of *Begonia* (family Begoniaceae) and *Eugenia cephalanthum* (Myrtaceae) are also used for flavouring food. A number of species with both edible leaves and fruits include *Mangifera pajang* (Anacardiaceae), *Elateriospermum tapos* (Euphorbiaceae), *Saraca indica* (Leguminosae), *Ficus stolonifera* (Moraceae) and *Nephelium mutabile* (Sapindaceae) . The famous gambir leaves belong to a species of climber called *Uncaria gambir* (Rubiaceae).

4.1.3 Palm Cabbages and Undeveloped Shoots

The cabbages are known as umbut or upa among the Ibans. The undeveloped shoots refer to immature leaves or meristems of mainly wild gingers and bananas. This group of vegetables are more popular in the Ulu Kanowit where 44 species were recorded with 37 belonging to the palms. Ulu Skrang had a total of 16 species with 10 palms, 3 gingers and 3 bananas. Five species of the palms and all the gingers also produce edible fruits.

It is interesting to note that almost none of the species are cultivated for they are readily available from the wild, both from the primary forest and secondary jungles.

Among the palms, the majority of the cabbages are obtained from the rattan. The most popular among these is *Plectocomiopsis geminiflora* (wi lalieh). Its

Altogether 184 species were recorded from ulu Kanowit. Out of this number, only 21 were previously known from the Phase I survey. This would give the total number recorded from the area at 313 species. The number from Ulu Skrang is 60 species.

Table 1: Plant species used for food

Category	No. of species		Spp. common to both areas	Net no. of species
	Kanowit	Skrang		
Oil from fruits	5	-	-	5
Fruits	90	71	42	119
Young leaves	38	26	12	52
Cabbages and undeveloped shoots	44	13	-	-
Young inflorescences	7	6	6	7

4.1.1 Fruits

There are many more fruit trees than vegetables in the forests. 90 species were recorded from the Ulu Kanowit area while 71 were known from Ulu Skrang. 42 species were common to both areas, giving the total net number to 119 species.

Species that are common to both areas mainly belong to members of the families Anacardiaceae, Burseraceae, Euphorbiaceae, Moraceae, Sapindaceae and Zingiberaceae.

The engkabang oil or minyak engkabang is obtained from five species of *Shorea* (Dipterocarpaceae). The most popular of these species is *Shorea macrophylla* which has been widely cultivated. Locally the oil is made into a butter used for cooking. It is also eaten with rice. The illepenuts are exported for a variety of uses in the chocolate and cosmetics industries.

Plants that produce edible fruits are mostly trees, while a small percentage are from palms, gingers and climbers. They include species which are both domesticated and wild. With the exception of a few fruits such as kepanyang (*Pangium edule),* dabai (*Canarium odontophyllyum)* and kemayau (*Dacryodes rostrata)*, most fruits are eaten raw. The sour fruits of *Baccaurea lanceolata* (lempa'ong) are used as a flavouring agent in cooling fish or meat.

Fruits which have been domesticated belong mainly to a number of well known families such as:-

(i) Bombacaceae e.g. *Durio zibethinus* (the famous durian)
Durio graveolens (isu)
Durio oblongus (nyekak)

(ii) Burseraceae e.g. *Canarium odontophyllum* (dabai)
Dacryodes rostrata (kemayau)

(iii) For general body pain : *Rourea mimosoides* (Connaraceae), *Phyllanthus urinaria* (Euphorbiaceae) and *Dischidia bengalensis* (Asclepediaceae). The *Dischidia* is also used to treat swollen liver.
(iv) For treatment of swollen legs in mothers after giving birth, the leaves of the fern *Syngramma wallichii* (Hemionitidacae) are pounded and used for massage.

(c) For treatment of fever, malaria and cholera, 9 species are used. Many of these are forest plants and include:-

(i) For fever and malaria : *Goniothalamus macrophyllum* and *G. velutinus* (Annonaceae), *Thottea rhizantha* (Aristolochiaceae) and *Garcinia* sp. (Clusiaceae)
(ii) For yellow fever : *Diospyros puncticulosa* (Ebenaceae);
(iii) For cholera and fever : *Lophatherum gracile* (Gramineae) and *Etlingera* sp. (Zingiberaceae).

(d) For treatment of stomach ache, gastric pain and diarrhoea, 7 species are known . Some examples are : *Artocarpus kemando* (Moraceae), *Lophatherum gracile* (Gramineae) and *Dalbergia parviflora* (Leguminosae). For diarrhoea and cough the forest climber *Ampelocissus imperialis* (Vitidaceae) is used to prepare an infusion for drinking.

(e) Seven species are used for the treatment of centipede bite, snake bite and bee sting. These creatures are common around the longhouses and in the forest. Some examples of the plants used include:

(i) For centipede bite and bee sting : *Alocacia beccarii* (Araceae), *Smilax leucophylla* (Liliaceae) and *Ficus grossularioides* (Moraceae);
(ii) For snake bite and bee sting : *Dianella ensata* (Liliaceae), *Lepisanthes amoenum* (Sapindaceae) and *Etlingera* sp. (Zingiberaceae).

Apart from the above, there are also plants used in the treatment of sore eyes e.g. *Dicranopteris linearis* (Gleicheniaceae); cuts and wounds e.g. *Croton ensifolia* (Euphorbiaceae); kidney problem e.g. *Lindera pipericarpa* (Lauraceae); and goitre e.g. *Torenia polyonoides* (Scrophulariaceae).

The Iban people also believe in illnesses associated with the evil spirits. The cure often involves the burning of plants to get rid of the spirits from the house. These plants are mostly aromatic in character, such as *Homalomena sagittifolia* (Araceae), *Blumea balsamifera* (Compositae), and species of *Goniothalamus* and *Polyalthia* of the Annonaceae.

5 MATS AND BASKETRY

Mats and baskets are two of the most popular items made by the women folks of many ethnic communities. The materials used are rattans of which 12 species are known, comprising 10 *Calamus* and 2 *Daemonorops*. Other materials are obtained from Marantaceae (1 species), Moraceae (1 species), Pandanaceae (2

very bitter-tasting shoots are believed to have medicinal properties in lowering blood pressure if taken regularly.

4.1.4 Young Inflorescences

Among the several species of wild gingers and bananas with edible young meristems and fruits, the young inflorescences are also eaten. The Iban refer to the ginger inflorescence as bungai muda or young flowers, and the banana inflorescence as tunkul pisang.

There is a strong contrast in the aromatic taste of the ginger flowers and the flat and often astringent taste of the banana flowers.

The most well-known among the gingers are the kecala (*Hornstedtia magnifica*) and tepus (*Etlingera fimbriobracteata*), used in the preparation of fish, wildboar meat or chicken cooked in bamboo containers, a popular Iban dish called "pansuh".

4.2 Plants with medicinal properties

Altogether 61 species have been collected from Ulu Skrang, representing mostly new records not known from Phase I. The list includes many species from young secondary forest and degraded land, such as *Blumea balsamifera* (Compositae), *Ageritum conyzoides* (Compositae), *Nephrolepis biserrata* (Oleandraceae) and *Phyllanthus urinaria* (Euphorbiaceae). These are common species that are often widely used also by the Chinese community. Uses for the 61 species of plants have been divided into 18 categorises based on the types of illness they threat. The main categories are described below:-

(a) For treatment of skin diseases which include shingles, ringworm, white spot and itchiness, 12 species are used. Some of the examples are:-
   (i) For shingles: *Alstonia scholaris* (Apocynaceae), *Willughbeia sarawakensis* (Apocynaceae) and *Homalanthus populneus* (Euphorbiaceae);

   (ii) For ring worm and white spot : *Cratoxylum glaucum* (Hypericaceae) and *Cassia alata* (Leguminosae);

   (iii) For itchiness which may be due to some allergic reaction : *Cratoxylum glaucum* (Hypericaceae), *Scoparia dulcis* (Scrophulariaceae) and *Clerodendrum adenophyllum* (Verbenaceae).

(b) For body pain and swellings for which 11 species are used. The problems include general body pain, swollen ankles and knee joints (which may be due to rheumatism), and tired muscles.

