INTERNATIONAL TROPICAL TIMBER ORGANIZATION

ITTO

PROJECT PROPOSAL

TITLE	DEVELOPMENT OF LANJAK-ENTIMAU WILDLIFE SANCTUARY (LEWS) AS A TOTALLY PROTECTED AREA (TPA) PHASE II
SERIAL NUMBER	PD 15/95 Rev.3 (F)
PERMANENT COMMITTEE	REFORESTATION AND FOREST MANAGEMENT
SUBMITTED BY	GOVERNMENT OF MALAYSIA
ORIGINAL LANGUAGE	ENGLISH

SUMMARY

On the basis of a Management Plan prepared during Phase I for an area of approximately 168,000 ha of unlogged lowland and hill forests located in the western interior of Sarawak, and contiguous with the Gunung Bentuang and Karimun Nature Reserve in West Kalimantan, Indonesia, the project intends to provide the following outputs as part of the main objective of establishing a Totally Protected Area, for the purpose of conservation of biological diversity and research into ecological processes relevant to sustainable forest management:

Main Outputs

1. provide and maintain the necessary infrastructure facilities, monitoring and research networks in the Sanctuary to serve 3. and 4. below;
2. provide and update the necessary guidelines for long-term management and the work plan for 3. and 4. below;
3. monitor and conserve biological diversity in the Sanctuary through protection, research, education and community consultation programmes;
4. provide technical and scientific training for local communities, Forest Department staff, students in forest ecology, animal and plant taxonomy, ethnobiology and other biodiversity-related fields;
5. Provide a management model applicable to Gunung Bentuang and Karimun Nature Reserve.

EXECUTING AGENCY	FOREST DEPARTMENT, SARAWAK, MALAYSIA
DURATION	24 MONTHS
APPROXIMATE STARTING DATE	TO BE DETERMINED

BUDGET AND PROPOSED SOURCES OF FINANCE

Source	Contribution in US$	Local Currency Equivalent
ITTO	**1,830,200**	
Gov't of Sarawak	954,520	*MR2,386,300*
TOTAL	**2,784,720**	

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PART I : CONTEXT

A. RELEVANCE TO ITTO

1. Compliance with ITTO Objectives

This project proposal meets the following Objectives of Articles 1 of the International Tropical Timber Agreement, 1983 (ITTA):-

(c) To help research and development which will improve forest management (Output 3)

(f) To encourage tropical timber reforestation and forest management (Outputs 3 and 4)

(h) To encourage national policies which aim at sustainable use and conservation of tropical forests and their genetic resources, and at maintaining the ecological balance in the regions concerned Outputs 3 and 4).

2. Compliance with ITTO Criteria

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

Conformation to the ITTO criteria involves:

(a) Improvement of forest management by research into the composition and ecology of natural forest and comparison with harvested forests (Output 3);

(b) Reforestation development by protection and monitoring of regenerating forest in areas previously under shifting agriculture and encouraging sustainable use of non-timber forest products (Output 3);

(c) Training of Sarawak Forest Department staff particularly those of the National Parks and Wildlife Office (NPWO) through active participation in fieldwork conducted by international and local consultants to acquire skills in data collection and analysis, and preparation of reports or presentations (Output 4);

(d) Contribution to institutional framework and national planning by setting up a model management structure for Totally Protected Areas, for application elsewhere in Sarawak and for use in future planning (Output 2).

3. **Relationship to ITTO Action Plan and Priorities**

Among priorities in the ITTO Action Plan, the following are either partially or wholly covered by this project, under the Committee on Reforestation and Forest Management:-

(a) Promoting and financing demonstration projects for different management models, and regional/sub-regional networks of such projects (Outputs 3,4 and 5);

(b) Helping to create research and database networks on tropical forest management (Output 5 directly related)

B. RELEVANCE TO NATIONAL POLICIES

1. **Relationship to policies affecting tropical timber**

(a) Forestry

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.

Thus, this project is consistent with the above stated policy elements by seeking to preserve a representative area of natural forest, rich in biodiversity, and with great scientific and educational potential.

2. **Institutional and legal framework**

Legislative and executive authority over forest in Malaysia lies with individual State Governments. In Sarawak, the Ministry of Resource Planning acting through the Forest Department is the relevant authority on the basis of Wildlife Protection Ordinance (1990) and National Parks and Nature Reserves (Amendments) Ordinance (1990). Protection has also been extended to wildlife within Forest Reserves under the recently enacted Forest Ordinance (including all amendments), 1994.

The project will be executed by the Forest Department through the National Parks and Wildlife Office (NPWO) located in Petra Jaya, Kuching. The headquarters of all government agencies relevant to the project (including the Ministry of Resource Planning) are located in Kuching.

The project will be carried out partly in the Kuching Headquarters and partly in field sites in the Lanjak-Entimau Wildlife Sanctuary. Some technical analysis and training will be carried out at the Sarawak Centre for Biodiversity.

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 :

i) 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;

ii) Examples of all unusual habitats or areas with rare or endemic species;

iii) Viable populations of animals, especially large mammals and birds which require large home ranges;

iv) Species which are naturally rare or endangered, or subject to intensive cropping, such as orchids.

These recommendations are consistent with the policy of the National Parks and Wildlife Section, whose central goal is " to preserve areas of significant geological, biological or historical value for the benefit, education and enjoyment of present and future generations".

Lanjak-Entimau had already been recognised as early as the 1980s and gazetted as a Wildlife Sanctuary in 1983 for conservation of wildlife in general, and for the orangutan in particular. The boundaries on the ground were demarcated by the Sarawak Forest Department.

The current project comprises two phases: Phase I includes compilation and analysis of data derived from scientific surveys of the primates, birds, herpetofauna, forest ecology and socioeconomy 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 with emphasis on the fauna; and recommendations on the locations of research centres and subcentres, manpower needs with inclusion of a detailed financial plan.

Present project proposals are based on the results and recommendations as laid out in the ITTO Consultants reports on:

- primates
- birds
- herpetofauna
- forest ecology
- socioeconomic aspects
- soils

The main findings of the these studies are given in Appendices I-VII.

2. PROJECT OBJECTIVES

2.1 Development Objective

Formulation of policies, strategies and procedures for the development of Lanjak-Entimau Wildlife Sanctuary to serve as a model in the conservation, protection and scientific utilisation of other Totally Protected Areas in Sarawak and Malaysia.

2.2 Specific Objective 1

To conserve the Lanjak Entimau Wildlife Sanctuary through a locally based programme of research into its biological diversity and other aspects of its living resources.

2.3 Specific Objective 2

Establish protection programmes for the Sanctuary through community consultation and community-oriented biodiversity resource development in the surrounding Buffer Zone.

3. PROJECT JUSTIFICATION

3.1 Problem to be addressed

The problems to be addressed in the Lanjak-Entimau Sanctuary lie in three basic areas:-

(i) protection of the Sanctuary from encroachment or other illegal activities such as poaching
(ii) ensuring the survival of the complex biodiversity of the Sanctuary
(iii) ensuring local communities benefit from development of the biodiversity resources of the Sanctuary

The problem mentioned in (i) is caused primarily by the remoteness of Lanjak Entimau and the time and effort involved in reaching most of the sites.

Gradual improvement of infrastructure and transportation facilities, creating a permanent NPWO presence in key areas of the Sanctuary should overcome this problem.

The problem in (ii) is caused by the the sensitivity of many species and biotic communities of the Sanctuary, and their extremely low rate of recovery from a reduction of population levels or the effects of disturbance. Populations of many species (such as orangutans) are at rather low densities.

This problem can only be overcome through comprehensive inventories and research into factors affecting survival and nutrition. Intensive research on the composition and natural processes of the forest will gradually provide knowledge appppropriate for sustainable forest management, including the management of rare animals.

The situation in (iii) is regarded as a problem because efforts to assert authority over areas traditionally used by local communities causes suspicion and potential conflict over policies or practices. The problem can be addressed by an active programme of consultation with local communities to seek their support and involvement. The latter includes their direct participation via employment in infrastructure development in the Sanctuary, research and education programmes and involvement in community improvement projects related to the biodiversity resources.

3.2 Characteristics of the project area

3.2.1 Location and Status

Lanjak-Entimau Wildlife Sanctuary is located in an area of rugged topography southwestern Sarawak between 111° 53'E to 112° 281/2' 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 ha, including proposed extensions of 18,414 ha

There is now an existing Base Camp with full facilities for 20 persons, and several former camps (presently not in use) at former research sites such as in ulu Skrang, Sg Tebellian (ulu Katibas), as well as at the summit of Bukit Lanjak.

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 Batang Lupar and Rejang rivers. Annual rainfall ranges from 2000-4000 millimetres per year.

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

Seven basic forest types exist in Lanjak-Entimau : alluvial, lowland dipterocarp, hill dipterocarp, summit ridge, submontane mossy, montane mossy and old secondary forest. These forests are potentially the richest in Sarawak with well over one thousand tree species. Tree densities are higher than in other sites in Sarawak and Peninsular Malaysia.

The Sanctuary also contains secondary forest from 80-130 years old. The rare, giant *Rafflesia* flower has been reported from several of these old secondary forest areas.

Numerous other plant species abound on the forest floor, particularly in mossy forest, rich in palms, gingers, ferns, pandans, pitcher plants and orchids. Several new species of plants have been discovered during recent surveys.

Also, at least 140 different kinds of medicinal plants have been identified. More than one hundred types of wild fruits and thirty-six varieties of jungle vegetables are found in the Sanctuary.

3.2.4 Fauna

Lanjak-Entimau's primate fauna includes the only viable population of the threatened orangutan in Sarawak, approximately one thousand individuals. Among other primate species include the rare white-fronted langur, and the Bornean gibbon. Gibbon densities are higher in Lanjak-Entimau than anywhere else in Borneo.

There are at least 203 species of birds in Lanjak-Entimau, with approximately half (13 of 29) of Sarawak's known endemics. Seven of the State's eight hornbill species breed there, as well as the spectacular argus and rare Bulwer's pheasants.

Seventy-five species of herpetofauna are now known from Lanjak-Entimau. four are new to science, while two others have been reported for the first time in Sarawak or are extremely rare. The potential total of herpetofaunal species exceeds three hundred, forming one of the richest areas of the Asian tropics.

Fish diversity is also high, and two new species were discovered among the twenty-six species collected incidental to herpetofaunal collections.

3.2.5 Socio-Economic Aspects

An estimated 12,400 people of the Iban community reside in the periphery of the Lanjak-Entimau Sanctuary.

A socio-economic study has shown that only about half of the population has formal education, and virtually all are involved in shifting agriculture. Most households are still without electricity and experience a chronic shortfall of rice, which must be purchased from towns.

Cash crops are not popular because of expensive maintenance (fertilizers, etc.) and poor infrastructure, resulting in high transportation costs.
Average incomes for individuals living on the periphery of Lanjak-Entimau are well below the State Government's official poverty line. Local communities still depend on the Sanctuary for supplies of forest produce, fish and wild game.

A majority of local residents, however, approve of the existence of the Sanctuary, and its status as a Totally Protected Area.

3.3 Other relevant aspects of the pre-project situation

Lanjak-Entimau wildlife Sanctuary, combined with the Gunung Bentuang dan Karimun Nature Reserve forms one of the largest areas devoted to tropical rain forest conservation in the world. As such it will make great demands on Malaysia and Indonesia to ensure its success.

Both countries face difficulties with infrastructure in both of these remote areas. Scientific expertise is also in limited quantity, and successful attainment of this aspect of the management plan (scientific monitoring and research) is likely to determine the long-term success or failure of the project as a whole. Thus, attention must be focused on building scientific capability at every level, and fully exploiting the "intellectual" potential of Lanjak-Entimau.

3.4 Intended situation after completion of Phase II

At the end of Phase II (by mid-1999), Lanjak-Entimau will possess:-

- well-demarcated, patrolled Sanctuary boundaries
- a functional Headquarters for coordination of the protection and monitoring programmes;
- two Ranger Stations for the NPWO and local staff involved in the protection and monitoring programmes;
- a functional Field Centre for scientific research with laboratory facilities;
- a series of twelve subcamps as way-stations for research, monitoring and protection;
- two climatological cum hydrological stations for scientific monitoring;

- initiation of long-term research programmes in biodiversity resources and ethnobiology;

- a database of species and other relevant information for Lanjak-Entimau, as well as a scientific collection of representative species from Lanjak-Entimau set up for reference purposes.

Training of NPWO staff and other Forest Department will be on-going, through their active participation in research and will continue both in the field and in the classroom. Special courses for local community leaders or other residents in technical and scientific techniques, and conservation will have been conducted and will be refined and modified according to perceived needs.

Seedling and gene banks will be operational in the Bukit Entimau, Bukit Sengayoh and other suitable areas of the Sanctuary.

3.5 Target Beneficiaries

This phase of the project will target several distinct groups or entities:-

(i) Staff of the NPWO and other members of the Forest Department will receive training and experience in scientific and field techniques, and in conservation management, while the Department will benefit directly from scientific data acquired for Sanctuary management;

(ii) Local community leaders and longhouse residents will be employed in scientific, infrastructure development and other Sanctuary programmes, and special technical courses in taonomy, ecology and conservation.

They will also directly benefit from contracts undertaken between the Sarawak Government and corporations or companies wishing to exploit and market biodiversity-related products (antibiotics, pharmaceuticals, etc.)

(iii) Local students at the secondary and tertiary level for field courses or longer-term research programmes in Lanjak-Entimau, whose level of technical expertise will be enhanced significantly.

(iv) The biological communities of Lanjak-Entimau, which will benefit not only from protection, but from the results of research into their ecological requirements.

3.6 **Project Strategy**

3.6.1 Reasons for selection

Since protection of biodiversity is of primary importance, advance inventories will be conducted, in order that the full potential of the Sanctuary's resources can be appreciated and realised. An understanding of the natural forest community, preservation of crucial genetic material and research into biotic materials used in traditional medicine form the three principal target areas related to Specific Objective 1.

Conservation of biodiversity will be achieved only through careful long-term scientific documentation of species richness, distribution and fluctuations. Phase II will set the framework for this detailed programme of data gathering and analysis.

Zoning of the Sanctuary will augment the protection subprogrammes, and provide areas for scientific investigation while avoiding direct disturbance of sensitive areas. Emphasis on scientific monitoring, taxonomic inventories and ecological studies will provide the intellectual raw material for developing management strategies in exploited forests and identifying bioactive components or compounds with medical or economic potential. Active participation by members of local communities, Forest Department staff, and advanced students will contribute towards building a core of technical and scientific expertise in Sarawak and contribute to the perpetuation of local conservation, monitoring and research efforts (Specific Objective 2 and Development Objective).