   (i) For swollen knees and ankles : *Ageritum conyzoides* (Compositae);
   (ii) For muscular pain : *Nephrolepis biserrata* (Oleandraceae);

(f) Fruits for polishing brass and silver wares – *Baccaurea lanceolata* (lemparong) – Euphorbiaceae;
(g) Leaves for soap – *Salomonia cantoniensis* (rumput pupok) – Polygalaceae

Other uses include bark for tying and making of bark cloth, leaves and fruits for dye, fibre for fishing lines and leaves for wrapping food.

8 RITUALS AND CEREMONIES

The Iban people are rich in customs and traditions. Many of these customs and traditions are closely linked to their everyday activities which revolve around farming, hunting, fishing and gathering of jungle produce. This is still the lifestyle among the majority of the rural communities.

Many plants play an important role in the rituals and ceremonies to bring the good luck or to keep away evil spirits. The herb *Cordyline terminalis* (sabang) is used to celebrate the gawai festival; *Garcinia andersonii* (sikop) and *Bromheadia borneensis*, a terrestrial orchid, are used during padi planting; *Costus speciosus* (letik) is believed to bring good harvest; *Ardisia colorata* (merjimah) and *Vernonia arborea* (entupong) keep away evil spirits; and *Homalomena sagittifolia* (belingau) is carried for good luck during hunting.

The Ulu Skrang Iban communities regularly use over 14 species of plants which include trees, shrubs, herbs, climbers and orchids. Of these, only veryfew plants such as *Cordyline terminalis* and *Piper betle* are cultivated. The others are usually available from nearby jungles and are collected whenever they are needed.

species) and Zingiberaceae (1 species). These plants are readily available from the forest, so that only very few of them are cultivated.
Rattan mats and baskets are much more valuable and durable compared to those made by bemban (*Donax canniformis*), pandan (*Pandanus* spp.) and sengang (*Etlingera littoralis*). The best quality rattans are wi sega (*Calamus optimus*) and wi letik (*Calamus caesius*). Different materials are selected to suit the purpose for which the mats or baskets are intended.

Baskets are also made from the petioles of the pantu palms (*Eugeissona utilis*) or leaf sheaths of sengang. The bark of tekalong (*Artocarpus odoratissimus*) is used for making the mat called "tikai lampit" in which parallel strips of the split rattan are held together by strips of the bark.

6 BUILDING MATERIALS

Many ethnic communities build their own houses and boats with timber materials readily obtained from the forest. Selection of the timber is important depending on the need. The criteria for selection generally include hardness, durability, texture and ease with which the timber can be worked. Many years of experience are necessary in order to identify and select the right species

The majority of the 35 species recorded are used in house construction and boat building. These species belong mainly to members of the family Dipterocarpaceae (e.g *Shorea, Dipterocarpus* and *Dryobalanops*). Parang or knife handles and knife sheaths are made from *Saraca declinata, Koompassia malaccensis* and *Azadirachta excelsa*, while *Polyalthia* and *Memecylon* spp. make excellent poles used in pushing boats over shallow rivers. *Upuna borneensis*, another dipterocarp, is much sought after for boat building because of its lightness and durability but is much less common than *Shorea* and *Dipterocarpus*.

Less permanent materials are used for farm huts and jungle sheds during hunting and gather of produce. Leaves used for thatching include those of *Campnosperma coriacea* (terentang), *Artocarpus* (pingan, selanking), *Musa* sp. (wild banana), many palms (e.g. *Eugeisonna, Licuala*), the fern *Blechnum orientale* (paku kijang), and the ginger *Etlingera littoralis* (tepus). The bark of some *Artocarpus* species make useful walling material.

7 OTHER USES

The forest plants have numerous other uses that are perhaps less well-known to many people. The following are some examples of the 27 species that have been recorded from ulu Skrang:-

(a) Fibre used for starting a fire – *Friesodielsia glauca* (randau rarak), Anononaceae;
(b) Latex for fixing knife handles – *Willughbeia sarawakensis* (akar kubal), Apocynaceae;
(c) Stem for pepper post – *Cyathea laurifolia* (paku kijang)- Cyatheaceae;
(d) Fish poison – *Diospyros mindanaensis* (tubai buah) – Ebenaceae;
(e) Fruits for perfume – *Lindera pipericarpa* (medang serai) – Lauraceae;

LEWS is a conservation area and while its biodiversity is protected it can be made available for use in non-destructive ways. Seed of useful trees for planting needs elsewhere in the State can be collected in certain zones of the TPA.

There is no recognised procedure for the establishment of *in situ* genebanks in the tropics. No such genebank has yet been specifically established in Malaysia. Thus criteria for genebank establishment have to be developed. Dipterocarps, the major timber-producing species in the state, do not produce seed annually but at irregular intervals of two to several years. Thus selected trees will need to be monitored so that seed can be collected and utilized as it becomes available.

OBJECTIVES

1. to develop criteria for the establishment of a genebank of useful tree species in the TPA, which once developed, can be applied in future in LEWS and elsewhere in Sarawak,
2. to establish genebanks within the TPA, by locating, identifying, marking and measuring mature trees of good form, both of commercially important timber species and other useful species such as wild fruit trees,
3. to produce species maps for timber trees and other species of economic importance in the genebanks,
4. to develop appropriate methodologies for plot monitoring and seed collection and plot maintenance,
5. to survey for other areas within the TPA for additional genebank sites,
6. to train Forest Department staff and members of the local community in basic phenology, seed collection and preservation and other relevant technical methodologies
7. to enter genebank data into the ITTO databases.

METHODOLOGY

Three field trips were made, to 2 sites in the TPA. A prototype genebank was set up at ulu Engkari, during which process the criteria and methodology for genebank establishment were developed. A second genebank was then established using these criteria, and the first genebank was extended and completed.

FINDINGS

A number of criteria were found to be important in the setting up of a genebank:

a) **Choice of site.** Sufficient suitable species and individuals must be present and the site accessible and of suitable terrain to permit monitoring and fruit collection.
b) **Choice of species and individuals to be included.** Dipterocarps are the most important timber species in LDF and HDF in Sarawak. Other timber species, both well known and lesser known, can also be included to widen the range of

APPENDIX 7

SUMMARY REPORT - GENEBANK ESTABLISHMENT

Kit Pearce
Botanist

BACKGROUND & RATIONALE

Forestry is an important economic activity in Sarawak. The State has large tracts of forested land and timber harvesting has long been a mainstay of the State's economy. Downstream activities are now gaining importance. Lately, in many areas, loss of individuals and populations of various species, and habitat degradation through such activities as logging and shifting cultivation has resulted in the deterioration of forest resources, including erosion of the genepool. To ensure the future of forestry in Sarawak the forest resource needs to be maintained and upgraded. The State has a stated objective of establishing large areas of plantations on logged and degraded land. For this purpose various species, including native species well adapted to local conditions, should be used. A large supply of seed of useful timber trees will thus be needed. *In situ* genebanks can be a source of such seed.

An *in situ* genebank is an area of natural forest where breeding populations of selected useful species are conserved for future use as sources of propagation material for use in breeding programmes to improve local useful species. A genebank should contain a sufficient number of well-formed, 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, seed of a range of species including dipterocarp and non-dipterocarp timber trees, as well as local fruit trees which may be more widely planted in future, should ideally be available. Each individual in the genebank must be identified and labelled in the field so the idenditiy of any seed which becomes available is known.

Lanjak-Entimau Wildlife Sanctuary (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 Dipterocarp Forest (LDF) and Hill Dipterocarp Forest (HDF), both forest types of major economic significance. The forest has been found to be rich in species of useful trees, including dipterocarp and non-dipterocarp timber species and wild fruit trees (Chai, 1995).

DISCUSSION

1. The ulu Mujok genebank is considerably richer in terms of species than the ulu Engkari genebank. This can be ascribed partly to ecological differences between the forest types of the two sites. The two genebanks will provide seed suitable for reforestation in both Lowland and Hill Dipterocarp Forest. 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. Thus, to incorporate a wider range of useful species more genebanks will need to be established in other areas of the TPA where some of these species occur.