3.6.2 Lessons drawn from past evaluation

Reports by the ITTO Consultants (see Appendices) have clearly demonstrated the enormous richness of Lanjak-Entimau's biological diversity. Lessons from these evaluations and from previous studies in botany, primatology and herpetology indicate that more than brief surveys are necessary to make full use of the Sanctuary's scientific and intellectual potential, as well as to integrate socio-economic development of local communities with conservation efforts.

The usual problem of conservation areas linked to research programmes has been that development of local expertise consistently lags behind, partly because of focus on projects proposed primarily by international researchers. Emphasis on direct local participation in research and educational programmes should help to address the problem, particularly if local students are given encouragement and incentives to work in the Sanctuary.

Finally, the history of protected areas in Sarawak shows that attention must be paid to needs of local communities to reduce potential conflicts arising from the protection and use of the Sanctuary.

3.6.3 Technical and Scientific Aspects

An emphasis on field studies and biological inventories will reduce dependency on highly sophisticated approaches to research in the Sanctuary. Nevetheless, technology will be applied for specific purposes, including:

(i) accurate compilation of environmental data;

(ii) recording of crucial ecological data for particular species (radio tracking-telemetry and electronic tagging systems) for research and management purposes.

All data will be entered into a Geographic Information System, which will provide a more effective, holistic approach towards long-term management efforts. More intricate analyses of data, such as research into molecular systematics or bioactive compounds will be done by outside agencies or institutions.

(iii) screening of selected plants or animals from bioactive compunds

As an integrated part of all technical studies, Forestry Department staff will be given technical training in plant and animal taxonomy through hands-on experience in identifying, measuring, recording and managing biodiversity-related data (for possible use in the potential development of the resource key community-based projects within the Buffer Zone)*

3.6.4 Economic Aspects

Virtually all the economic benefits to be realised from development of the Lanjak-Entimau Sanctuary cannot be directly assessed because they will not be directly exploited. Among these existing unassessed natural entities include natural forest products such as rattan, wild fruits and vegetables, wild protein from fish and game, traditional medicinal products, flood and erosion control (reducing amelioration of flooding effects downstream), clean water, reduced vectors of diseases associated with humans or livestock and intellectual progress in scientific fields leading to discoveries in applied areas, just to name a few.

The economic value of such products and processes is usually substantial, but rarely viewed as possessing any inherent real significance in their pristine or unexploited form. This value only arises as costs to rejuvenate the habitat or mitigate negative effects of its modification, or (in the case of the value of scientific discoveries) accrues only slowly over time.

Nevertheless, concrete benefits will be realised from term programmes in sustainable management, based on comparative research in Lanjak-Entimau and the Model Forest Management Area.

More importantly are potential economic benefits to be derived from the biodiversity resources of the forest flora and fauna in the form of anti-cancer, anti-bacterial/viral, endorphin-mimetic, or other substances with medical or pharmaceutical applications.

Furthermore, benefits in the form of forest rehabilitation in Sarawak, Malaysia and the region can be enhanced via the implementation of gene banks/seed source areas in the undisturbed habitats of the Lanjak-Entimau Sanctuary.

* This aspect of the project has been adapted partly from the In Bio programme in Costa Rica (Appendix IX)

3.6.5 Social Aspects

The communities on the periphery of the Lanjak-Entimau Sanctuary have been occupying their present locations usually for several generations, and in some instances, even longer. They occassionally regard conservation programmes with suspicion, assuming that they may eventually be deprived of important components of their livelihood, *e.g.*, forest produce, fish and wild game.

The current strategy strives to benefit local communities by increasing their real earnings through employment, and scientific and technical training in the development of biodiversity resources in the Buffer Zone. Regular consultation will be held between the ITTO Consultants, Sanctuary officers and area communities leaders.

Development of biodiversity-related resources will bring socio-economic benefits ultimately superior to those derived from programmes such as subsidy driven communal forestry, while acquisition of technical skills will ensure that society does not leave rural people behind. Use of inexpensive computer technology will be among the technical skills introduced, as well as basic instruction in the identification, natural history of organisms (for subsequent determination of their economic potential). Socio-economic costs will be negligible, since local people still remain free to pursue their traditional livelihood and regular sources of income. Management of the Sanctuary will not deprive them of any resource currently available to them while augmenting their scientific knowledge of raising the levels of their technical skills.

From a broader perspective, field studies and biodiversity research by Sarawak scientists and students will have a gradual but eventually profound impact on the appreciators of the great resource.

3.6.6 Environmental Aspects

The development of Lanjak-Entimau as a Totally Protected Area will not only provide for preservation of the entire Lanjak-Entimau area as an intact ecological unit, but will allow peripheral secondary forests to regenerate.

Lanjak-Entimau is sufficiently large to allow for the survival of a major component of Sarawak's complex biological diversity, and floral or faunal species which are rare or threatened outside the Sanctuary.

Flora or fauna determined to produce bioactive substances of potential economic (medicial or pharmaceutical) importance will not be directly exploited from the protected forest but instead from material eiher from outside the Sanctuary, or cultivated/cloned based on small samples.

Preservation of forested habitats in the surrounding Buffer Zone will also contribute to the conservation of biological diversity by providing extended secondary habitats for dispersal of species which either possess high densities within the confines of the Sanctuary, or seek external food sources in the more succulent secondary growth.

Protection of the Sanctuary in conjunction with Batang Ai National Park will serve to protect the hinterland of the Batang Ai Reservoir, furnishing an abundant supply of clean water and reducing the rate of siltation.

Finally, close communication links with the management authority of Bentuang-Karimun National Park in West Kalimantan will be sought in order to exchange important information on species and community distribution and abundance, mutually applicable scientific and technical programmes as well as successful approaches to the implementation of biodiversity-based community development programmes.

3.6.7 Managerial Aspects

By implementing the project, the Forest Department will gain valuable training and expertise for its staff, in science and other technical areas as well as experience for future decision-making.

Suitable policies and procedures developed through implementationof Phase II, if suitable, can be applied to the management of other protected areas in Sarawak.

As in the previous Phase of this project, all operational decisions will be made by the ITTO Projects Coordinator with advice from the Director of Forests and the Co-Project Leader. The necessary protection and monitoring functions will be accomplished by staff of the National Parks and Wildlife Section, who so ably carried out the work during Phase I.

The project is conceived as a combination of research in biodiversity and ecology, with direct feedback from results into training, interpretive and technical education programmes with potential economic spin-offs for local communities..

3.7 Reasons for ITTO Support

3.7.1 Advantages of ITTO

The advantages of multilateral funding, efficient and speedy appraisals and reliable allocation of funds experienced during Phase I makes ITTO support for Phase II both suitable and appropriate.

Support from ITTO also eliminates any potential sectoral problems arising from several different or separate funding sources.

Furthermore, many of the potential benefits of the project are broadly applicable (genebank, ethnobotany or other biodiversity research) in countries where ITTO has existing programmes.

3.7.2 Relationship to support by other donors

The present phase of the project is oriented towards monitoring and inventory, and other aspects related to research in biodiversity. Additional research projects will be sponsored externally, with the present project providing basic infrastructure and facilities.

3.8 Risks

Outputs of Phase I have been successfully achieved without any serious disruption. The only foreseeable risk to the implementation of the project involves either

(i) initial lack of local support for the research programmes, or
(ii) problems arising in specific limited areas where communal rights might become an issue.

In both cases, the Forest Department has resources to ensure effective communication and consultation to quickly resolve any issues causing potential risk to successful implementation.

4. OUTPUTS

(1) Infrastructure

a. a permanent Sanctuary Headquarters with accomodation for 12 persons;

b. a permanent Field Station with laboratory facilities and accomodation for 20 persons

c. two permanent Ranger Stations with office and accomodation for six persons

d. Twelve permanent subcamps, with basic cement slab and frame for flysheet and hammock beds

e. A monitoring network of climatology and hydrometric stations (2)

f. Two designated seed source / gene bank areas

(2) Management Guidelines

a. priorities for biodiversity inventories

b. priorities for ecological studies

c. identification of areas in the Buffer Zone for community-based bio-diversity- resource development projects

(3) **Training**

a. participating ("on the job") technical training for rangers, forest guards and local community residents experimental, design, the use of taxonomic keys and scientific instrumentation

b. scientific and biological conservation courses (flora & fauna, ecology, laws) for local community leaders and residents

c. training of local secondary and tertiary students in biodiversity (flora and fauna) and in scientific research techniques*

* i.e. training as "parataxonomists"

d. interpretive and educational training materials for local residents and general public

e. Audio-visual documentation of bio-diversity for scientific or office use

(4) Research

Data Bases on:

a. climatic and hydrological data;

b. floral and mycological inventories

c. floral (and faunal) species of medicinal and pharmacological significance or other traditional use;

d faunal inventories (small mammals and insects) for understanding of the forest community as well as for conservation and management purposes.

e. distributions and populations of rare or threatened species for the purpose of conservation and management.

f. bioactive compounds and their origin (species, distribution, type of effect on utility, etc.) to be used in negiotiating agreements with companies or corporations interested in their medical, pharmaceutical or other application.

5. ACTIVITIES AND INPUTS (see Table 1)

Output 1:	Infrastructure	Inputs: RM is Government Contribution US$ is ITTO Contribution
1.1	**Build permanent Headquarters**	**Local Sub-contract RM 300,000**
1.2	**Build Field Station with laboratory and quarters**	**Local Sub-contract RM 400,000**
1.3	**Build Ranger Stations with quarters**	**2 @ RM150,000 RM 300,000**
1.4	**Build Sub-camps**	**12 @ RM1,750 = RM21,100**
1.5	**Establish climatological and hydro-monitor network (2 stations)**	**3 p-m Local Cons.**

Output 2:	**Management Guidelines**	**Inputs:**
2.1 - 2.3	**Initial drafting, updating final presentation**	**24 p-m International Cons.**

Output 3 : Research Database (see Table 2) :

3.1 Monitoring and ecology:

3.1.1	**Climatology and hydrology Baseline environmental quality**	**3 p-m Local Cons.**

3.2	**Biological Inventories:**		**12 p-m International Cons.**
	3.2.1	**Botany**	
		(i) Plant taxonomy	**8 p-m Local Cons.**
		(ii) Mycology	**6 p-m Local Cons.**
	3.2.2	**Zoology**	**12 p-m International Cons.**
		(i) Insects (canopy survey)	**12 p-m Local Cons.**
		(ii) Small mammals	**6 p-m Local Cons.**
		(iii) Herpetofauna	**6 p-m Local Cons.**
		(iv) Fish fauna	**6 p-m Local Cons.**
		(v) Game management	**6 p-m Local Cons.**
Output 4:	**Community development**		**12 p-m International Cons.**
	4.1	**Ethnobotanical gardens**	**12 p-m Local Cons.**
	4.2	**Non-timber produce cultivation (rotan, etc.)**	**6 p-m Local Cons.**
	4.3	**Training courses* in technical skills and ecotourism**	**4 p-m Local Cons.**

* **Providing classroom instruction to augment participatory (or, "on-the-job") training which will be an integral part of all projects**

The inputs are summarised as follows:-

Inputs by ITTO:-

* Project funds of US$1,830,200 for following components of Phase II (inclusive 5% contingency):-

(i) International Consultants
(ii) Local Consultants
(iii) Local Support Staff
(iv) Field equipment and Special Supplies
(v) International travel and relevant site visits*
(vi) Review, Reporting and Promotion

Inputs by the Government of Malaysia and the State Government of Sarawak:-

- Project funds of RM2,386,300 for infrastructure and management
- Provision of 15 professional staff (including one Co-Leader) for periods of between 3-12 months each
- Provision of one Executive Forester = Sanctuary Manager, fifteen forest guards and full-time assignment to Lanjak-Entimau for 3 years 2 boats operators and 2 drivers.
- Provision of vehicle operation/maintenance, boat and helicopter hire and operations/maintenance of utilities.
- Construction of permanent headquarters, field station/laboratory complex, ranger stations and subcamps.
- Provision of tools and field equipment for boundary maintenance
- Provision of HQ office supplies, field communication equipment and operating costs of telephone and fax.

6. Logical Framework Worksheets (Tables 1 & 2, Figures 1, 2 & 3)

* **Including to Bentuang-Karimun N.P. HQ, West Kalimantan**

TABLE 1

A LIST OF FACILITIES IN LANJAK-ENTIMAU, THEIR JUSTIFICATION AND USES

DEVELOPMENT OF LANJAK-ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA

FACILITY	JUSTIFICATION	USES/BENEFITS
Headquarters, ulu Katibas (Ng Bloh)	- Entry point of most extensive watershed (Katibas River) - Crucial location for control of boundaries and protection - Substantial local human population	- Convenient as staging point for protection and research programmes - Adjacent to areas suitable for ecotourism (in Buffer Zone) thus providing local employment - NPWO presence will reduce activites detrimental to the Sanctuary
Field Station Laboratory, ulu Engkari (Ng Segerak)	- Already existing Base Camp facilities - Access to Bukit Lanjak - Area of high biological diversity - Adequate and suitable manpower available	- Most scientific research providing interpretive materials and local employment - Local community projects providing local employment - Initial screening for bioactive compounds
Ranger Stations (Ng Bloh, Ng Segerak, Ng Serembuang, Jemarang)	- Logistic centres for protection programmes - Education dispersal centres (community programmes) - Coverage of entire Sanctuary	- Provide presence and community contact for protection programme - Easy access for Forest Department staff - Ongoing reading and maintenance of scientific equipment
Sub-Camps (12 locations)	- Permanent interior camps sites for monitoring and scientific studies to reduce destruction caused by numerous temporary camps - Strategic locations of facilities in sections of the Sanctuary providing direct access to monitored areas	- Easy access to protection and research programmes - Savings in time and money devoted to camp construction - Reduces impact of repeated human visits

TABLE 2

JUSTIFICATION, LINKAGES AND BENEFITS OF RESEARCH AND COMMUNITY PROJECTS

DEVELOPMENT OF LANJAK ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTED AREA

PROJECT	JUSTIFICATION	LINKAGE*	BENEFITS**
R_1 Inventory of flora	Phase I studies found high diversity, but sampling limited Phytochemical screening	Baseline diversity in old secondary and primary forests for comparison with ITTO MFMA studies; Sarawak Biodiversity Centre; local universities	Discovery of new species; Identification of medicinal plants or other species with economic potential
R_2 / C_1 Gene bank/Seed source	Identification, monitoring and development of gene banks/seed soures for species of socio-economic importance (timber, food, bioactive compounds)	Biodiversity resource development by local communities in partnership with the Sarawak Government and corporations	Economic development of local communities, social & economic benefits to the State as a whole
R_3 Mycological Inventory	No mycological surveys yet carried out in Lanjak-Entimau; Phytochemical screening	Link-ups with pharmaceutical industry; Sarawak Biodiversity Centre; local universities	Discovery of species with medical or other potential
R_5/C_4 Wildlife (Game species)	Virtually no existing information on population dynamics or movements	ITTO studies in MFMA; sustainable use by local communities	Understanding of population densities and dynamics to determine levels for sustainable use by local communities

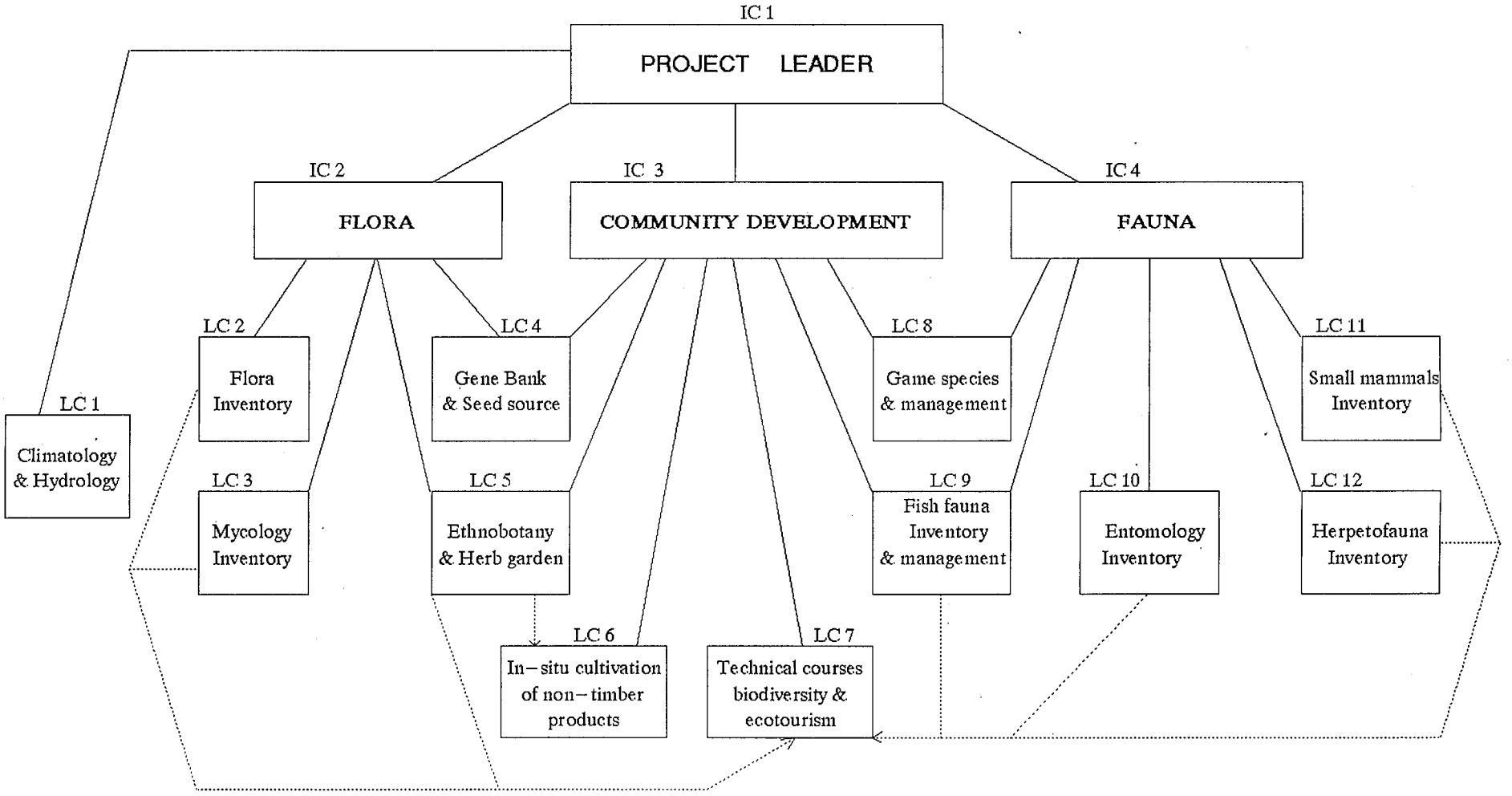
PROJECT	JUSTIFICATION	LINKAGE*	BENEFITS**
R_6 Small mammals inventory	No such inventory yet done in Lanjak-Entimau	ITTO studies in Phase I of MFMA, Environmental impact assessments; Sarawak Centre for Biodiversity	Discovery of new species; understanding of community changes in natural or exploited forests
R_7 Herpetofauna inventory	Phase I survey obtained less than 50% of potential total, while obtaining **four** new species; screening for bioactive compounds	ITTO environmental studies in MFMA aquatic habitats; Global studies such as effects of ozone layer thinning; Sarawak Centre for Biodiversity; Institutes of pharmaceutical or medical research; local universities	Discovery of new species; Identification of new bioactive compounds (i.e., natural antibiotics or pain killers); food species (e.g. monitor lizard, turtles) ranching by local communities
R_8 Entomological survey	Phase I survey coverage less than 20% of species	ITTO studies in MFMA; Institutes for medical entomology; local universities; pharmaceutical companies; Sarawak Centre for Biodiversity	Discovery of new genera and species; Discovery of pollination, or insects of medical significance; Displays for public education
R_9/C_5 Fish fauna inventory and management	No comprehensive inventory yet in Lanjak-Entimau. (Limited collections in Phase I produced two new species)	ITTO MFMA studies in aquatic habitats of MFMA; local universities; development of community expertise on the culture of local fish species	Discovery of new species; Understanding of community changes in modified habitats; Recommendations to local communities on sustainable use of natural fish population

PROJECT	JUSTIFICATION	LINKAGE*	BENEFITS**
C_2/R_1 Cultivation of non-timber forest products	Use of Buffer Zone in sustainable use of non-timber products; Protection of sanctuary from intrusion	Sarawak Ministry of Agriculture; Sarawak Handicraft Association	Increased availability and sustainable use of non-timber forest products (rattan, mengkuang, fruits, etc),; Employment and income for local communities
T_1/T_2 Training courses in conservation and ecotourism	Knowledge needed for promotion of conservation and effective implementation of ecotourism programmes	Malaysian Tourism Development Corporation; Sarawak Tourism Association	Training and experiences for local community; Involvement of local communities in conservation of the Sanctuary

* education, institution building or other technically-oriented activities or partnerships

** all projects include employment of local residents as labour, guides or advisors, also technical training in taxonomy or other technical skills

Figure 1 : Linkages between components of Phase II Project



IC = International Consultant
LC = Local Consultant
___ = Lines of authority
..... = Technical input and consultation

TABLE 3 : ELEMENTS OF RESEARCH DATABASE

Development of Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area

Project Elements	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Development Objective : Policies, Strategies and implementation procedures for conservation of Lanjak-Entimau Wildlife Sanctuary to provide a development model for other protected areas in Sarawak	(i) Implementation based on completed management guidelines (ii) Strategies and policies adopted	(i) Guidelines in Management Plan (ii) Implementation schedule according to Management Plan	Approach and strategies consistent with Forest Department Policy and local aspirations
Specific Objective : To contribute to knowledge of the ecology and biodiversity of natural forest to improve sustainable forest management	(i) List research project results (ii) List number of local scientists staff, students, local residents trained or involved (iii) List current uses of (i) in development programme	(i) Research reports and management guidelines (ii) Records of project/course participation	Management programs will be acceptable to various sectors involved

TABLE 4

Project Title : Development of Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area

Project Elements	Objectively Verifiable Indicators	Means of Verification	Important Assumption
1 Infrastructure			
Facilities (1.1-1.3)	Structures to be in place by 18 mo.	Physical inspection	Sub-contracts award and equipment received
Networks (1.4-1.5)	Stations to be in place by 18 mo.	Physical inspection	Sub-contracts award and equipment received
2 Management guidelines			
(2.1-2.3)	Two drafts by end of year 2 Final version by end of year 3	Reports	Consultants appointed
3 Research and Development Database			
(3.1-3.3)	Computerised data bases and research reports	Reports and physical inspection	Consultants appointed and equipment received
4 Community Development			
(4.1-4.2)	Sites acquired and structures in place Stocks acquired	Physical inspection	Consultants appointed, equipment received and materials prepared
(4.3)	Syllabus completed, participant identified		

7 WORK PLAN

The work plan organised according to activities is given below:-

Infrastructure of Headquarters and Field Centre

- as well Climatology / hydro-stations : by end of year 1
- Ranger stations, subcamps : by mid-year 2

Appointment of Consultants : by 1/2 of year 1

Progress reports (mid term) : end of year 1

Final Report : end of year 2

FIGURE 2
Work Plan for Phase II :–
Development of Lanjak–Entimau Wildlife Sanctuary as a Totally Protected Area

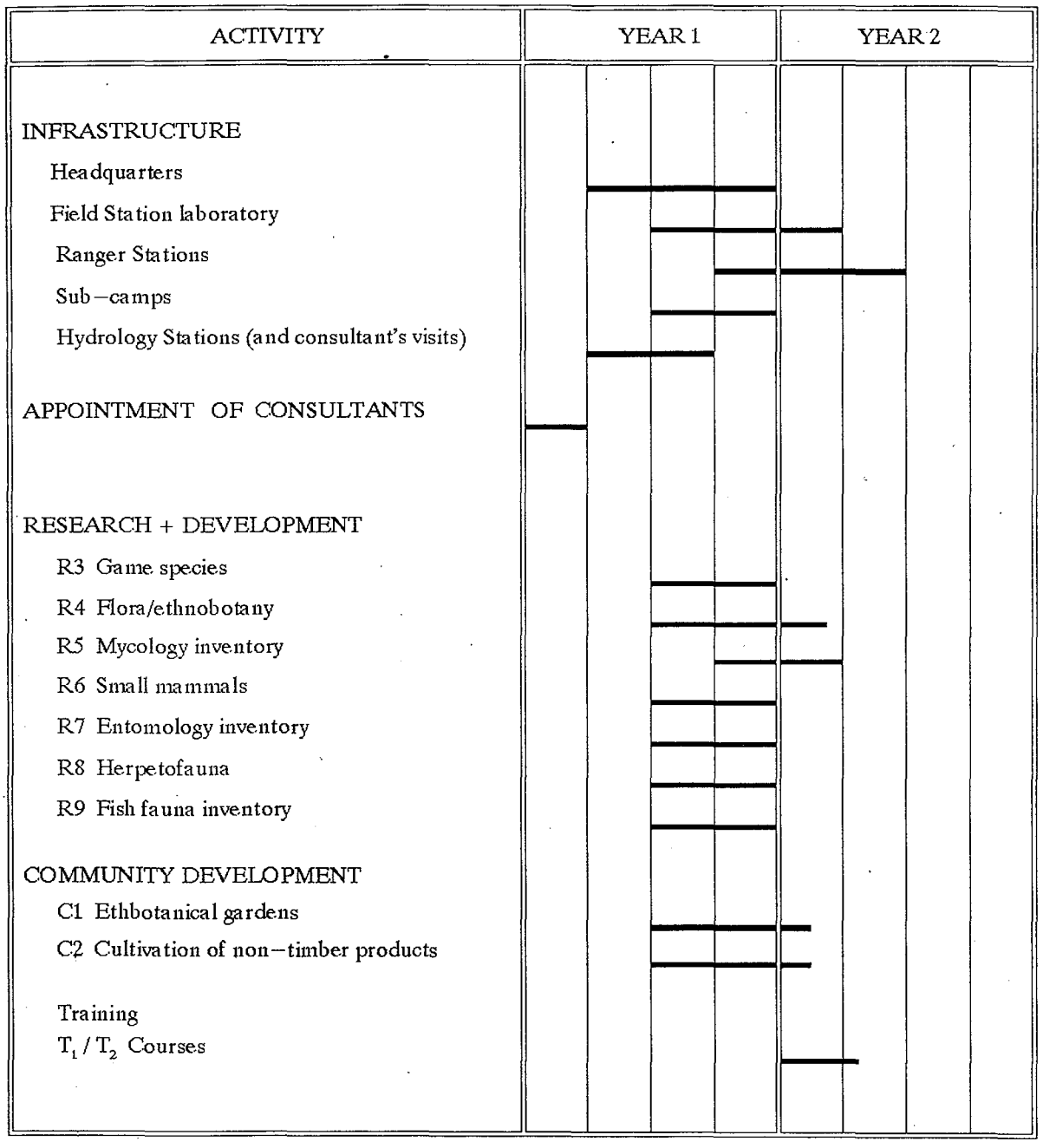
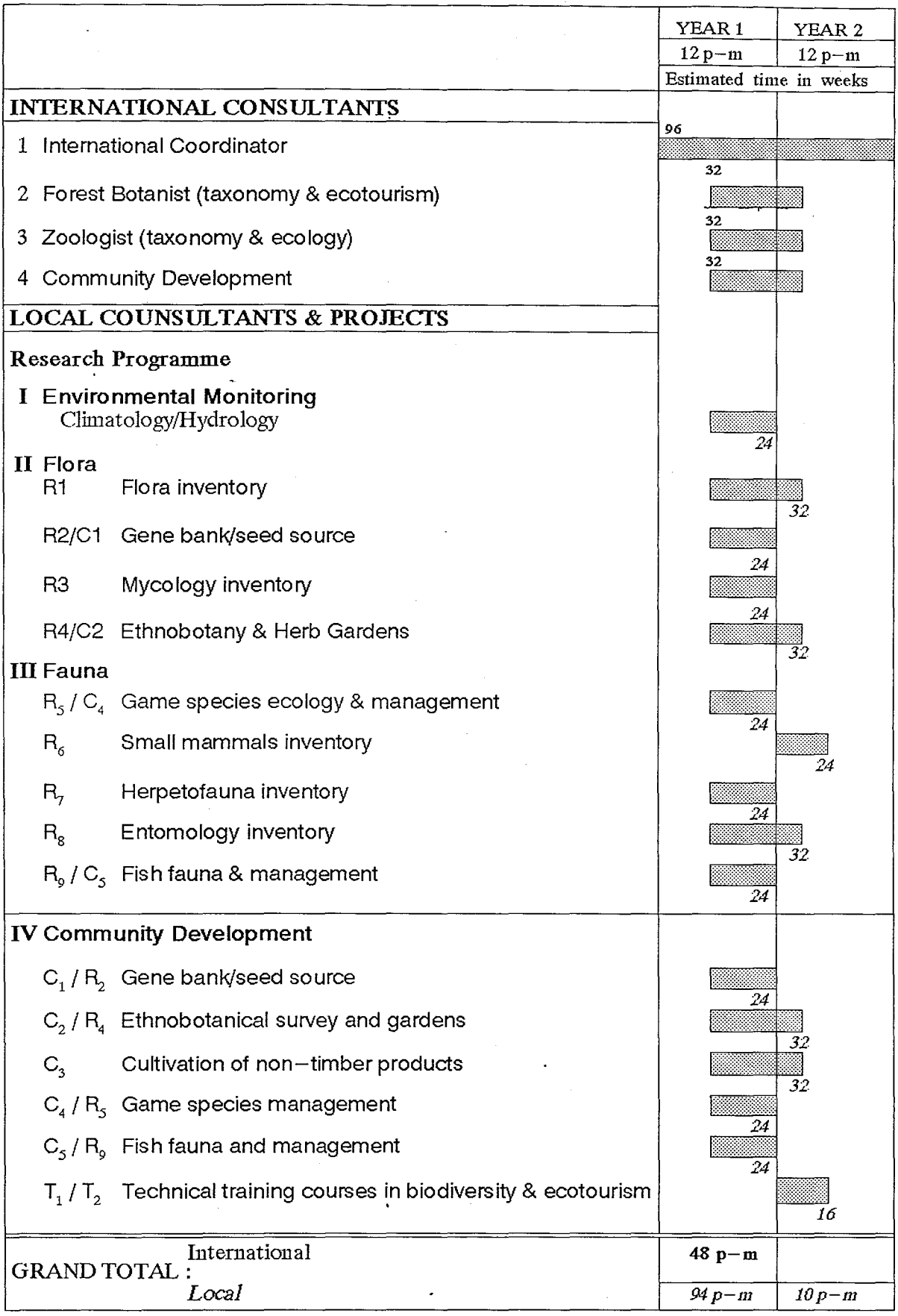