2. Maps showing the layout of the genebanks, the subplots within them, their relief and the position and identification numbers of trees included in them, have been prepared.

3. The project has involved only the establishment of the genebank. Phenological monitoring of, seed collection from and maintenance of the genebank, will be important subsequent activities (see Recommendations).

4. Genebanks will need to be made as extensive as possible within the limitations of accessibility and terrain. Some genebank trees are expected to be lost (several trees were lost by windthrow from the ulu Engkari genebank during the period April to August).

5. Members of the local community were involved in the establishment of the two genebanks and were thus exposed to the concept of a genebank and methodology for its establishment. They were instructed in the need to keep damage to area (from rintis cutting, tree identification and labelling) to a minimum. Certain local community members with much logging experience knew the trees well and consistently, accurately assigned local names to trees in the genebank. They also provided information on the usefulness of certain species. Such individuals will have much to contribute in future genebank establishment.

6. There was a two-way flow of learning during this project with the counterpart giving invaluable help in the field with practical details especially plot selection, surveying and marking, and camp organization. The team from Sarawak Forest Department carried out surveying, and tentative identification of trees accurately and efficiently.

timber types available. Wild fruit tree species should also be included, as these may become economically more important in the future and/or involved in the improvement of major local fruit species.

c) **Setting up, surveying and permanently marking genebank plot.** Terrain and the long-term nature of the project must be taken into account and the plot marked in a way that will be able to last several decades.

d) **Enumeration, identification and labelling of trees in the genebank.** An efficient way of rapid, accurate identification of trees was developed using specimens of fallen leaves together with local names supplied by local community members. A lasting yet non-damaging method of labelling trees was developed in which a numbered metal disc was attached to the tree with wire making allowance for future girth increment.

e) **Permanent record of genebank.** A map of each genebank, showing its shape, size, relief, and the position and identification number of each individual tree in it was prepared. The identification number, species and local name of each individual included in each genebank was entered into a database.

Two genebanks in different areas were established during the time available, as summarised below:

Criteria	Ulu Engkari Genebank	Ulu Mujok Genebank
Site	Tintieng Geroggang/Ubah Ribu Ridge, ulu Engkari (southern part of LEWS)	Sg. Ensirieng ulu Mujok (western part of LEWS)
Accessibility	< 1 day walk from Ng. Segera Ranger Station	c. 1 day from Ng. Ju Field Station by boat and foot
Forest type	Lowland Dipterocarp Forest (LDF)/Hill Dipterocarp Forest (HDF) transition and HDF	Lowland Dipterocarp Forest
Altitudinal range	600 - 740 m	230 - 250 m
Size	4.42 Ha	6.29 ha
No. of individuals	602	643
Number of species	25, including 15 dipterocarp spp. other timber spp., and 4 wild fruit spp.	56, including 44 dipterocarp spp. other timber spp. and 5 wild fruit spp.

RECOMMENDATIONS

1. Members of the local community should be trained and employed in phenological monitoring (regular checking for evidence of flowering) of the genebank, fruit collection and genebank maintenance. For phenological monitoring and fruit collection training needs to be carried out during a fruiting season.

   a) Phenological monitoring of the genebank trees needs to be carried out monthly by trained members of the local community. Those involved will be asked to immediately report by radio any sign of flowering of numbered trees. Once flowering begins the appropriate authority can be informed and arrangements made for fruit collection.

   b) A protocol for fruit collection, labelling and temporary storage of fruit, is presented.

   c) Maintenance of the genebank **must** be carried out every three years from the time of its establishment. During maintenance checks will be made on the pegs marking the genebank and the labels on the trees. Any mortalities of genebank trees will be noted and marked on the genebank map, and climbers cut.

2. The appropriate infrastructure, equipment and funding for seed collection has to be provided. This will involve lines of communication from the genebank site to the Forestry Research Section of the Forestry Department, semi-permanent camps/seed collection centres near genebanks, and facilities at Basecamps for temporary storage of seed as well as arrangements for transportation of seed.

3. Further genebanks need to be established in the TPA in areas rich in a different range of species from those already in the two existing genebanks. Bukit Sengayoh, ulu Sg. Katibas has already been found particularly rich in Dipterocarps (Chai, 1995) and would be a suitable site for the establishment of the next genebank.

4. The use of the genebanks as an educational resource for local, national or international training in genebank establishment and management could be considered.

5 CONCLUSIONS AND RECOMMENDATIONS

Species richness, abundance and distribution appear to be related to collecting sites. 93 out of the total of 147 individual specimens were collected from the vicinity of Ng Menyarin in the ulu Katibas, while the largest number of species from a single site (23) was also obtained there.

The study of herpetofauna requires long-term and intensive collecting in order to obtain a proper understanding of species richness, distribution and abundance. Continued inventory should concentrate on specific sites such as the forest floor and canopy. Long-term studies would involve monitoring of selected sites, identification of indicator species, and ecological studies on the role of amphibia within the forest ecosystem.

APPENDIX 8

SUMMARY REPORT ON HEREPETOFAUNA SURVEY

Robert B. Stuebing
Herpetologist

1 BACKGROUND

The herpetofaunal community forms an integral part of the species richness of Sarawak's fauna. In view of its high diversity and ecological importance, an inventory was first carried out during Phase I. It was recommended that systematic / taxonomic collections should be encouraged and areas of collections must be monitored to protect the integrity of the biotic community.

A total of 97 species have already been identified with amphibians being the most abundant with 51 species. The total number represents 31% of the known terrestrial herpetofauna of Sarawak. One frog, one lizard and one snake were new to science.

2 OBJECTIVES

Further study is carried out in order to continue and expand the inventory at new sites, and to identify and initiate monitoring of population of several key species.

3 METHODOLOGY

Specimens were collected along stream, river and forest transects at night. Field data of the specimens included stream size, substrate, distance from water and height above the ground.

Frog specimens were anaesthetised in a solution of chlorobutanol, while reptiles were enthanised by injection with a nembutal solution. After weighing and tagging with field numbers, the specimens were preserved in 10% formalin.

4 FINDINGS

The findings included observations made during the ITTO Borneo Biodiversity Expedition (IBBE) in 1997. The results were compared with those collected from Bentuang-Karimun National park (BKNP) in Kalimantan.

41 species were collected exclusively in LEWS compared to 51 in BKNP. Of the herpetofauna associated with small rivers and large streams 2-10 metres wide, *Limnonectes leporinus, L. ibanorum, Rana hosii* and *Bufo juxtasper* were very common. The torrent frogs, *Meristogenys poecilis* and *M. phaeomerus* were more abundant in LEWS than in BKNP.

(ii) **To rehabilitate the areas in the buffer zone used for shifting cultivation** to prevent further soil degradation. This will result in conservation of the area.

(iii) **To promote the ex situ conservation of the genetic resources**. The indigenous crop species in the pilot project and demonstration plots all form the nucleus for genetic conservation upon which a more comprehensive collection can be built in the future.

(iv) **To promote the cultivation** of indigenous herbs, medicinal plants and non-timber products.

(v) **To promote utilization** of non-timber products in order to improve the nutritional status of the inhabitants and as an alternative health care option.

(vi) **To commercialise** non-timber products and to generate cash income through job creation and sale of products to improve the economic well being of the inhabitants.

The project commenced in July 1997 and was completed in a year.

2 PROJECT AREA

2.1 Location

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 (Anon 1996). It is contiguous with the Bentuang-Karimun 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 187,000 ha but the buffer zone is much smaller in area. The project areas located in Rh Api and Rh Enggong in ulu Katibas River and Rh Mengiring and Rh Gerasi in ulu Mujok River. These are the most remote longhouses on these rivers and the nearest to LEWS. Access to these longhouses remains difficult. It takes about five hours by longboat from the nearest town. The journey is hazardous during high water . During low water, poling, pulling and pushing over shallow waters and rapids is required.

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 1,284 m a.s.l. 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 is steep but pockets of relatively flat land can be found.

SUMMARY REPORT ON THE CULTIVATION OF INDIGENOUS CROPS IN FOUR IBAN VILLAGES IN THE LANJAK-ENTIMAU WILDLIFE SANCTUARY (LEWS) BUFFER ZONE

Kueh Hong Siong
Horticulturist

1 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 establishment of the Lanjak Entimau Wildlife Sanctuary in 1983 and a Totally Protected Area (TPA) in 1990 in an area traditionally used by local communities causes suspicion and potential conflict. Community improvement projects must be in place to ensure that the community benefits from development of the biodiversity resources of the Sanctuary.

The community development project on indigenous crops meets the following objectives and Article 1 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 project involved the planting of indigenous crops in on-farm trials and on-station demonstration plots. The specific objectives of the project are as follows

(i) **To reduce pressure** on the Lanjak-Entimau TPA. 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.

There is great diversity including fruits, vegetables, medicinal plants and plants used as dyes, handicraft making and ornamentals.

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.

2.6 Socio-economy

2.6.1 Background

An estimated 12,400 people of the Iban community reside in the periphery of the LEWS. It represents 0.6% of Sarawak's population.

2.6.2 Demographic characteristics

A total of 102 longhouses comprising 1,761 households are located in the vicinity of the buffer zone. Each household has an average of 5 members. 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.

2.6.3 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.

2.6.4 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.

2.6.5 Farming

Subsistence farming of hill rice in a shifting cultivation system is practised by 94% of the households. Average yield is 500 kg/ha. The fallow period has 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.

The Sanctuary is drained by the Batang Lupar tributaries (Sg Ai, Sg Lemanak and Sg Skrang) and the Batang Rajang tributaries (Sg Katibas, Sg Kanowit, Sg Poi and Sg 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 per annum. The wettest months (October-January) received 300-350 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.

Alluvial soils of the Bemang Seduau and Malang series occur in valleys and levees and its agricultural capability is classed under Category 3 with minor to moderate limitations to cropping of a wide range of crops. Only 0.4% of the sanctuary falls into this class along Sg Ngemah, Sg Mujok, Ulu Sg Mujok and the confluence of Sg Joh and Sg Bloh. Most of the planting of indigenous crops are located in this soil type in small flood plains, levees and river banks as they are suitable for vegetables and fruits.

Red Yellow Podzolic soils of the sanctuary originated from sedimentary rocks mainly coarse-grained sandstones and shales. The Merit and Bekenu families are common. Only 0.5% of the sanctuary's land area belongs to this category. Classed as Category 3-4 agriculturally, it is suitable for perennial crops where slopes are not too steep.

Skeletal soils found on steep slopes and ridges are shallow (< 50 cm depth) with rocky surface and steep gradients and have little or no agricultural potential (Class 4-5). It occupies 99% of the area and is either very infertile or with high potential for erosion. The skeletal soils are best left under primary forest cover as any disturbance will result in severe erosion.

In site selection the soil capability is given due consideration as the success and sustainability of these two pilot projects 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.

4.1 On-farm Trials In Ulu Katibas and Ulu Mujok.

Dialogue sessions were held to select participants, crops and sites. Implementation followed by sourcing of planting materials, nurserying, land clearing and preparation, planting, maintenance and data collection.

In order to ensure sustainability, transfer of technology was effected through dialogue sessions and in situ training and hands on training of Forest Department staff and farmers.

Bringing inputs such as planting materials and fertilizers to remote areas was costly. To overcome this, a low input package was used. Leguminous cover crop *Arachis pintoi* was introduced to control erosion on steep slopes, improve soil conditions by organic matter accumulation and symbiotic nitrogen fixation. This was supplemented by planting nitrogen fixing trees (NFTs) *Gliricidia sepium* and *Erythrina poeppigiana* where the leaf litter and prunings can be used as green manure to add fertility to the soil.

The pilot project consisted of planting indigenous crops by 11 farm families in four longhouses in Ulu Katibas and Ulu Mujok in the vicinity of LEWS buffer zone. The farmers appreciate the commercial and food value of indigenous fruits. The most preferred fruit trees are dabai (*Canarium odontophyllyum*), isau (*Dimocarpus longan* var. *malesianus*) and petai (*Parkia speciosa*) which form all the principal planting. They were also required to plant seven species of other indigenous fruits to assess their potential. Eight commercial species of which two were non-seasonal were also planted.

Two species of rattan, the multiple stemmed rotan sega (*Calamus caesius)* and single stemmed rotan manau (*C, manan*) were planted under thinned out secondary forest.

The farmers were in general not interested in the cultivation of indigenous vegetables as these were easily available in the wild and no market existed in ulu 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.

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 Department of Agriculture because of the remoteness of the longhouses.

2.6.6 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 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 but 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 Forest Department Sarawak 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 Department of Agriculture (DOA) Sarawak 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 Forest Department Sarawak 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 CULTIVATION OF INDIGENOUS CROPS

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.
The planting consisted of on-farm trials and demonstration plots.

The indigenous crops are to serve as a source of food and cash income. Table 2 shows the nutritional value of selected indigenous fruits and vegetables. Dabai and nyekak are very nutritious with high values for energy and potassium. In Sarawak the nutritional value of indigenous fruits and vegetables are comparable to cultivated species with the added advantage that they are pesticide free (Voon and Kueh 1998, in press).

The results show that it is not only technically possible to cultivate indigenous fruits but it is also commercially viable.

6 CONCLUSIONS

Planting of indigenous food crops will reduce poverty and malnutrition that are quite rampant in the area. For viability non-seasonal fruits must be included and a low input package must be utilised.

Improving the livelihood of the inhabitants will reduce pressure on the TPA.

Planted on shifting cultivation land it will rehabilitate such degraded land.

A significant number of indigenous crop species in the pilot planting and demonstration plots form the nucleus of a more comprehensive collection for ex situ conservation of genetic resources.

7 RECOMMENDATIONS

7.1 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 Department of Agriculture'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 1761 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.

Indigenous fish culture, and apiculture should also be encouraged

4.2 Demonstration Plots In Ng Bloh and Ng Ju Ranger Stations

Forty seven species of fruits were planted in a demonstration plot in Ng Ju Ranger Station in Ulu Mujok of which 17 are commercial species and six are non-seasonal. 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.

For indigenous vegetables, 15 species were planted in Ng Bloh and Ng Ju Ranger Stations.

A demonstration plot consisting of 16 species of medicinal plants was successfully established in Ng Bloh Ranger Station even though some damage was caused by unexpected severe flood apparently caused by the La Nina weather phenomenon. Three species of *Calophyllum* which contain the anti-AIDS compound will be planted pending land preparation which has been hampered by incessant rain since July 1998.

5 RESULTS AND DISCUSSION

5.1 Mortality

Establishment of fruits and rattan was good based on the mortality rate. The mean mortality rate of 10.1% (0-44.4%) is acceptable under farmers conditions. Farmers who achieved less than 5% are excellent, 5-10% good, 10-15% fair and more than 15% poor. The main causes of mortality were:-

(i) Delayed planting and inadequate care of seedlings
(ii) Water logging on heavy soils
(iii) Weedicide damage
(iv) Mammalian pest damage

5.2 Plant Height

Plant height was measured after planting as a basis for height increase assessment after six months planting. Plant girth, date of first flowering and fruiting and yield and quality assessments will be recorded.

5.3 Preliminary Economic Assessment

An estimation of the income that can be derived from 10 plants each of isau, dabai and petai (0.62 ac) 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 1) which is 2.2 to 3.8 times the State's poverty line. In LEWS, Phase I the sociologist reported that on average the household income in the vicinity of the LEWS was half the State's poverty line.

7.4 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 ecotypes 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.

7.5 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 DOAs 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 ITTO 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 (*Pontius 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 is RM30 to RM130/kg.

7.6 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 DOA Sarawak 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 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. 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.

7.2 Community Forestry Based On Indigenous Timber Species In LEWS Buffer Zone

The sociological report of LEWS Phase I demonstrated that common occurrence of poverty and malnutrition of the inhabitants.