FIGURE 3 : Time Schedule for Consultants
Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area



Note 4 = **International Consultant**

4 = *Local Consultant*

p–m = person–months

8 INSTITUTIONAL ARRANGEMENTS FOR EXECUTION AND OPERATION

8.1 Management Structure

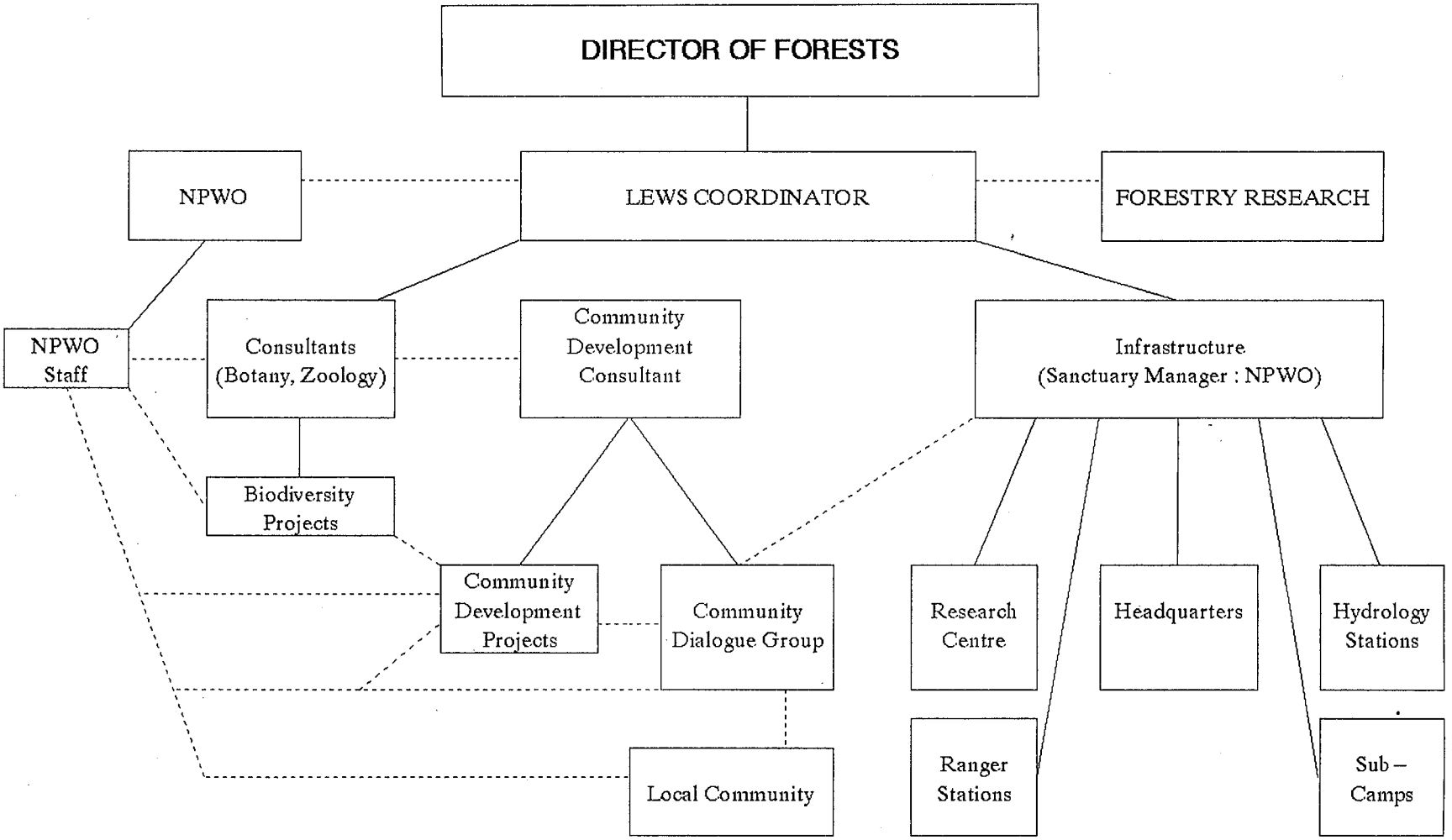
The project will be executed by the Sarawak Forest Department, Malaysia through the National Parks and Wildlife Office (Figure 4).

As noted in 3.6.5, the Sanctuary Manager will obtain feedback via dialogues with local communities to be taken into consideration prior to implementation of the various stages of the Management Plan.

The main blocks of work for development of the Sanctuary will be implemented as follows (see Work Plan above)

(i)	INFRASTRUCTURE	(a)	Headquarters, Field and Ranger Stations through sub-contracts by Forest Department under supervision of Department Engineer.
		(b)	Gene bank/seed source plots by NPWO and Department Botanist.
(ii)	RESEARCH	(a)	NPWO and other relevant sections of the Forest Department, collaboration with institutes of higher learning.
(iii)	COMMUNITY DEVELOPMENT		
	C_1 - C_5	(a)	NPWO Education Unit, Forest Department Research Unit and Silviculture Unit
	T_1 - T_2	(b)	NPWO Education Unit
(iv)	GUIDELINES/ MID-TERM REPORT		Co-Project Leader/Assistant Director, Forest Department

Figure 4 : Organisation chart for Phase II : Development of Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area



PART III - MONITORING, REPORTING AND EVALUATION

1 MONITORING REVIEWS

Evaluation of Phase II of the project will be undertaken by ITTO and the State Government of Sarawak according to their existing policies and procedures. The organisation, terms of reference and terming of this evaluation will be a joint decision of these two bodies.

However, the evaluation shall take place within year 2 of Phase II.

2 REPORTS

The implementing agency shall produce two reports before the last day of the Second year of Phase II.

(i) Output Report, containing a summary of all achievements including status of infrastructure, outcome of protection programme, research results and benefits rendered to local communities.

(ii) Recommendations Report, containing follow-up actions necessary for long-term stability and efficiency of the management programme of the Sanctuary.

PART IV : BUDGET

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

Timing and budget for local and international consultant activities in the Research and Community Development aspects are based on the Indicative Time Schedule attached to the Work Plan.

An international coordinator is foreseen for the entire period of 24 months.

For research programmes, the needed consultant input is estimated at two-thirds field activities and one-third data analysis and report writing.

Consultant time for training are assumed twice the length of the training course.

Exchange rate : US#1.00 = R (Malaysian Ringgit) 2.5

Activities by category for Work Plan of Phase II:–
Development of Lanjak Entimau Wildlife Sanctuary as a Totally Protected Area

No.	Plan Reference Section	Manual Activity	Location	Crew Composition		No. Trips	Days per trip	Total person days	Total (Staff)		Est. expenditure* (labour)	
				Staff	Labour				Persons days	Persons months	Labour	Staff
1		Site visits by Project Leader	Headquarters	1	4	3	5	60	15	0.5	3,800	2,700
			Base Camp/ Research Station	1	4	3	4	48	12	0.4	3,000	2,200
			Ranger Station	1	4	2x2:4	4	64	16	0.6	4,000	2,900
			Sub–camps	1	4	12x1	5	240	60	2.0	15,200	11,000
			Longhouse	1	4	10x1	5	200	50	1.6	12,700	9,000
		Subtotal		5	20	32	23	612	153	5.1	38,700	27,800
2		Site visits by International & Local Consultants										
		Flora	Field sites	5	12	6	14	1,008	420	14.0	63,600	60,500
		Fauna	Field sites	6	12	6	14	1,008	504	17.0	63,600	72,600
		Community Development	Field sites (longhouse)	3	8	10	19	800	300	10.0	50,500	43,200
		Climatology–Hydrology	Weather & hydrology station sites	1	4	4	5	80	20	2.7	5,100	2,900
		Subtotal		15	36	26	52	2,896	1,244	43.7	182,800	179,200
3		Construction of facilities										
		(i) Headquarters	Ng Bloh, ulu Katibas	1	16	3	30	1,440	14	0.5	91,000	12,000
		(ii) Field Centre/	Ng Segrak, ulu Engkari	1	16	3	30	1,440	14	0.5	91,000	12,000
		Research Centre	Ng Jemarang, ulu Mujok	1	16	2	30	1,440	14	0.5	91,000	12,000
		(iii) Ranger Stations	Ng Serembuang, ulu Skrang	1	16	3	30	1,440	14	0.5	91,000	12,000
		(iv) Sub–camps	(12 locations in LEWS)	1	6	1x12	14	1,008	14	0.5	63,655	2,000
		Subtotal		5	70	22	134	6,768	70	2.5	427,655	50,000
		TOTAL		25	126	80	209	10,276	1,467	51.30	RM 649,155	US$ 257,000

* to nearest RM100

FINANCIAL PLAN FOR PHASE II OF THE PROJECT : DEVELOPMENT OF THE LANJAK ENTIMAU WILDLIFE SANCTUARY AS A TOTALLY PROTECTION AREA

Time	Year 1				Year 2				Contribution by Malaysia	ITTO Contribution Requested
	01	02	03	04	01	02	03	04	RM	US$
A PERSONNEL – INTERNATIONAL										
48 person–months @ $10,000	30,000	30,000	120,000	120,000	70,000	30,000	30,000	30,000		460,000
B PERSONNEL – LOCAL										
Sanctuary Manager (G3 @ RM1221 + RM604 allowances)	–	–	5,475	5,475	5,475	5,475	5,475	5,475	32,850	
Government Counterparts										
Local consultants – 104 person–months @ $6,000	–	–	160,000	160,000	160,000	144,000	–	–		624,000
Local support staff	–	–	50,000	50,000	50,000	50,000	–	–		200,000
Subtotal									32,850	824,000
C FIELD TRANSPORTATION / DUTY TRAVEL										
Subsistence allowances: Staff									257,000	
Labour									340,000	
Boats, motors (10) @ $3,500 ea.	–	–	35,000	–	–	–	–	–		
Operation @ RM20/–hrx460 hr	–	–	23,000	23,000	23,000	23,000	–	–	92,000	
Helicopter hire @ RM1,000/hr x 80 hr (including transport of construction materials)	–	–	20,000	20,000	20,000	20,000	–	–	80,000	
4x4 vehicles (2) amort.	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	60,000	
operating 1000 ha @ 120/hr	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	16,000	
Subtotal									845,000	

Time	Year 1				Year 2				Contribution by Malaysia	ITTO Contribution Requested
	01	02	03	04	01	02	03	04	RM	US$
D CAPITAL ITEMS										
Equipment:										
Hydrology/Meteorology (2 weather & river gauging stations)	–	25,000	–	–	–	–	–	–		25,000
GPS units	–	10,000	–	–	–	–	–	–		10,000
Laboratory equipment	–	50,000	50,000	–	–	–	–	–		100,000
Repeater system (purch.)	–	20,000	–	–	–	–	–	–		20,000
Audio–visual equipment	–	10,000	–	–	–	–	–	–		10,000
Tools (Nursery pumps, piping)	–	25,000	–	–	–	–	–	–		25,000
Subtotal										190,000
E CONSUMABLE ITEMS										
Research station	–	300,000	100,000	–	–	–	–	–	400,000	
Headquarters	–	200,000	100,000	–	–	–	–	–	300,000	
Ranger stations (2)	–	200,000	100,000	–	–	–	–	–	300,000	
Sub camps (12)										
– iron frames 12 @ RM1,200)	–	–	14,500	–	–	–	–	–		
– cement 12 x 30 bags @ RM18.00)	–	–	6,500	–	–	–	–	–	21,000	
Subtotal									1,021,000	
F SURVEYS										
GIS Database (data entry) – RM50,000	–		–	–	50,000	–	–		50,000	

Time	Year 1				Year 2				Contribution by Malaysia	ITTO Contribution Requested
	01	02	03	04	01	02	03	04	RM	US$
G AIR TRAVEL										
Int'l staff trips @ US$6,000 (return airfare and regional site visits*)	6,000	–	18,000	–	–	–	18,000	6,000	–	48,000
Within Malaysia RM36,000	–	–	6,000	6,000	6,000	6,000	6,000	6,000	36,000	
Subtotal									36,000	48,000
H OFFICES EXPENSES & COMMUNICATIONS										
HQ Office space 180 m², RM25/m² /mm (est0	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	96,000	
Supplies purch. RM250/mm 2 yr	750	750	750	750	750	750	750	750	6,000	
Cellular phone RM2,500 /yr – 1 yr	–	–	650	650	650	650	–	–	2,600	
Telephone & fax operate RM75/ mo – 2 yr	225	225	225	225	225	225	225	225	1,800	
purch. 15,000	–	15,000	–	–	–	–	–	–	15,000	
Computers (3) purch. US15,000	–	15,000	–	–	–	–	–	–		15,000
Subtotal									121,400	15,000
I ITTO MONITORING, REVIEW & EVALUATION $30,000	–	–	–	15,000	–	–	–	15,000		30,000
J REPORTS & TRANSLATION	–	–	–	–	–	–	–	10,000		10,000
SUB–TOTAL									2,056,250	1,577,000
K CONTINGENCY (10%)									205,625	157,700
L ITTO ADMINISTRATIVE SUPPORT COSTS (5.5%)									124,403	95,409
SUM OF ITTO & MALAYSIAN CONTRIBUTION (US$)									**2,386,278**	**1,830,109**
							To the nearest hundred		**2,386,300**	**1,830,200**

* Bentuang–Karinun

APPENDICES

APPENDIX I

Summary report on the topography geology and soils of the Lanjak-Entimau Wildlife Sanctuary

Sia Puon Chiew
ITTO Geologist

1.0 General topography

Lanjak-Entimau is rugged throughout, with its most strongly dissected terrain in the south. Elevations range from about 60 metres a.s.l. in the flood plains of the north to a maximum of 1284 metres a.s.l., at the summit of Bukit Lanjak in the Sanctuary's southwestern quadrant. The hills of the north are generally of more modest altitudes, usually less than 700 m.

Most of the southern two-thirds of the Sanctuary, bounded approximately by a line running between Bukit Entimau (988 m) and Bukit Sengayoh (875 m) possesses elevations greater than 300 m. and hills above 700 m a.s.l. Nevertheless, there are no areas at or above 1300 m. in elevation except for Bukit Lanjak itself.

Major river valleys navigable by longboats range from 60-120 m. a.s.l. in the north to approximately 120-180 m. in elevation in southern waterways.

2.0 Watersheds

Lanjak-Entimau occupies two main watersheds, composed of three major and four minor drainage blocks. The entire Sanctuary is located within the headwaters of the Batang Lupar and Rejang Rivers.

The Rejang drainage (77%) includes the north and northeast of the Sanctuary, while Batang Lupar tributaries (23%) are restricted to its southwestern corner.

Subdrainages of the Rejang system include Sg Kanowit in the west; the Sg Ngemah-Sg Mujan, Sg Poi and Sg Mujok in the north; and Sg Katibas with its numerous tributaries in the northeast and central parts of Lanjak-Entimau .

The Lupar tributaries drain the southwestern and southern portions of Lanjak-Entimau, comprising the Sg Skrang and Sg Lemanak in the southwest and the tributaries of Batang Ai in the south. (**Table 1**).

Table 1 : Drainage Pattern of the Rivers in the Sanctuary

Major Rivers	Major Tributaries	Areas of Watershed as % of Total	
Batang Lupar	Ai	13	
	Lemanak	1	
	Skrang	9	23
Batang Rejang	Katibas	42	
	Kanowit	19	
	Poi	7	77
	Ngemah	9	

3.0 Drainage

The rivers of the Sanctuary cut mostly across the regional strike (the direction in which the folding of most layers has occurred) traversing deeply eroded valleys through a complex of highly dissected steep ridges with little flood plain development within the Sanctuary. Rapids are formed in the many areas where the rivers encounter resistant strata. An exception occurs in the northern tributaries such as the upper Kanowit and Katibas. These flow parallel to the regional strike through thick beds of resistant sandstone along the strike of softer shales.

Several tributaries of the Kanowit, Poi, Ngemah and Katibas also have water courses flowing through more easily eroded rock along existing faults in a generally northwesterly orientation. Despite the existence of rapids, many of these rivers have broad channels with relatively laminar flow and substantial volume year round.

In contrast, the upriver areas of the Engkari, ulu Ai and Lubang Baya cut across the strike, flowing southwest, creating channels which are narrow and deeply incised, with tortuous channels that become shallow during the dry season. Upriver terrain is extremely rugged with steeply sloping hills rising directly from the river beds. Numerous sidestreams exists, though many are intermittent since runoff is rapid because of the largely ungraded basins.

Only a small percentage of precipitation is likely to infiltrate the soil profile. Flash floods are common and can be severe (as much as a six meter rise for example) affecting the alluvial lands along the rivers and limiting agricultural potential.

4.0 Rainfall

No meteorological stations are located within the Sanctuary. However, data obtained from stations at Ng Tutong and Lubok Antu in the South, and at Sg Ngemah in the north between 1966 and 1985 indicate that the mean annual rainfall for the area is approximately 3,500 mm.

The wettest months (October-January) receive about 300-350 mm, while the driest months, about 200 mm. Nevertheless, rainfall levels can fluctuate substantially from month to month. Also, the higher terrain of the Sanctuary probably receives higher amounts of rainfall than have been recorded at peripheral stations such as Lubok Antu and Ngemah.

5.0 Geology

Geologically, the Lanjak-Entimau Sanctuary is composed entirely of sedimentary rocks associated with Stages I (Upper Cretaceous) and II (Paleocene to Upper Eocene) of the Belaga Formation. In the Sanctuary, the boundary between Stages I and II of this formation lies approximately between the headwaters of the Rejang and Lupar Basins, running roughly northwest to southeast .

Much of the southern areas (Stage I) consist of hard, greenish or grey, shiny phyllite rocks, produced from shales in low grade metamorphism (heat and pressure from folding). Fine-grained greyish sandstones are exposed at many of the rapids and strikingly contrasting veins of milky white quartz are occasionally visible.

In the northern areas of Stage II, slaty shales are common, with occurrence of calcareous greywacke (a dark green to black, hard sandstone containing unidentifiable remains of marine organisms). Impure limestone concretions were found in calcareous shale along Sg Nyawang, containing fossilised tube-like tracks of some marine organism (**Haile, 1957**).

6.0 Soils

The soil types of Lanjak-Entimau fall into three main taxonomic categories, namely Alluvial, Red -Yellow Podzolic and Skeletal **(Tables 2 & 3).** These have the following general characteristics:

Table 2 : Soil classification from Lanjak-Entimau *

Great Group	Criteria	Family	Criteria	Series
Alluvial	Accreting alluvium, not gleyed	Seduan	Clayey	Seduan
				Malang
		Bemang	Fine loamy	Bemang
Red Yellow Podzolic	Red Yellow matrix colours, increase in clay with depth	Merit	Clayey	Merit
				Jakar
		Bekenu	Fine loamy	Bekenu
				Sarikei
Skeletal	Less than 50 cm in depth	Meluan	Lithic contact	Meluan
		Kapit	Paralithic contact	Kapit

Table 3 : Soils and land capability of the Lanjak Entimau Area*

Soil Unit	Agricultural capability class	Soil Great Group
hilly riverine valley	3td/2i : minor to moderate limitation	Alluvial
		Red-Yellow Podzolic
		Skeletal
low hills or moderately dissected terrain	3td: moderate to serious limitation	Red-Yellow Podzolic
		Skeletal
strongly dissected terrain	4td/5td: serious limitations	Skeletal
		Red-Yellow Podzolic
predominantly strongly dissected terrain	5td: unsuitable	Skeletal
		Red-Yellow Podzolic

* **Based on Tan (1979), Teng (1979) and survey data.**

Alluvial soils are derived from the accreting alluvium of rivers, and possess a homogeneous or uniform profile, with little differentiation except for the top horizons. These soils occur in valleys and levees in Lanjak-Entimau, though their diverse properties are derived from parent material of varying origins. Alluvial soils formed from sandstone are light-textured (sandy and sandy-clay loams), while those derived from shales and mudstones possess heavier textures (clay and clay loams).

Agriculturally, alluvial soils are classed as category 3, excellent for a wide range of crops with little or no management. Only 0.4 % of Lanjak-Entimau's soils fall into this category, occurring sparsely along the Sg Ngemah, Sg Mujok, ulu Sg Mujok and in small areas near the junction of the Sg Joh and Sg Bloh. These areas are nevertheless limited by their susceptibility to severe flash flooding.

Red-yellow podzolic soils of the Sanctuary have originated from sedimentary rocks, specifically coarse-grained sandstones and shales. They are often fairly uniform in chemical and mineral content because of intense weathering and relative maturity. Fine, crumbly structure exists only in the uppermost layer combined with the dense root mat of a mature forest. Gravel or stones are abundant in subsoils, and clay content increases with depth, which in the Sanctuary is usually less than 100 cm. The reddish yellow colour of these podzols is caused by the presence of oxidised iron. The Merit and Bekenu families of red-yellow podzolics are common in the Lanjak-Entimau .

Red-yellow podzolic soils are classed 3-4 agriculturally (i.*e.* good but restricted by steep slopes and used preferrably only for perennial crops). They occur principally in low hilly areas, and are considered suitable for agriculture only when they are found on gently sloping terrain. They account for only about 0.5 % of the Sanctuary's land area.

Skeletal soils are found on the steep slopes of ridges and crests. They are a complex group with a variety of texture, structure and chemical content, and their soil profiles are constantly renewed by erosion. Typically shallow (< 50 cm depth) with a rocky surface and steep gradient, skeletal soils have little to no agricultural potential (classed 4 - 5) because of an almost total absence of chemical fertility.

The first category of skeletal soils is widespread in Lanjak-Entimau though comprising only about 13% of the land area and distributed in a patch from Sg Ensirieng south to Bukit Entimau. These soils are considered marginal for agricultural purposes because they occur on strongly dissected and often steep terrain, with high potential for erosion.

A second category of skeletal soils occurring on predominantly strongly dissected terrain is found where slopes are so steep that gravity continously disrupts the formation of a soil profile. They include the Kapit-Merit soils of steep mountain slopes. These skeletal soils occupy 86% of the Lanjak-Entimau land area, have no agricultural potential and are best left under primary forest cover, as removal would greatly accelerate the process of soil movement.

APPENDIX II

Summary report on the forest ecology and flora of Lanjak-Entimau Wildlife Sanctuary

Dr. Paul Chai Piang Kong
ITTO Forest Ecologist

1.0 Background and methods

Lanjak-Entimau is sufficiently large in area to contain a highly significant component of Sarawak's total biological diversity. Virtually all of the Sanctuary is under forest cover, and although the appearance and structure of the forest might appear similar, the communities and ages of the vegetation vary considerably.

Trees of the lowland and hill dipterocarp forests are generally small with a pole-like appearance, and large trees (DBH > 70 cm) comparatively fewer than in other parts of Sarawak. The forest is highly complex both between and within sites. There are altogether seven distinct vegetation formations in the Reserve (**Table 1**).

Mixed dipterocarp forest covers about 80% of the Sanctuary area, while montane forest occurs only on Bukit Lanjak.

Table 1: Forest types of the Lanjak-Entimau Wildlife Sanctuary at three sites

Forest Type	Sengayoh	Entimau	Lanjak
1 Alluvial	150 m	165 m	-
2 Lowland Dipterocarp	250-400 m	310-410 m	600-700 m
3 Lowland Dipterocarp (poles)	-	200-250 m	-
4 Hill Dipterocarp	600-750 m	530-700 m	800-900 m
5 Summit Ridge	800-900 m	780-800 m	-
6 Submontane Mossy	-	-	1150 m
7 Montane Mossy	-	-	1250 m
8 Old Secondary	160 m	165 m	400-550 m

2.0 Floral diversity and abundance

2.1 General aspects

Numerous differences in species composition between sites leads to a high level of floral diversity for the Sanctuary as a whole. The richest flora occurs in lowland dipterocarp forest, followed by old secondary forest and hill dipterocarp forest. Submontane and montane habitats are much poorer in species.

From the study of these sites, the total number of tree species greater than 10 cm diameter identified from Lanjak-Entimau was 1075, while trees less than 10 cm diameter and non-trees totalled 786 and 179 respectively. Total number of species per habitat and other details are given in **Table 2.**

Table 2 : Total nos. of families, genera & species, densities and basal areas recorded from different forest types

Forest Types	Families	Genera	Species	Total No. Trees Recorded	Av. No. Trees/Ha	Mean B.Area $m^2 ha^{-1}$
Alluvial	38	111	265	779	518	30.98
Lowland Dipterocarp	52	152	494	2,406	810	51.45
Old Secondary	53	144	376	1,324	588	35.65
Hill Dipterocarp	43	123	368	1,900	844	36.32
Summit Ridge	48	110	285	1,243	1,029	45.29
Submontane	40	73	123	436	968	53.65
Montane	33	55	93	498	1,106	40.79

Overall, Lanjak-Entimau has about 12% more genera and 30% more species than the forests of Mulu National Park. Hill dipterocarp forests in Lanjak-Entimau are almost 50% richer in species and approximately 50% higher in tree density than in Mulu.

The total number of species identified from Lambir Hills National Park (1086) is higher than that found in Lanjak-Entimau. (**Chai, *et. al*, 1994**) since researchers in Lambir measured trees down to 1 cm in diameter. In Lanjak-Entimau, measurements of only

trees greater than 10 cm in diameter were made, implying that there are potentially more species yet to be recorded.

Lanjak-Entimau is also much richer in species and higher in tree densities when compared to Sg Menyala and Pasoh Forest Reserve in Peninsular Malaysia.

The Dipterocarpaceae and Euphorbiaceae are dominant in the lowlands, while the Myrtaceae and Guttiferae increase in dominance with altitude. Myrtaceae become most abundant in summit ridge forest. The highest tree densities occurred in montane mossy forest and the lowest in alluvial forest. The main forest types are given below:-

2.2 Alluvial Forest (60 - 120 m a.s.l.)

Alluvial forest (AF) occurs in low-lying areas and flood plains, ordinarily where the terrain is gentle. It is confined mostly to the northern areas of Lanjak-Entimau, and rather rare in ulu Engkari and ulu Batang Ai in the south. The canopy is from 22-26 m. high, and while structure and morphology may appear similar, species composition is usually different. The Dipterocarpaceae is the most common family of this habitat type, with an unusually high concentration of species from this family at the ulu Ensirieng site (27 species from four genera, with 18 species of *Shorea*). Emergent *tapang* trees (*Koompassia excelsa*) are relatively common. Distinct differences were evident between sites, as only four dipterocarp species were found at Sg Joh, even though the elevations are similar and the distance between sites not great.

The total number of species was 265 for all sites, with only 33 species from 18 families common to both Sg Ensirieng and Sg Joh. More than 50% of the total trees belonged to five families (Euphorbiaceae, Myrtaceae, Myristicaceae, Guttiferae and Lauraceae), while tree density in the two alluvial plots sampled ranged from 500-539 per ha. More than 90% of Sg Joh trees were less than 40 cm in diameter **(Details are given in Tables 3 and 4)**

Table 3 : The most common families in the Alluvial Forest

SG JOH				SG ENSIRIENG			
Family	Gen	Spp.	Trees	Family	Gen	Spp.	Trees
Euphorbiaceae	10	23	58	Dipterocarpaceae	4	27	53
Lauraceae	6	10	28	Euphorbiaceae	11	23	64
Rubiaceae	6	7	24	Myrtaceae	1	14	27
Leguminosae	4	6	12	Myristicaceae	5	12	27
Sapindaceae	1	5	31	Lauraceae	5	10	30
Sapotaceae	1	5	23	Guttiferae	3	10	13
Elaeocarpaceae	1	5	13	Burseraceae	4	9	20
Moraceae	1	5	12				
Total	30	66	201	Total	33	105	264

Table 4 : Total nos. of taxa, trees and basal area from Alluvial Forest plots. Figures in brackets show density/ha

Locality No.	Sg Joh	Sg Ensirieng	Mean
Families	38	38	38
Genera	79	85	82
Species	132	161	147
Trees	375 (500)	404 (539)	389 (518)
Basal Area (m^2ha^{-1})	25.91	36.06	30.98

2.3 Lowland Dipterocarp Forest (200 - 410 m a.s.l.)

Lowland dipterocarp forest (LDF) is the most extensive forest formation in the Lanjak-Entimau Sanctuary, though rarely found below 200 m a.s.l., since the forests of these lower elevations are almost entirely secondary. The LDF reaches its maximum elevation at approx. 700 m a.s.l. on Bukit Lanjak, the site with the lowest number of genera and species.