It is recommended that a small holder forestry project is proposed based on technology generated by Forest Department, Sarawak and management system developed by Model Forest Management Area (MFMA) by ITTO. 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 sumatrana*) 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 fruits 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.

7.3 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 100 acres. The 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 is proposed. The ex situ conservation is a good gene bank 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 bioactive 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.

TABLE 2 :NUTRITIONAL COMPOSITION OF SELECTED INDIGENOUS FRUITS AND VEGETABLES

	Nutrient composition per 100 g edible portion																
	Proximate composition								Minerals								
	Energy (kcal)	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)
Dabai	339	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	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
Petai	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	-
Belimbing manis	24	92.0	0.7	-	0.1	5.0	1.8	0.4	-	-	7	-	-	-	-	-	25.8
Terong Dayak	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
Paku ikan	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
Kecala	32	90.8	1.3	13.8	1.0	4.4	1.2	1.4	30	541	32	27	40	62	1.2	0.6	0.0

** Not analysed

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.

TABLE 1 : ECONOMIC POTENTIAL OF INDIGENOUS FRUITS

Fruit	Yield (kg/tree)	Ex-farm Price (RM/kg)	Income			Remarks
			RM/tree	RM/10 trees	RM/10trees/ annum	
Isau (*Dimocarpus longan* var. *malesianus*)	300	3 - 8	900 - 2400	9000-2400	3000-8000	Fruits once in 2-4 years
Dabai (*Canarium odontophyllum*)	300	2 - 5	600 - 1500	6000-15000	3000-7500	Fruits once in 1-2 years
Petai (*Parkia speciosa*)	1000 pod	RM2/3 pods	700	7000	7000	Non seasonal with 1-2 peaks annually
Total / annum					13000-22500	
Total / month					1083 - 1875	

(b) fish stock assessment – estimation of relative abundance for selected fish, species composition, fish harvest and consumption.
(c) To suggest recommendations for the long-term sustainable management of the fish resources of the sanctuary.
(d) To encourage the locals to rear local fish for food and side-income
(e) To assess the suitability of selected local fish for culture
(f) To assess the fish resources of the Sanctuary

2.1 Experimental rearing of local fish

This pilot project is aimed at involving the local people to rear suitable local fish for their own consumption and with some for sale. Priority is to culture the favoured species with high market value.

2.1.1 Materials and methods

(a) *Longhouse selection*

Based on a prior assessment survey of site suitability, three longhouses were selected. These were as in the following order:-

(i) Rh Gerasi, in upper Mujok – valley pond of about 243 m^3 constructed, carrying capacity 2,300 tails of fish
(ii) Rh Api, in upper Katibas – concrete tank of about 76 m^3 constructed, carrying capacity 800 tails of fish
(iii) Rh Enggong, in upper Katibas – valley pond of about 235 m^3 constructed, carrying capacity 2,115 tails of fish

(b) *Fish growth monitoring*

Samples of the fish fry/fingerling will be measured (for SL and TL)^3 and weighed initially and at intervals. A record sheet had been designed for data recording.

It must be pointed out here that the trial is not based on any special treatment of feed. Neither is there any replicate nor control. Rather, it is to observe fish growth under the community-based management regime – a field trial under the prevailing field condition. Fish growth performance can only be meaningfully assessed when sufficient data on fish weight and length (SL and TL) have been obtained for a period of at least 10 – 12 months from the date of initial stocking.

(c) *Monitoring of water parameters*

The water quality will be monitored in terms of the pH, temperature, dissolved oxygen (D.O.), turbidity and conductivity using a digital water quality checker equipment; transparency will be checked using a secchi disc.

(d) *Feed and feeding*

SUMMARY REPORT ON FISH MANAGEMENT STUDY

Stephen Sungan
Fish management Specialist

1 BACKGROUND

Lanjak Entimau Wildlife Sanctuary (LEWS) was initially proposed primarily to protect and sustain viable breeding population of orangutans, but has since been upgraded and expanded for the *in-situ* conservation of its rich biodiversity resources. Many reports have indicated LEWS as potentially the richest forests in Sarawak with its diverse flora and fauna. Management should therefore focus on the protection and development of this biodiversity at all levels, and the advancement of monitoring and research studies. State-wide, there is increasing general complaints about the dwindling fish resources from the numerous natural inland water bodies-rivers, streams and lakes. In this regard, LEWS should be viewed as both one very important step and a critical area towards conservation of the State's riverine fish resources for the long-term benefits of not just the peripheral communities but the State as a whole. The rapid rate of land-based development activities State-wide is inevitably impinging on the aquatic environment.

Among the biological components of the biodiversity, fish is viewed as one of the most important resources and of more obvious immediate significance, particularly to the natives. Fish and fishing are important aspects of their lives.

Fish diversity there is reportedly high. During Phase I of the ITTO project, 26 species of fish were collected incidental to the herpetofaunal survey, including two new species. The fauna inventory study recorded no less than 82 species, 31 genera and 8 families (Leh, 1998). A wide range of aquatic habitats exist, and not all were covered in the survey. There is therefore every possibility of discovering more species new to science.

With declining fish resources in the immediate areas near their longhouses due to fishing pressure and the increasing threat of pollution, there is every temptation for the locals, as well as outsiders, to encroach into the Sanctuary.

Under the above premises, how can the fish resource be managed for the benefits of both the LEWS and the locals residing around the buffer zone? This is another aspect of the present study.

2 OBJECTIVES

The present fish management study, under Phase II of the ITTO Project, comprised two major components:-

(a) experimental fish rearing involving the people (community development project); and

- Ulu Engkari river and Ng Segera
- Ulu Skrang
- Ulu Mujok, inside the sanctuary
- Ulu Katibas and Bloh rivers

Ulu Engkari and Ulu Skrang were visited only once. Comparatively more trips were made to Ulu Mujok and Ulu Katibas because of the siting of the pilot experimental fish rearing in these areas.

2.3.3 Sampling of rivers and streams

Fish sampling was carried out for selected rivers and stream only and confined to tributaries of Katibas-Bloh and Mujok rivers. Tributaries of rivers such as Sg Engkari, Batang Lemanak, Batang Skrang and other rivers inside the sanctuary were not surveyed and sampled in view of the time factor and the comparatively remote nature of these areas.

2.3.4 Questionnaires

A total of 9 villages were interviewed using the questionnaires. The longhouses included two in Ulu Engkari, 3 in Ulu Katibas and 4 in Ulu Mujok. The interview in Ulu Engkari was done by FG Stephen Antang who had been briefed prior to conducting the interview. In Ulu Mujok, FG Joannes assisted in interviewing the residents of the longhouses. The 3 longhouses in Katibas were interviewed with assistance from the Ng Bloh Station labourers.

2.3.5 Informal talk with the locals

This is considered as a very useful way of getting any other information that may not be covered or revealed in the questionnaire feedback. 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 is important towards planning management strategies for the LEWS.

3.0 FINDINGS AND DISCUSSION

3.1 Experimental fish rearing

The pond at Rh Gerasi had to be stocked again following the flooding of the pond (water overflowed its dam) which resulted in the escape of the fishes already put in. To date, 200 tails of locally caught semah fry and another 500 tails of tengadak fry (supplied by Agriculture Department)[1] have been put in.

[1] The participants said they were not able to get them from the wild

(c) *Monitoring of water parameters*

The water quality will be monitored in terms of the pH, temperature, dissolved oxygen (D.O.), turbidity and conductivity using a digital water quality checker equipment; transparency will be checked using a secchi disc.

(d) *Feed and feeding*

For the pilot project it was agreed that only a limited amount of artificial feed, i.e. only 10 bags of artificial pellet feed, was to be supplied. The participants were required and expected to provide locally and cheaply available feed stuff. The rationale is to cut down on feed costs and to give them a sense of commitment. They have been advised to grow local plants such plants such as kangkong (*Ipomoea* sp.), tapioca (*Manihot* sp.), ara (*Ficus* sp.), bunkang (*Eugenia* sp.), and kelampai (*Dysoxylum* sp.) as sources of natural food for the fishes. Ensurai (*Dipterocarpus oblongifolius*) flowers and fruits are natural fish foods too.

(e) *Project committee for each longhouse*

The participants were strongly advised to form a committee to oversee the running of the project such as the daily routine of feeding and maintenance of the pond/tank.

2.3 Assessment of the fish resources

In general, fish stock assessment cover many aspects such as the estimation of standing biomass, species composition, abundance by species, catch biomass, fishing effort and so on (Bagenal, 1978). For this study, attempts were made to assess a few aspects in view of the time factor.

2.3.1 Materials and methods

Works carried out to gather information on the existing fish resources included:

(a) Field visits to sites within and around selected areas of LEWS to study the general conditions on the ground;
(b) Casual sampling of selected rivers and streams to get empirical data on and a picture of the existing fish stocks;
(c) Interviewing residents of selected longhouses using questionnaires; and
(d) Informal talk and discussion with the local people to gather any other information relating to the fisheries of the area.

2.3.2 Field visits

These referred to trips made to some areas within and around the sanctuary. The purpose was to study the general condition in the field. Places and area visited were:-

prevailing situations, it is feared that the cumulative catch is more than the optimal quantity of maximum sustainable yields. However this aspect requires further detailed study.

3.2.3 Causes of fish decline

This trend of diminishing fish resources from the rivers, generally applicable throughout Sarawak, is blamed on the interplay of numerous factors. These include over-exploitation, deteriorating aquatic environment, degradation and loss of important habitats especially breeding and nursery grounds, and illegal fishing methods (which people rarely admitted resorting to).

4 SUMMARY OF RECOMMENDATIONS

Among the rich biological resources within the LEWS, fish is perceived by the local residents as having immediate and obvious importance. Fish, as other resources, are subjected to continual exploitation pressure by the people. Zoning of the Sanctuary as described in the earlier reports should be adhered to and followed in terms of use and restriction. Survey results indicated that the high-value fish such as semah, empurau and tengadak, once abundant and still targeted for exploitation, have greatly dwindled in population. For this reason, the rivers Joh, Jenuah and Takai need to be accorded special protection to safeguard the fry and fingerlings of these *Tor* species and other species residing there.

Education of the people, particularly those longhouse communities surrounding the boundary should be given immediate and greater emphasis by the authorities managing the LEWS. This should be coupled with suitable posters to remind them about the strict enforcement of the rules to deter encroachment into and poaching inside the LEWS. The success in managing the LEWS lies more on the ability of the authorities to manage the social component than the LEWS entity *per se.* Gaining the support and cooperation of the local communities is seen as the greatest challenge towards the conservation of the biodiversity of this sanctuary.

Local fish can be reared successfully in captivity in ponds and tanks when properly managed. The success of the pilot project above is important as there is keen interest among the locals to go into aquaculture. The above project should also be continued and extended to other villages in order to benefit other people as well. This is one way of reducing pressure exerted on the sanctuary's resources.

Basic research into the biology and ecology of high-value fish species which are considered endangered, should be carried out before they get depleted.

Within the LEWS itself, the existing total environment should be minimally disturbed to conserve the complex yet important ecology of the whole system. Strengthening the manpower of the executing agency i.e. Forestry Department will ensure more effective management of the sanctuary as a Totally Protected Area.

3.2 Assessment of fish resources

3.2.1 Fish abundance

Based on the survey of selected rivers and streams, fishes such as kepiat (*Puntius collingwoodi*), kulong (*Lobocheilus bo*), bantak (*Osteochilus* sp.) and seluang (*Rasbora* spp.) are currently the most common in all the rivers. The much-favoured and once-abundant species especially empurau, tengadak and semah in the river systems have decreased appreciably. Based on the locals' experiences, these three are dwindling by as much as 50-100%. Penyau (*Punthius cf. schwanenfeldii*), which is very similar to tengadak, is also rarely caught nowadays. Because of the ever increasing demand, both locally and in the towns, these species are likely to be continually subjected to exploitation, driving the natural stocks lower.

Certain tributaries of the Bloh and Katibas rivers still have semah and empurau. By comparison, the Bloh tributaries Sg Joh and Sg Jenuah have a higher relative abundance of semah than empurau. However, no tengadak was caught in all the rivers surveyed.

In Mujok, the survey done on Sg Semawang, Sg Spuna Ili and the stretch of riffles area in upper Mujok river did not yield any semah, empurau or tengadak fry or fingerling. In fact the Ng Ju station labourers brought for the purpose of this survey commented that there was not much point in making more sampling stations as they were of strong opinion that there is hardly any more fish of high value present in these parts of the river system. Residents of the two longhouses made similar remarks. Surprisingly, based on feedback, the tributary Sg Ju[2] (near Ng Ju Forestry Station) has better presence of semah fry and fingerling compartively. Kepiat (*Puntius collingwoodi*) is the species now common to all the river systems around here, and presently also the most abundant, followed by kulong.

There are apparent changes in fish abundance. The much-favoured species have decreased appreciably over the years while the less-preferred species tend to become common, though not necessarily increase in relative quantity over the same period.

3.2.2 Fish consumption

Based on the interview of 9 selected longhouses, the amount of fish consumed ranged from 2-15 kg/household/month, with an average of 6.6 kg/household/month; the highest consumption being by Rh Api in Ulu Katibas. The amount of fish consumed by the villages ranged from 42-154 kg/village/month – lowest in Rh Raba (Ulu Engkari) and highest in Rh Lenggang (also in Ulu Engkari). The annual fish consumption ranged from 504 – 1848 kg/village/year. It could be inferred but generally, the amount of fish caught from the rivers range in close amount to the above figures, assuming that all the fishes caught are for domestic, consumption. Under the

[2] Most of the semah for stocking the fish pond of Rh Gerasi were caught from this river

Wildlife Sanctuary Order, 1983 had formally granted the rights to some of the neighboring villagers to collect jungle produce from specified areas for their own consumption.

1.2 Socio-economic aspects

Hunting is still part of the culture among some of the Ibans inhabiting the periphery of the Lanjak-Entimau Wildlife Sanctuary. The need to give due emphasis on hunting practices of those inhabiting areas surrounding the Sanctuary is critical. The meat of the wild game animals is generally not only seen as a source of protein but more importantly as a commodity which could generate income to local communities. As most households within the periphery of the Sanctuary still practice shifting cultivation and hunting to supplement their income, a comprehensive study on hunting practices and the current status of game species within the affected areas are needed for planning and formulation of the management plan. This is to ensure that conservation of the Sanctuary would be socially and culturally acceptable to the communities concerned. At the same time, in the context of management and conservation it is essential to have a better understanding of the local communities, their problems, aspirations and needs so that appropriate management policy can be drawn up.

2 STUDY SITES, OBJECTIVES AND METHODS

2.1 Study Sites and Objectives

Three sites at the periphery of the Lanjak-Entimau Wildlife Sanitary were selected for the study. These were: Lubok Antu and Sri Aman which cover upper Batang Ai and Skrang in the south, Julau and Kanowit which cover upper Mujok and Ngemah in the west, and the Song-Kapit area which covered upper Katibas in the east.

Heavy human habitations are among some of the major reasons why these three sites are preferred for the study apart from the fact that they all lie within the Sanctuary's buffer zone. This heavy human habitation is expected to exert heavy pressures on game populations in the area.

This study is aimed at collecting information and data on hunting practices and the current status of large game ungulates such as deer and wild boar from the area. to ensure the sustainable supply of wild meat to local communities within the buffer zone with minimum damage to the ecosystem of the core areas of the sanctuary.