Overall, dipterocarp species constitute at least 43% of the forest of the lower elevations (200-300 m), forming a major element of the second canopy layer at about 30 m from the ground (with an upper canopy height between 35-40 m). The largest trees though relatively few in number, exceed 100 cm in diameter. In fact, trees attaining breast-height diameters of 60 cm or greater comprise only about 3% of all LDF trees measured.

The most common trees include genera such as *Dipterocarpus*, *Shorea*, *Koompassia*, *Scaphium* and *Hydnocarpus*. The five most abundant families are the Euphorbiaceae, Dipterocarpaceae, Myristicaceae, Myrtaceae and Lauraceae. Altogether, a total of 52 families, 152 genera and 494 species were found, with the Euphorbiaceae and Dipterocarpaceae as the two dominant families, with a combined total of 119 species between them. Tree density at three lowland sites (Sengayoh, Entimau and Lanjak) range from 777-811 per ha. Only 17 tree species were common to all LDF plots. **Details are given in Table 5 and 6)**

Table 5 : Total nos. of taxa, tree populations and basal area in Lowland Dipterocarp Forest plots. Figures in brackets show density/ha.

Locality No.		Sengayoh	Entimau		Lanjak	Mean
			240 m	400 m		
Families		40	44	44	36	41
Genera		98	96	96	69	90
Species		197	215	192	147	188
Trees		604 (805)	608 (811)	583 (777)	636 (848)	608 (810)
Basal Area (m^2ha^{-1})	Total	51.20	42.94	64.23	47.44	51.45
	Dipts	16.39	16.12	20.65	28.65	20.49

Table 6 : Most common families from Lowland Dipterocarp Forest

Family	No. of Genera	No.of Species	No. of Trees
Euphorbiaceae	21	63	251
Dipterocarpaceae	6	56	587
Myristicaceae	5	30	169
Myrtaceae	1	26	134
Lauraceae	10	24	83
Burseraceae	3	24	140
Total no. of families = 52 Total no. of genera = 152 Total no. of species = 494			

2.4 Old Secondary Forest (120 - 200 m a.s.l.)

Most of the dipterocarp forest at low elevations in Lanjak-Entimau has been affected by agricultural activities occurring over the past 100-150 years. Many longhouse communities, especially in the Katibas area, claimed to have resided in and around the

Sanctuary for up to 180 years. The Lanjak Entimau secondary forests (OSF) are estimated to be from 80-130 years old, and are similar in appearance to mature natural forest. However, canopy height varies considerably (25-38 m) and the ten most common families are all non-dipterocarps.

The Euphorbiaceae are dominant, while only 4-9 species of the Dipterocarpaceae can be found at any one site. Tree diameters are small, and 95% of trees are less than 40 cm in diameter. Less than 3% exceed 60 cm. The species total is 376, with from 528-625 trees at any one site. Only 20 species are common to all three secondary forest sites. Also, the undergrowth in this habitat type is dense and floristically rich, with many palms and climbers. Details for this forest type are summarised in **Tables 7 & 8**.

Table 7: Total nos. of taxa, trees and basal area in Old Secondary Forest plots. Figures in brackets show density/ha

Locality / No.		Segurugoh	Tekalit	Jela	Mean
Families		43	41	40	41
Genera		97	83	79	86
Species		167	167	146	160
Trees		396 (528)	469 (625)	457 (609)	441 (588)
Basal Area	Total	26.22	40.86	30.44	32.50
(m^2ha^{-1})	Dipts	1.12	6.46	4.06	3.82

Table 8 : The most common families in old secondary forest. The seven most common families in the forest are indicated by *

Family	Segurugoh			Tekalit			Jela		
	Gen	Spp	Trees	Gen	Spp	Trees	Gen	Spp	Trees
Euphorbiaceae*	14	27	53	9	21	81	8	16	89
Myrtaceae*	1	12	24	2	21	38	2	17	50
Lauraceae*	8	9	49	6	8	19	2	10	20
Annonaceae	2	9	15	1	5	13	1	3	5
Guttiferae*	4	8	12	2	5	8	4	13	45
Myristicaceae*	4	6	16	4	11	18	2	5	7
Anacardiaceae	4	5	6	4	8	16	3	4	5
Burseraceae*	3	4	4	2	9	19	3	10	31
Fagaceae	2	3	8	1	6	9	3	6	7
Dipterocarpaceae*	3	3	7	4	9	27	2	4	38
TOTAL	49	95	214	38	108	255	32	90	302

In late 1994, residents of ulu Engkari reported to Sarawak Forest Department staff that local flowers of the giant ***Rafflesia*** were blooming at the edge of a farming plot near the Lanjak-Entimau boundary, ulu Segerak, about two hours walk from the LEWS Base Camp. One flower and six buds were subsequently found on 23 March, 1995 (**Tan, 1995**).

Residents of the last longhouse (*Rumah Lenggang*) in ulu Engkari reported several sites within the Sanctuary (*Emperan Lallang*, *Emparan Sarugar* and *Batu Galan*) where *Rafflesia* had last been seen in flower in 1990-1991. No buds were found, though the host plant was present. The species of *Rafflesia* has been identified tentatively as a variety of *Rafflesia keithii*, one of the largest members of the species.

2.5 Dipterocarp Forest (530 - 900 m a.s.l.)

Hill dipterocarp forest (HDF) occurs at elevations from 530-900 m a.s.l. in Lanjak-Entimau, and has the same structure as lowland dipterocarp forest except for a more distinctly pole appearance. At least 70% of trees are below 30 cm in diameter. .

Dipterocarp seedlings are abundant in the understorey, under a main canopy from 24-28 m high. The five most common families are the Dipterocarpaceae, Euphorbiaceae, Guttiferae, Myrtaceae, and Myristicaceae. As in lowland dipterocarp forest, the Euphorbiaceae and Dipterocarpaceae are dominant (78 species). The total species found numbered 368, with 43 species of dipterocarps.

Bukit Lanjak has a higher tree density (940 per ha) but fewer genera and species. Elsewhere, in Sengayoh and Entimau, tree densities range between approximately 746-828 per ha . A summary is given in **Tables 9 and 10**.

Table 9:Total nos. of taxa, trees and basal area from Hill Dipterocarp Forest plots. Figures in brackets show density/ha.

Locality / No.		Sengayoh	Entimau	Lanjak	Mean
Families		30	35	38	41
Genera		85	71	64	90
Species		178	177		188
Trees		621 (828)	574 (746)	705 (940)	608 (810)
Basal Area (m^2ha^{-1})	Total	57.33	55.50	51.14	51.45
	Dipts	29.39	24.93	13.26	20.49

Table 10: Five most common families in Hill Lowland Dipterocarp Forest with total numbers of families, genera and species

Rank	Family	No. of Genera	No.of Species	No. of Trees
1	Dipterocarpaceae	7	43	553
2	Euphorbiaceae	15	35	113
3	Guttiferae	4	27	113
4	Myrtaceae	1	26	170
5	Myristicaceae	4	21	118
Total no. of families = 43 Total no. of general = 123 Total no. of species = 368				

2.6 Summit Ridge Forest (850-990 m a.s.l.)

Summit ridge forest is a pole forest surveyed on steep narrow ridges in Bukit Sengayoh and Bukit Entimau. It differs substantially from the mossy submontane and montane forests of Bukit Lanjak, and thus a different terminology has been used.

These forests are unable to retain moisture because of constant exposure to direct sun and to wind currents with resulting high rates of evapo-transporation. Trees are tall and slender, forming a canopy at approximately 25 m above the ground. The five most common families were the Myrtaceae, Euphorbiaceae, Guttiferae, Dipterocarpaceae and Anacardiaceae. Tree densities were comparable to other areas of dipterocarp forest .

The understorey contains rattan seedlings, small palms, ginger plants and ferns. Herbs (*Sonerila* sp) and orchids (*Bulbophyllum lowii*) are common. Details for this forest type are summarised in **Tables 11 & 12.**

Table 11: Numbers of families, genera, species density and basal area from Summit Ridge Forest * No at 0.75 ha

Locality / No.		Sengayoh	Entimau	Mean
Families		41	37	39
Genera		86	71	79
Species		173	152	163
Trees		495 (788)*	756*	716*
Basal Area (m^2ha^{-1})	Total	55.56	35.02	45.29
	Dipts	12.28	2.49	7.38

Table 12: The most common families in Summit Ridge Forest with total nos. of families, genera and species

Rank	Family	No. of Genera	No.of Species	No. of Trees
1	Myrtaceae	2	29	216
2	Euphorbiaceae	13	22	52
3	Guttiferae	4	20	58
4	Dipterocapaceae	3	20	135
5	Anacardiaceae	8	17	58
6	Fagaceae	3	17	169
Total no. of families = 48 Total no. of general = 110 Total no. of species = 285				

2.7 Submontane Mossy Forest (approximately 1000 m a.s.l.)

Submontane mossy forest is restricted to the Bukit Lanjak area, from Ubah Ribu ridge on the northeastern side, running northwest to Bukit Lanjak Mit and onto Bukit Peninjau, and grades into montane forest at elevations above 1000 m. Canopy height is generally 20-25 m, with emergents of *Shorea longifolia* and *Shorea obscura*. There is more tree diversity (families, genera and species), but lower population densities than in the

montane forest. There are few dipterocarps, and the dominant families are the Myrtaceae, Guttiferae and Lauraceae. A summary is given in **Table 13.**

Table 13 : The most common families in Submontane Forest with a total no. of families, genera & species

Rank	Family	No. of Genera	No.of Species	No. of Trees
1	Myrtaceae	1	14	48
2	Guttiferae	3	11	75
3	Euphorbiaceae	6	8	11
4	Lauraceae	3	6	26
5	Dipterocapaceae	3	6	24
Total no. of families = 40 Total no. of general = 73 Basal area = 53.653 m^2ha^{-1} Total no. of species = 123				

2.8 Montane Mossy Forest (1100 - 1250 m a.s.l.)

This is the stunted forest found primarily on Bukit Lanjak, growing mainly in flatter areas. The canopy height is mostly less than 20 m and almost 90% of the trees are less than 30 cm in diameter. All are encased in water-saturated mosses, and the dominant families are the Myrtaceae, Guttiferae, Lauraceae, Elaeocarpaceae and Fagaceae. In total numbers of trees, the Euphorbiaceae are the most common. Total numbers of species are about 25% less than in submontane forest.

The ground flora is rich, and includes palms, gingers, ferns, herbs of the Rubiaceae and Melastomataceae, pandans, orchids and abundant *Nepenthes*. Details are summarised in **Table 14**.

Table 14 : The most common families in Montane Forest with a total no. of families, genera, species and basal area

Rank	Family	No. of Genera	No.of Species	No. of Trees
1	Myrtaceae	1	12	58
2	Guttiferae	2	9	63
3	Lauraceae	6	8	27
4	Elaeocarpaceae	1	6	24
5	Fagaceae	3	4	17
Total no. of families = 33 Total no. of general = 55 Basal area = 40.79 m^2ha^{-1} Total no. of species = 93				

3.0 Medicinal and other plants of traditional use

Approximately 140 different kinds of plants for treating a variety of internal and external ailments were described from Lanjak-Entimau by traditional medical practitioners from the Kedayan, Lun Bawang and Iban communities. Plants with non-medicinal use such as in dye making,were also identified.

4.0 Fruit trees and vegetables

Residents from areas adjacent to Lanjak-Entimau reported that they consumed over 114 varieties of wild fruits, and at least 36 varieties of jungle vegetables. Fruit producing trees used by local people are primarily from the Families Euphorbiaceae (principally *Baccaurea*), Leguminosae (principally *Dialium*), Moraceae (principally *Artocarpus*), and Sapindaceae (principally *Nephelium*). The Palmae and the Zingiberaceae are the two most important non-tree families producing edible fruits. Popular vegetables are produced mainly from palm and rattan shoots, and gingers.

Lanjak-Entimau also contains genetic stocks of important fruit species including *Artocarpus* (jackfruit, *cempedak*), *Baccaurea* (*tampoi*), *Dacryodes* (kemayau), *Canarium* (*dabai*) and *Garcinia* (mangosteen), to name just a few.

APPENDIX III

Summary report on the primates of the Lanjak-Entimau Wildlife Sanctuary

Raleigh M. Blouch
ITTO Primatologist

1.0 Background

The Lanjak-Entimau forests have been known to possess a rich primate community for many years. Identification of the ulu Batang Ai, contiguous with Lanjak-Entimau, as an important area of orangutan abundance was made as early as 1960 (Schaller, 1961).

Of 11 species of higher primates known to occur in Borneo, six of these are found in Lanjak-Entimau. In addition, the Sanctuary is also home to two primitive primates, the slow loris (*Nycticebus coucang*) and the western tarsier (*Tarsius bancanus*), though these nocturnal species were not surveyed during the present project.

Ten sites in the North, Central and South regions of Lanjak-Entimau were chosen to represent the range of altitudes, forest types and degrees of human activity to be found within the Sanctuary. At each site, two transects each 4 km long were cleared and marked at 25 m intervals.

Surveys were performed by the ITTO Consultant or by Officers of the National Parks and Wildlife Section of the Sarawak Forest Department, totalling 1568.6 km over a period of 8 months. All primates seen or heard were recorded, and field data analysed via the computer programme Transect 2.2.

In addition, all fruit trees which were reported to be important to the orangutan diet, and greater than 10 cm Diameter Breast Height (DBH) were counted along a belt extending 10 m on each side of the transect. Details of all survey techniques are given in the ITTO Consultant's report (**Blouch, 1994).**

Incidental sightings of bird species such as the argus pheasant (*Argusianus argus*) and hornbills (Bucerotidae) were also recorded and the data turned over to the ITTO Ornithologist.

2.0 Orangutan (*Pongo pygmaeus*)

2.1 Densities

Orangutans are the least common primate in the Sanctuary, and were sighted only 27 times during the surveys. Orangutan densities were highest in the South (1.09 groups/km^2 or 1.73 individuals/ km^2), intermediate in the Central region and lowest in the North (0.13 groups/km^2). The highest density of orangutan nests (151.6/km^2) was found at approximately 500-800 m a.s.l., while the population estimate for orangutans in the Sanctuary was slightly more than 1000 animals. Densities varied between sites, with the highest at Sg Lelap, and the lowest (none) at Sg Poi.