2.2 Methodology

The major part of the study involved interviews and questionnaires with local communities, individual hunters and wild meat traders on matters related to hunting at each selected site. This covers the economic importance of the game meat to local communities. The information asked in the interviews were recorded in standard forms. Some of the information is as follows;

SUMMARY REPORT ON THE STUDY OF GAME MANAGEMENT IN AREAS SURROUNDING LANJAK ENTIMAU WILDLIFE SANCTUARY (BUFFER ZONE)

Engkamat Lading & Oswald Braken Tisen
Game Management Specialists

1 INTRODUCTION

1.1 Background and status

Lanjak Entimau Wildlife Sanctuary is located in an area of rugged topography in southwestern Sarawak between 111°53'E to 112°28'E and 1° 19'N to 1° 51'N, in portion of the Kapit, Sarikei, Sibu and Sri Aman Division. Administratively it lies within the Districts of Song, Kanowit, Julau, Lubok Antu and Sri Aman. The total area of the Sanctuary is about 187,172 Ha. This is inclusive of its proposed extensions of 18,414 Ha.

Its hilly terrain ranges from about 60-1200 metres above sea level, and forms the origin of the watersheds of the Batang Lupar and Rajang rivers. Soils within the Sanctuary are generally poor and the majority are unsuitable for any agricultural project (Stuebing, 1996).

Due to the abundance of some primate especially the orangutans (*Pongo pygmeaus*), the area has been recognized as a key area for wildlife conservation since 1960's (Schaller, 1961). Even though parts of the region were sparsely settled by Iban people who originally came from Kapuas during the last century, there are currently no permanent settlements within the boundary (Jiram, 1994). This lack of human presence within Lanjak –Entimau could be attributed to several factors such as its rugged topography, inaccessibility and soil infertility (Sia, 1994). However the area has been regularly frequented and used by local people from down rivers of Katibas, Mujok and Kanowit for gathering forest products, fishing and hunting.

Because of its faunal and floral richness, Lanjak-Entimau was officially gazetted as a wildlife sanctuary in 1983. Its originally stated purpose was conservation of Sarawak's largest remaining population of its orang utans (Stuebing, 1996), beside hundreds of other primates, ungulates and species. With its vastness and remoteness, the Sanctuary is subject to possible encroachments including logging, shifting cultivation, hunting and other resources extraction activities. Conflict of interests between the protected areas and the indigenous community who have settled in the neighbouring areas for generations are bound to occur (Jiram, 1996). In order to avoid this conflict, the State Government, through its Lanjak-Entimau

3.2 Site 2 : Hulu Sekrang/Lemanak , Pakan and Julau

Site 2 comprised Pakan and Julau in the West of the Sanctuary and extending to Setolak and Sepantu logging areas in Hulu Sekrang and Lemanak. Besides, a few patches of primary forest, most of the Ulu Sekrang and Lemanak consisted of logged-over forest which is now being used by local residents for shifting cultivation.

Market surveys for possible wild game trade done at Pakan and Julau included canteens run by local people in Ulu Pakan and Lemanak, as well as at both of the logging camps.

3.3 Site 3. Hulu Katibas

Site 3, which included Song in the North and the Bloh areas in Ulu Katibas in the East, covered the last four longhouses in the Katibas area. Market surveys for the sale of game species were done at 'tamus' at Kanowit and Song while interviews and questionnaires on hunting practices and general status of game animals within the area were conducted among some local shifting cultivators from the longhouses having privileges to farm inside the Sanctuary along Sg. Bloh and Ulu Katibas.

The vegetation along Sg. Katibas outside the Sanctuary is mainly secondary forest. A similar situation also occurred for some distance inside the Sanctuary along Sg. Bloh and Katibas where shifting cultivation is widely practiced.

3.4 Market surveys on sale of Wild Game Meat

"Tamus" in Lubok Antu town are receiving a regular supply of wild game meat particularly wild boar from Ulu Batang Ai (Site 1). The price of wild boar meat in Lubok Antu ranges from RM9.00 – RM10.00 per kg. Depending on the quality and abundance of meat. During peak wild boar season some of the suppliers would go down to as far as Sri Aman where the price ranged from RM8.00 – RM12.00 per kg. Preserved wild boar meat is usually sold at RM10.00 per kg.

A similar range of prices for wild boar meat is obtained from "tamus" in Pakan and Julau, i.e. from RM10.00-RM12.00 per kg. The supply to Julau town comes from Ulu Mujok while the supply from Ulu Skrang goes to Setolak and Sepantu logging camps, though sometimes as far as Nanga Engkamup in Pakan. Most of these wild meat markets are usually equipped with freezers, run by local residents who normally cater for workers of the logging camps nearby.

The price of wild boar meat is lower in the interior at RM5.00-RM8.00 per kg. However, the retail price of wild boar received by local canteens in the interior usually ranges from RM3.00-RM4.00. There has been not much change in price of wild boar meat since the last five years. For sambar deer, despite the irregularity of the meat supply, the price is almost similar to that of wild boar, while the barking deer fetches a slightly lower price.

- Name of the individual hunters and place
- Method of hunting by each hunter at each site
- Number of hunters per family per longhouse
- Number of dogs and guns at each longhouse
- Estimated number of catch per hunter per month and per year (hunting success). This is particularly important for the assessment of harvest rate in each area
- Estimated total number of animals caught in each site (in term of individuals kill and their weight)
- Estimated income per hunter or wild meat trader per year out of the wild meat trade.
- Location of their popular hunting spots and its estimated distance from their longhouse
- Location of highest ungulate concentrations, why and when
- Preferred hunting month (season) and why
- Hunting frequency
- Fruits or food preference by the game species
- Price of game meat per Kg in rural and town areas
- Main purpose of hunting
- Local communities response on the newly gazetted Wildlife Protection Ordinance particularly on the trade ban of wildlife.

Beside interviews and questionnaire, wildlife surveys also involved visitations to popular hunting spots such as saltlicks with the local hunters. This method is aimed at estimating the index of animal abundance through possible tracks and footprints. Nurmohamed (1985) reported that deer tends to stay in areas surrounding saltlick within a radius of up to 10 km. Data on distances of hunting spots from their longhouse and percentage of the community who hunt will also be used to determine the hunting pressure on each area.

3.0 RESULTS

3.1 Site 1 : Batang Ai

The site comprised Lubok Antu town and areas of upper Batang Ai including the Ulu Lobang Baya. A total of 5 longhouses within the Batang Ai National Park were covered in the interviews, surveys and questionnaires about hunting practices and game status. Market surveys were mainly done at 'tamus' or markets at Lubok Antu and Sri Aman.

As the Sanctuary is contiguous with the Batang Ai National Park, the park itself is considered as a buffer zone for the Sanctuary. There is low human habitation toward the upper part of Batang Ai, especially Ulu Lobang Baya, as most of their young people have migrated to towns looking for cash jobs.

comprise old people who seldom go for hunting. They are usually pre-occupied with shifting cultivation activities. They do however kill game species that come to their farms and gardens to feed.

Out of the 103 hunters surveyed, 53% considered hunting for subsistence only, 37% took wild meat for sale, while 25% took wild meat for their own consumption as well as for sale.

4 DISCUSSIONS

Hunting over Setolak-Sepantu area is not sustainable as hunting is carried out by local people, logging workers and people from town areas. Both subsistence and commercial hunters use the area. The canteens at Setolak and Ng Engkamup are equipped with freezers and cater for outside markets.

It is recommended that hunting by outsiders should be stopped in order to reduce impact on game species in the buffer zone to ensure sufficient supply of meat for local use. It is hoped that this will reduce illegal hunting into the Sanctuary.

Hunting success within the Btg Ai area by the local inhabitants with privileges has remained constant for the past five years. Locals with hunting privileges who bring friends from outside to go for hunting trips should not be allowed. Commercial hunting carried out by few locals with privileges to hunt within the Btg Ai National Park should be stopped. It is still premature to conclude if the hunting practices in the area is sustainable at this point of time.

Game species in particular wild boar are quite abundant in the Katibas area. The existence of three canteens equipped with freezers for stocking wild meat for markets in towns have changed the trend of subsistence hunting to commercial hunting by a few individuals with privilege to hunt in the Sanctuary. With the total ban in trade of wildlife, these canteens should not be allowed to continue.

3.5 Hunting Spots and Sources of Wild Meat

"Temuda" or old shifting cultivation plots surrounding and also within the Sanctuary are the most preferred hunting spots by local hunters. However hunters within Ulu Skrang usually hunt along logging roads. During peak wild boar season hunters from Katibas often go hunting along the riverbank by boats.

During peak wild boar seasons, hunters do not need to go out far into the forest. The wild boar would usually come to the backyard of their farmhouse foraging for food and tubers such as tapioca. With the limited number of cartridges, trained-hunting dogs are now considered as an important asset for most local hunters. Well-trained dogs could be easily used to track and locate wild boar in the forest.

Hunting along logging roads is done by local people and timber camp workers. Urban hunters also come into the area to hunt for own food and for trade. Enjak (pers. comm,), a local canteen operator at Sepantu camp in Ulu Lemanak mentioned that since logging operation has started in Ulu Skrang and Lemanaj, local hunters now could only get one wild boar out of two to three hunting trips. In comparison, in 1980's when logging was just started, a hunter on a pick-up truck could easily get four to five animals per night. Town hunters from Sibu, Sarikei and Julau also hunt in Setolak and Sepantu logging area. These people have no hunting rights over the area.

The majority of the local hunters interviewed hunt for their own consumption while a small number of them are commercial hunters. However, there are numbers of subsistence hunters who occasionally sell their catch to the nearest canteens and towns.

Most rural people from the study sites depend on logging to earn money. Due to the present economic downturn, a number of timber camp workers are no longer being employed and have to return home while others tend to go for temporary migration to town areas to look for job. Those who are staying back home have very limited alternatives to support their families. As most of their lands are not suitable for commercial agricultural activities, they are always tempted to go for easy and "fast" sources of money by indulging in hunting.

3.6 Community Survey Results

A total of 241 individuals in the households surveyed is the three sites were economically active males. Out of this figure, 83 individuals (34.44%) were part-time hunters while 20 of them (8.30%) were classified as regular hunters. The latter included those who considered hunting as their profession. In contrast, part-time hunters are those who hunt for their own food only.

Many of the longhouses in Ulu Batang Ai are not fully occupied. Migration to town areas as well as resettlement such as Skrang Land Development Scheme has been common. The remaining households in few longhouses in Batang Ai

BOTANIST

(a) To conduct botanical inventory in specific areas to provide data for the protection of critical habitats and endangered floral and faunal species in the buffer and wilderness zones;

(b) Collect, identify and recommend plant species of ornamental potential for cultivation;

(c) Liaise with Sarawak Forest Department botanists in botanical resarch and development of data base;

(d) Collaborate with the Horticulturist, Fish and Game Management Specialists on the selection and utilisation of species that will contribute to the successful implementation of the community programme;

(e) Produce a final report on the findings.

Man-months : 18

APPENDIX 12

TERMS OF REFERENCE

PROJECT LEADER

For the implementation of Phase III, the Project Leader will:-

(a) Initiate and direct the implementation of the research and community development programmes in collaboration with the Sarawak Forest Department;

(b) Recommend appropriate local consultants to work in the programmes;

(c) Co-ordinate and supervise research and development activities in the Sanctuary;

(d) Collaborate with the Forest Department in the formation and functioning of the Special Wildlife Committee for the Sanctuary;

(e) Liaise with the Project Leader of Bentuang-Karimun National Park in Kalimantan in the development of collaborative research activities;

(f) Produce mid-term and final progress reports;

(g) Oversee the production of a GIS data base for the Project data;

(h) In collaboration with Bentuang Karimun Project produce a management plan for the Trans-boundary Biodiversity Conservation Area.

Man months: 36

HORTICULTURIST

(a) Develop gardens of indigenous crops for *ex-situ* conservation, training, demonstration and research;

(b) Establish nurseries for indigenous crops for the gardens and for supply to local communities;

(c) Develop a training programme and conduct training courses on the cultivation and utilisation of indigenous crops;

(d) Collaborate with the Botanist in the cultivation of indigenous ornamental plants;

(e) Conduct a market survey to collect information on the sale of indigenous crops;

(f) Assist local participants in the establishment of their gardens;

(g) Prepare a manual on the maintenance of indigenous plant gardens;

(h) Produce a final report at the end of the study.

Man-months : 18

FOREST ECOLOGIST

(a) Initiate study on the phenology of timber trees in gene banks;

(b) Investigate and select appropriate areas for more gene bank establishment;

(c) Collaborate with the Forest Research Division of the Forest Department on the maintenance, observation and monitoring of existing gene banks;

(d) Develop a procedure for seed collection and storage and germination studies;

(e) Provide training to Forest Research staff and local employees on gene bank maintenance and phenological monitoring;

(f) Produce a final report and manual for gene bank maintenance and monitoring

Man-months : 30

FISH MANAGEMENT SPECIALIST

(a) Develop facilities for the breeding of indigenous fish species;

(b) Develop a training programme and conduct training courses on indigenous fish farming;

(c) Collaborate with the Horticulturist and Botanist on the selection and cultivation of suitable indigenous food plants for the fish;

(d) Conduct a market survey to collect information on the sale of indigenous fish species;

(e) Assist local participants in fish farming activities;

(f) Produce a manual on farming of indigenous fish;

(g) Produce a final report at the end of the study.

Man-months : 10

ORANGUTAN SPECIALIST

(a) Study the abundance, distribution and migration range of the orangutan population in Lanjak Entimau and Batang Ai National Park in Sarawak and Bentuang-Karimun National Park in Kalimantan;

(b) Collaborate with Bentuang-Karimun sister project in carrying out the above study;

(c) Develop guidelines for collaborative management with Bentuang-Karimun to ensure the survival of orangutan in Borneo;

(d) Produce a final report at the end of the study.

Man-months : 12

GAME MANAGEMENT SPECIALIST

(a) Initiate a pilot study on the rearing of selected indigenous game species;

(b) Develop a training programme and conduct training courses on the farming and management of game species;

(c) Assist local participants in game farming activities;

(d) Conduct a survey among the local communities to collect information on wild meat consumption;

(e) Produce a manual on breeding of game species;

(f) Produce a final report at the end of the study.

Man-months : 10

Summary on the Revision of Phase III Proposal based on comments and recommendations of the Expert Panel

At the recommendations of the Seventeenth Expert Panel, the Project Proposal has been modified and strengthened as follows:-

1. Part I, Section 3 : Relationship to ITTO Action Plan and Priorities has been modified by taking into account the Libreville Action Plan for the Committee on Reforestation and Forest Management. This modiffcation is given on Page 3 of the proposal.

2. The sustainability aspect of the project is explained under Part II, sub-section 3.4 on Page 8. With the recent decision to revise the Wild Life Protection Ordinance (1998) to provide for a more effective mechanism for environmental and natural heritage protection, and for the setting up of a Special Wildlife Committee to involve direct local participation, the Sarawak Government is fully committed to ensure the sustainability of the project for the benefits of future generations. The LEWS Special Wildlife Committee will be fully responsible for the TPA's management.

3. The risk assessment is further explained under sub-section 3.8 on Page 15. The project has identified the inherent cultural characteristics of the local communities as an important factor that may result in a slow response from interested participants on the agro-forestry programme at least at the initial stage. Other risks can be more easily overcome.

   The schedule for joint research and co-management of the Trans-boundary Biodiversity Conservation Area will need to be worked out by the Malaysian and Indonesian Governments at the national and regional levels. A joint working committee is suggested.

4. The proposed centre for agro-forestry programme is given in more detail in sub-section 3.6.4 on page 15. The centre will be strategically located in close proximity to the local communities to create a sense of belonging and to enhance their interest and participation. It is also proposed to include eco-tourism training facilities at the centre in conjunction with the Batang Ai National Park tourism development programme.

5. The budget is reduced by US$139,920 to US$853,300 (Part IV, Page 25) following the adjustments of Activities and Inputs on Page 16. This reduction came from those activities for which some expertise from the Forest Department is available to assist in the implementation.

The Malaysian Government's contribution has been increased from RM2,227,000 to RM3,553,000 to cover mainly additional salaries for counterparts and infrastructure for the agro-forestry cum eco-tourism training centre. There is also a need for more landcruisers and boats to be allocated to the project.

The Workplan on Page 22-23 has also been adjusted accordingly.