2.2 Correlation with fruit tree abundance

A total of 62 species from 39 genera of fruit trees were counted, of which eight genera (*Durio, Baccaurea, Castanopsis, Lithocarpus, Garcinia, Artocarpus, Ficus and Nephelium*) were selected as especially important for orangutan nutrition. Within the South region of the Sanctuary, the highest densities of orangutans were positively correlated ($r = 0.61$) with fruit tree density. The overall picture of Lanjak-Entimau that emerges is that the Sanctuary is a marginal to fair orangutan habitat possibly because of the paucity of fruit trees in all but one of its regions.

2.3 Illegal hunting of orangutans

There was little evidence of widespread hunting of orangutans, and virtually every hunter interviewed claimed he would not kill such an animal. Nevertheless in September-October 1993, orangutan parts were discovered in three separate areas, providing some proof that some orangutans are killed by hunters. Unfortunately, even a low rate of hunting can be a serious problem since birth intervals in orangutans can average as long as eight years (**Galdikas and Wood, 1990**).

Field observations support the view that if orangutans are few despite an apparent abundance of fruit trees, hunting is likely to be the problem. This situation applies to the Tebellian, Latong and Batang Ai sites. Nevertheless, **Schaller**'s (**1961**) assessment of the Lanjak-Entimau/Batang Ai area 35 years ago suggested that orangutan populations even then, were considered sparse, indicating that habitat quality rather than hunting may be the deciding factor in determining abundance. Thus, even if hunting were to cease entirely, Sanctuary managers should not anticipate any dramatic increase in orangutan densities.

2.4 Viability of the orangutan population

Even though small populations of vertebrate animals can face a high probability of extinction, the 1000 or so resident Lanjak-Entimau orangutans are part of a larger population extending both into the Batang Ai National Park where there are probably about 300 animals and the vast Gunung Bentuang-Karimun Nature Reserve with probably at least several hundred more individuals. The consolidation of these three entities in late 1994, into the Lanjak-Entimau Bentuang-Karimun Biodiversity Conservation Area is a major accomplishment towards ensuring the survival of the orangutan in western Borneo.

2.5 Rehabilitation of captive animals

The existence of a viable population of orangutans in Lanjak-Entimau makes it unnecessary and unwise to consider reintroduction of captive orangutans into the Sanctuary. Because the resident populations are probably at or near the carrying capacity of the forest environment, such introductions are likely to create competition for resources between residents and the newcomers, with potential negative effects. This fact in addition to the possibility of introducing disease from the outside, and the lack of veterinary and other support facilities for a rehabilitation programme, make consideration of the latter not advisable. Orangutans introduced from outside the Sanctuary pose the risk of causing instability in the resident population.

3.0 Gibbons (*Hylobates muelleri*)

3.1 Densities

Gibbons were the primate species most frequently encountered during surveys. The population of Bornean gibbons in the Sanctuary probably numbers more than 24,000, with densities of 10.2 groups/km^2 in the South, 5.2 groups/km^2 in the Central region, and only 0.2 groups/km^2 in the North (Overall the density is about 4.3 groups/km^2). The overall figure is considerably higher than that reported for Batang Ai National Park (1.7 groups/km^2; **Meredith, 1993**).

In fact, the southern Lanjak-Entimau populations possess the highest density currently known for Bornean gibbons. **MacKinnon (1977)** reported a density of 10.5 groups/km^2 in ulu Segama, Sabah, but this figure was revised downwards to 5.3 groups/km^2 by Johns (1992) working subsequently in primary forest in the same area.

3.2 Correlation with fruit tree abundance

The relatively sparse densities of gibbons in the North region of Lanjak-Entimau, similar to the distributional trend of orangutans in the Sanctuary, may be caused by a low density of fruit trees. Nevertheless, the present surveys concentrated on fruits important to orangutans, who have only partial dietary overlap with gibbons.

Another explanation may be needed, particularly since surveys showed that numbers of trees of the genera *Ficus* and *Artocarpus*, supposedly key food sources for gibbons (**Bennett, *et al.*, in prep.**), are low in the South where gibbon densities are highest.

4.0 Langurs (*Presbytis* sp.)

4.1 Densities of Maroon langurs

The estimate for the maroon langurs (*Presbytis rubicunda*) was 28,400, or about 3.5 groups/km2. This figure is from 25-75% higher than that reported for Barito Ulu, Central Kalimantan (**Bodmer, *et al.*, 1991**) and Batang Ai National Park (**Meredith, 1993**) respectively. This species occurred at significantly higher densities in the Central and South regions than in the North.

4.2 Densities of White-Fronted langurs

The population of white-fronted langurs (*Presbytis frontata*) was estimated at 13,400, or 1.7 groups/km2. This figure exceeds that thought to represent the approximate existing total population level (10,600) for all Indonesian Reserves. The density reported for Batang Ai National Park (**Meredith, 1993**) was slightly lower than for Lanjak-Entimau, at about 1.2 groups/km2.

The density of white-fronted langurs appears to be uniform throughout the three regions surveyed. Both species were least common in the North, however.

MacKinnon (1987) regarded the status of the white-fronted langur as vulnerable because of restricted range and relatively low densities, and because the animals are hunted for food. The Lanjak-Entimau population is thus significant for the long-term survival of this species.

4.3 Illegal hunting and population density

Since intensity of hunting does not appear to be correlated with langur abundance in Lanjak-Entimau, habitat quality in the form of food availability is likely to be the main factor controlling size of langur populations.

5.0 Monkeys (*Macaca* sp.)

5.1 Densities of pig-tailed and long-tailed macaques

For monkeys, neither the pig-tailed macaque (*Macaca nemestrina*) nor the long-tailed macaque (*Macaca fascicularis*) were common in Lanjak-Entimau, though the data suggest that the latter is more abundant in the North, while the former is more common in the South.

Our small sample of observation of Macaques in the Sanctuary makes it difficult to draw any conclusions concerning the reasons for their existing distributions. These monkeys may be more attracted to disturbed areas and are abundant outside protected areas. Therefore they are not really of special management concern in Lanjak-Entimau.

APPENDIX IV

Summary report on the birds of the Lanjak-Entimau Wildlife Sanctuary

Robert Grubh

ITTO Ornithologist

1.0 Background

The lowland and hill dipterocarp forests of Lanjak-Entimau form an important refuge for the at least two-thirds of the known resident avifauna of Sarawak. An earlier Lanjak-Entimau expedition listed a total of 165 bird species from the Sanctuary area (**World Wildlife Fund, 1982**).

Observations of birds and mist netting were carried out over a period of 13 months at nine different locations throughout the Sanctuary (ulu Engkari, Bukit Lanjak, Sg Jelak, ulu Mujok, ulu Menyarin, ulu Ensirieng, Sg Serembuang, Sg Lelap and Sg Bloh). Bird rings with the address of the Sarawak Forest Department were made and placed on 1709 birds from 113 species.

2.0 Diversity and abundance

A total of 213 species were found in the Lanjak-Entimau, comprising 203 resident Sarawak species and 10 migrants. This represents 53% of Sarawak's resident avifauna. The avifauna by family is given in **Table 1**. About 45% of the Sarawak endemics, or 13 of 29 species, were found in Lanjak-Entimau (**Table 2**).

3.0 Ecology of the avifauna

Ecologically, about 80% of the Sanctuary's birds are dependent on trees either for foraging, nesting or both, while seven percent depend on hill streams and rivers. The remaining species (13%) exploit a wide variety of habitats or are passage migrants.

TABLE 1

Listing of the birds of Lanjak–Entimau wildlife Sanctuary and adjacent forests by family

Family Name	Examples	Number of Species Recorded	Percentage
Ardeidae	Herons, Egrets	1	6
Accipitridae	Hawk, eagle, kite	6	30
Falconidae	Falcons	1	33
Phasianidae	Pheasants, Partridges	4	36
Rallidae	Rails	1	14
Scolopacidae	Sandpipers, snipes	1	4
Columbidae	Pigeons, doves	6	40
Psittacidae	Parrots	2	66
Cuculidae	Cuckoos, Malkohas	12	54
Strigidae	Owls	5	50
Caprimulgidae	Nightjars	1	25
Apodidae	Swifts	7	75
Trogonidae	Trogons	4	66
Alcedinidae	Kingfishers	8	80
Meropidae	Bee–eaters	2	100
Bucerotidae	Hornbills	7	87
Capitonidae	Barbets	8	88
Indicatoridae	Honeyguides	1	100
Picidae	Woodpeckers	12	75
Eurylaimidae	Broadbills	5	62
Pittidae	Pittas	4	57
Hirundinidae	Swallows	2	66
Campephagidae	Cuckoo–shrikes, Minivets	3	27
Irenidae	Ioras, Fairy Bluebird	5	83
Pycnonotidae	Bulbuls	18	81
Dicruridae	Drongos	3	60
Oriolidae	Orioles	1	25
Corvidae	Crows, Jays, magpies	2	33
Sittidae	Nuthatches	1	100
Timaliidae	Babblers	26	74
Turdidae	Thrushes, chats	6	50
Sylviidae	Warblers	6	42
Muscicapidae	Flycatchers	20	62
Motacillidae	Pipits, Wagtails	2	40
Sturnidae	Starling, Mynas	1	33
Prionopidae	Bristlehead	1	100
Nectariniidae	Sunbirds, Spiderhunters	9	52
Dicaecidae	Flowerpeckers	5	45
Ploeeidae	Sparrows, Munias	1	16

TABLE 2

ENDEMIC BIRDS OF BORNEO FOUND IN LANJAK–ENTIMAU

	Scientific Name	Common Name	Recorded in LEWS
1	*Microhierax latifrons*	Whitefronted Falconet	
2	*Arborophila hyperythra*	Redbreasted Tree Partridge	
3	*Haematortyx sanguiniceps*	Crimsonheaded Wood Partridge	X
4	*Lophura bulweri*	Bulwer's Pheasant	X
5	*Batrachostomus harterti*	Dulit Frogmouth	
6	*Harpactes whiteheadi*	Whitehead's Trogon	
7	*Megalaima eximia*	Blackthroated Barbet	X
8	*M. monticola*	Mountain Barbet	
9	*M. pulcherrima*	Golden–naped Barbet	X
10	*Calyptomena hosei*	Hose's Broadbill	X
11	*C. whiteheadi*	Whitehead's Broadbill	
12	*Pitta arcuata*	Bluebanded Pitta	X
13	*P. baudi*	Blueheaded Pitta	X
14	*Chlamydochaera jefferyi*	Blackbreasted Triller	
15	*Zoothera everetti*	Everett's Ground Thrush	
16	*Ptilocichla leucogrammica*	Bornean Wren–Babbler	X
17	*Napothera atrigularis*	Blackthroated Wren–Babbler	X
18	*N. crassa*	Mountain Wren–Babbler	
19	*Cettia whiteheadi*	Short–tailed Bush Warbler	
20	*Muscicapa superba*	Bornean Blue Flycatcher	X
21	*Pachycephala hypoxantha*	Bornean Mountain Whistler	
22	*Prionochilus xanthopygius*	Yellowrumped Flowerpecker	X
23	*Arachnothera juliae*	Whitehead's Spiderhunter	
24	*Oculocincta squamifrons*	Pygmy White–eye	
25	*Chlorocharis emiliae*	Mountain Blackeye	
26	*Pityriasis gymnocephala*	Bornean Bristlehead	X
27	*Lonchura fuscans*	Dusky Munia	X
28	*Oriolus hosei*	Black Oriole	

While the bird fauna of Lanjak-Entimau presents a wide array of foraging habits, most birds (93%) partially or completely depend on a diet of insects. A total of 114 species from the Sanctuary were exclusively dependent on insects.

Fruits are taken by about 32% of the Sanctuary's birds, while around 20 % feed on small vertebrates. Even though the percentage of exclusively frugivorous (*e.g.*, fruit eating) species is relatively small compared to the number of insectivores, the amount of biomass consumed in the form of fruit is enormous because many of the frugivores are of large size or feed in flocks, such as hornbills and pigeons. Major diet components of Lanjak-Entimau birds are given in **Table 3.**

Through their feeding activities, Lanjak-Entimau birds contribute to four important ecological processes within the forest ecosystem, including pollination, seed dispersal, nutrient enrichment and biological control of insects.

A substantial number of flowering plants of the forest require visits by birds for pollination. Some relationships have existed for such a long time that flowers (*e.g.*, of the Loranthaceae) have developed special structures to attract particular bird species in order to ensure pollination (primarily flowerpeckers, sunbirds and spiderhunters).

Frugivorous birds *(e.g.*, hornbills, pigeons, bulbuls) are crucial dispersal agents for fruit trees, promoting germination and dropping seeds far from parent trees, under the shade of which seedlings are unlikely to survive.

Literally tons of nutrients rain down daily into the Lanjak-Entimau forest in the form of bird droppings. This easily absorbed source of nitrogen and phosphate plays an important role in the ecosystem's nutrient recycling.

Since more than 90% of the Sanctuary's bird species consume insects as at least a portion of their diet, the role of birds as controllers of insect pests is an important one. Outbreaks of caterpillars or flying insects are exploited, thus keeping insect populations in check.

TABLE 3

Feeding Habits of the forest birds of the Sanctuary (non–aquatic and non–nectar feeders)

Family	Examples	Number of species	Feeds on significant quantities of			
			Insects	Herpeto–fauna	Birds/ rodents	Fruits/ seeds
Accipitridae	Eagles	4		/	/	
Falconidae	Falconet	1	/	/	/	
Phasianidae	Partridges, Pheasants	5	/	/		/
Columbidae	Pigeons	5				/
Columbidae	Dove	1	/			/
Psittacidae	Parrots	2				/
Cuculidae	Cuckoos	7	/	/		/
Cuculidae	Malkohas, coucal	5	/	/		
Tytonidae	Bay Owl	1	/	/	/	
Strigidae	Owls	4	/(2)	/	/(3)	
Caprimulgidae	Nightjars	1	/			
Apodidae	Swifts	7	/			
Trogonidae	Trogons	4	/			
Alcedinidae	Kingfisher	1	/			
Meropidae	Bee–eaters	2	/			
Bucerotidae	Hornbills	7	/	/	/	/
Capitonidae	Barbets	8	/			/
Indicatoridae	Honeyguide	1	/			
Picidae	Woodpeckers	12	/			
Eurylaimidae	Broadbills	6	/ (4)			/ (2)
Pittidae	Pittas	5	/			
Hirundinidae	Swallows	2	/			
Campephagidae	Cuckoo–shrikes Minivets	3	/			
Aegithinidae	Iora, leafbirds, Fairy bluebird	5	/			/
Pycnonotidae	Bulbuls	16	/			/
Dicruridae	Drongos	3	/			
Oriolidae	Orioles	1	/			/
Corvidae	Crested Jay	1	/			
Corvidae	Magpies	1	/	/	/	/
Sittidae	Nuthatches	1	/			
Timaliidae	Babblers	27	/			
Turdidae	Thrushes, Forktails	5	/			
Sylviidae	Warblers	6	/			
Muscicapidae	Flycatchers	19	/			
Prionopidae	Bristlehead	1	/			
Percentage of species feeding upon different food sources		180	94%	20%	9%	33%

4.0 Nesting and reproduction

A majority of Passerine birds, which include 19 families in Sarawak, have been reported to breed from December to May (**Fogden, 1972**). The brood patches of 1356 individuals of 63 species from several families of passerine birds (bulbuls, babblers, flycatchers, sunbirds, spiderhunters and flowerpeckers) were examined during the course of the fieldwork.

Overall, there appeared to be two breeding peaks, one from March to May, and a second from July to September. Few or no individuals showed signs of breeding during other months.

Of the 203 bird species resident in Lanjak-Entimau, 36 species nest within tree-holes. Generally, large old trees are required for these nesting sites, providing sufficient variety of size and substrate suitable to many different hole nesters.

Certain species adapted to mature forests are adversely affected by human disturbance, including shifting cultivation and logging. Encroachment into the Sanctuary in several areas (e.g., ulu Mujok, Sg Ensirieng and Sg Kanowit) may have resulted in the disappearance of some species, including the argus pheasant. Hunting is also a factor affecting larger species such as hornbills and pheasants, which are hunted for food and for the decorative quality of their feathers.

5.0 Hornbills

Hornbills, though primarily frugivores, are known to occasionally take small vertebrates such as lizards and birds. **Leighton (1982)** reported 240 species of fruit trees visited by hornbills, though the Genus *Ficus* (producing figs) is the most important one. Others included the Annonaceae, Lauraceae, Myristicaceae and Meliaceae. These are also, incidentally, the primary food sources for orangutans and gibbons.

Trees recognised by local Iban residents as important to Hornbills include *Dacryodes rostrata*, *Ficus* spp., *Horsfieldia* spp., *Knema* spp., *Myristica* spp., *Litsia garciae*, *Cinnamomum pendulum* and *Mangifera havilandii*.

Locals also report that if the forest trees fail to produce much fruit, hornbills will not breed in that year. The unpredictable fruiting by trees in the Bornean forest requires frugivores such as hornbills to traverse large distances in search of food, so that preservation of large tracts of intact forest is necessary for the hornbills' survival.

Seven of the eight hornbill species known from Sarawak are found in the Lanjak-Entimau area. The most common are the rhinoceros and helmeted hornbills, which are well distributed throughout the Sanctuary. The other species are seen and heard occasionally, though the wrinkled hornbill was the most infrequently recorded.

6.0 Pheasants

Both Bulwer's and Argus pheasants feed on a wide variety of items, including fallen fruits, insects and other invertebrates, and even small vertebrates such as frogs and lizards.

Pheasants of the Sanctuary include the great argus (*Argusianus argus*) and Bulwer's pheasant (*Lophura bulweri*). A single sight record of the crestless fireback (*Lophura erythropthalma)* will require further verification. Pheasants though reported, were however not seen or heard in ulu Mujok and Sg Jepiu forests.

APPENDIX V

Summary report on the herpetofauna the Lanjak-Entimau Wildlife Sanctuary

Rob Stuebing

ITTO Herpetologist

1.0 Background and methods

The great diversity of herpetofauna in Lanjak-Entimau is directly related to habitat complexity found in the Sanctuary. Kavanaugh reported 38 herpetofaunal species **(World Wildlife Fund, 1982)**. Day and night sampling of both adults and larvae in mature vegetation, leaf litter and along streams led to the discovery of a total of 75 species of amphibians and reptiles at five sites over a period of six months.

Daytime sampling included systematically clearing - 56m^2 quadrats of leaf litter for small reptile, amphibia and tadpole sampling with electrofishing apparatus. Night samples were done as either stream or forest transects of approximately 500 m length 90-120 minutes walk from 8-16 workers using headlamps.

Species found totalled 49 amphibians, one turtle, 12 lizards and 13 snakes. Specimens have been deposited in the laboratory of the National Parks and Wildlife Office of the Sarawak Forest Department.

2.0 Diversity and abundance

So far, at least 26 species endemic to Borneo have been found in Lanjak-Entimau, and seven species known only from Sarawak. Among the significant finds were a frog not previously known from Sarawak (*Rhacophorus reinwardti*); a new species of frog of the genus *Philautus*; the fourth known specimen of a rare legless lizard (*Ophisaurus buttikoferi*) known only from Borneo and two previously undescribed species, a lizard (*Pseudocalotes saravacensis*); and a pipe snake, *Cylindrophis engkariensis*). Undoubtedly, there are more species awaiting discovery.

Details of sampling techniques, habitats and specimens collected are given in the ITTO Herpetologist's report (**Stuebing, 1994**)

3.0 Distribution

Overall, most of the amphibian and lizard fauna was well distributed throughout the Sanctuary (species found at all five sites). However, species of tree frogs (Rhacophoridae) and most snakes were found at only one or two sites.

No strictly montane species were obtained, even on Bukit Lanjak, though small areas of submontane and montane vegetation occur at that site (**Chai, 1995**). Lack of aquatic breeding habtitats apparently has restricted the number of frog species able to exist on Bukit Lanjak.

4.0 Conservation aspects

Threats to the Lanjak-Entimau herpetofauna are minimal at present, and it remains difficult to distinguish between active rarity of herpetofaunal species and insufficient information about their distributions. Nevertheless, a majority of the forest herpetofauna would become rare if the primary forest is sufficiently disturbed.

Many amphibians, such as frogs of the genera *Meristogenys* and *Ansonia,* to name a few, decline or disappear when rivers become silted. Shifting agriculture destroys many leaf litter species such as microhylid frogs and snakes of the genera *Calamaria* and *Rhabdophis*. The long term effects of such losses are not known.

Fortunately, shifting cultivation is generally uncommon and peripheral to the Sanctuary, and apart from opportunistic use of a several species for food (ranid frogs, turtles and pythons), exploitation of the herpetofauna by local people is not yet a significant threat.

APPENDIX VI

Summary report on the socio-economic aspects of communities residing near the Lanjak-Entimau Wildlife Sanctuary

Jiram Sidu
ITTO Sociologist

1.0 Background

1.1 Conservation goals

Lanjak-Entimau Wildlife Sanctuary lies within a region of inland hills and steep valleys, with large areas mainly of primary forest. The main community living at the periphery of the Sanctuary are Iban, who were the "pioneers" of the area with a total of 102 longhouses and an estimated population of 12,400 people.

The principal objective for developing Lanjak-Entimau as a Totally Protected Area is to preserve its unique natural environment, most importantly its flora and fauna. Socio-cultural aspects cannot be ignored however, as rural communities rely on natural forest for food, fuel, building materials and income. Conflict of interest between the Protected Area and the indigenous community are bound to occur, particularly in a situation where people have resided in the area for generations. Thus, an integral part of the Project is to involve local people in the planning and implementation, and to simultaneously raise their standard of living and to motivate them towards assuming a positive role in management and conservation efforts. Their direct participation in development of the Sanctuary will be a crucial component in fostering the success and sustainability of the programme.

The communities now living at the periphery of the Sanctuary are subsistence farmers who have only recently incorporated cash crops as part of their farming efforts. However, difficult access to markets, costly inputs and related problems often make cash crops uneconomical, resulting in few opportunities for them to supplement their income.

1.2 Identification of community needs

The socio-economic study of the communities living on the periphery of the Sanctuary has been undertaken to determine current attitudes, needs and problems in relation to future conservation and management of Lanjak-Entimau as a Totally Protected Area. Data has been collected on demography, land use and ownership, socio-economic status, economic activities, use of forest resources and general attitudes and opinions regarding the establishment of the Sanctuary.

Two sets of structured questionnaires were used, one for background information on the village through group interviews and the other for detailed information based on interviews with selected heads of households. The latter were chosen via systematic random sampling, and the number of households interviewed was proportionate to the size of the longhouse, usually about 15% of existing households (except in ulu Engkari with 28% of three longhouses only). Of the 102 longhouses within the vicinity of Lanjak-Entimau, 74 (73%) were included.

All longhouses with admitted rights under the Second Schedule of the Lanjak-Entimau Wildlife Sanctuary Order (a total of 35 longhouses, in ulu Ngemah, ulu Kanowit and ulu Katibas), irrespective of whether they had less than 10 households, were included.

2.0 Demographic characteristics

2.1 Distribution of population

Location and number of all villages and households involved in the study are given in **Table 1**. A total of 102 longhouses comprising 1,761 households with 12,398 persons were determined to be within close proximity of the Sanctuary. This figure represents 13% of the population of the Districts of Julau, Kanowit, Song and Lubok Antu, and about six per cent of the population of Sarawak.

Table 1 : Total number of Villages & households selected for the Study

Area/River System	Number of Longhouse	Total Household	No. of Respondentt
Upper Kanowit - Julau District	26 (25)	559	841 (15%)
Upper Ngemah - Kanowit District	51 (24)	747	72 (10%)
Upper Katibas - Song District	22 (22)	415	62 (15%)
Upper Engkari - L.Antu District	3 (3)	40	12 (30%)
Total	102	1,761	230 (13%)

Note: Figures in brackets refer to the number of selected longhouses and percentage of households sampled

Of the existing 1,761 households, the average household had approximately 5 members. Women outnumber men about 54:46. Some ratios were affected slightly by having one or more male members on *bejalai* (temporary migration). About 53% of the population were within the "economically active" age group of 15 and 60.

2.2 *Bejalai* and outside income

Men on *bejalai* now seek income from either unskilled work in logging camps, plantations or jobs in major towns in the construction and petroleum industries. Some communities have more than 15% of young males involved in temporary employment away from the longhouse. The custom has become an economic necessity for them to acquire savings for the family needs.

3.0 Education and Health

3.1 School attendance and educational level

The level of education is relatively low compared to urban areas of Sarawak, with only 52% of the population with education, including those still in school. The main reason given for children not attending secondary school was the distance to the schools and the

(unaffordable) costs involved. The educational level of women is about 10-15% lower than that of men, since female children are frequently confined to the home to aid in domestic chores..

3.2 Health and Sanitation

For the communities on the LEWS periphery health and sanitation facilities are limited. Most hospitals are at least a day's travel, frequently two, from the longhouse. Most clinics are so far located only in the vicinities of Julau and Lubok Antu. Most areas have a dispensary within a hour's journey or so by boat, but these facilities are usually capable of meeting and handling only the most basic health or medical needs. Malnutrition among children remains high compared to urban areas in Sarawak, with longhouses near Lubok Antu and Julau having 30-50% of children with some degree of malnourishment.

3.3 Water and electricity supply

Most water systems (except for the ulu Ngemah Resettlement area) are gravity-fed, and many are inadequate for parts of the year so that many communities still rely heavily on rivers as a source of water for domestic use.

Electricity supplies are limited, with 82% of the longhouses in ulu Katibas, 62% in ulu Kanowit and 33% in ulu Engkari still without electricity supply. Portable generators supplied under the MRP (Minor Rural Projects), or occasionally owned by individual families, are sometimes used.

4.0 Land tenure and use

Land on the periphery of the Lanjak-Entimau Sanctuary is claimed by local longhouse communities under Native Customary Rights (NCR). In pre-colonial times these rights were exercised merely through the felling of virgin forest. However, under the State Land Code of 1957, with effect on 1st January, 1958 opening of any new land requires the written permission of relevant authorities (**Zainie, 1994**). No NCR is created unless such permission is granted.

Iban families will usually claim rights over old secondary forest or *damun* cleared by them, or by their forebears, including fruit trees or other permanent plantings. Farming rights over this land are inherited in the same manner as other heirlooms or property. Use of virtually all land on the periphery of Lanjak-Entimau has been acquired in this way.

The majority of households in the peripheral communities occupy cultivated or fallow land, averaging about 20 ha per household. This varies, however, between areas. Whereas those households from communities on the northern and western boundaries of Lanjak-Entimau have usually from 5-200 ha of land, 92% of ulu Engkari households possess only eight hectares, or less. Approximately 1-10% of the households of all the surrounding communities have no land at all.

Disputes can arise over ownership of cleared land or even uncut forest (*pulau kampong*) near the longhouse. Furthermore, traditional claims over a long period often make local people skeptical about any development plan involving resettlement (since absentee claims have never been recognised under the State Land Code. The original gazettement of Lanjak-Entimau in 1983 sought to offset some of these problems by granting special privileges to certain communities in ulu Ngemah, ulu Kanowit and ulu Katibas for collecting forest produce.

5.0 Farming and protein sources

5.1 Crops and cultivation cycles

Land is kept primarily for the production of hill rice, cultivation of which is done by 94% of all households near the Sanctuary, who cultivate anywhere from 0.5-6 hectares each. Yield (kilograms per hectare) ranges from 464 in the Kanowit area to 590 in the area surrounding Lubok Antu.

After harvest, the land must be left fallow. Until several decades ago, such land would have remained fallow for at least 20 years to allow regrowth of closed canopy forest. Land shortages faced by most households, however have caused the fallow period to be shortened to as little as five years in up to 79% of the cultivated land. This shortened cycle reduces fertility while increasing losses to insect and plant pests. Near the Lanjak-Entimau boundary, additional losses are regularly caused by wild pigs, monkeys and other wildlife from the forest.

Virtually all households now face a chronic shortage of rice. The proportion of the households having insufficient rice ranges from 60-70% in ulu Ngemah, to only 30-40% in ulu Kanowit and ulu Katibas, with the figure for ulu Engkari somewhere in between. This situation forces most Iban households near Lanjak-Entimau to purchase rice from traders in the towns, eroding the community's already meagre cash reserves, leading to demands for more land. Dependence on produce collected from the forest (rattan, mengkuang, wild vegetables and game) also increases.

Often thought to be a solution to this dilemma, cultivation of cash crops such as rubber, pepper, cocoa, or fish and livestock rearing has only partially succeeded. A number of these crops, particularly pepper and cocoa, require costly maintenance in the form of pesticides and fertilisers, beyond the means of most farmers given the already high cost of transporting the produce to market **(Appendix IX).**

5.2 Socio-economic consequences of land shortages

A widespread shortage of land forces farmers to reduce the fallow period of their "temuda" (secondary forest) leading in turn to reduced yields of their staple crop, rice. Poor crop production is also intensified by the loss of working male members who seek cash income away from the longhouse, resulting in neglect of farms and gardens. The Iban of the Lanjak-Entimau area remain isolated, and face a lack of crucial infrastructure and services, revolving around poor transport facilities to major towns. This in turn limits their ability to acquire capital, either via sale of produce or part-time employment. Income for heads of households from communities on the Sanctuary's periphery averages less than half of the State Poverty line income level of RM495/month, causing negative impacts on health and education, and increased pressure on the Sanctuary.

6.0 Hunting

Hunting and fishing are indispensable to the Iban communities residing near Lanjak-Entimau for obtaining sufficient protein in their diet. All longhouses are involved in hunting to some degree, and the target species is the bearded pig, though other game are taken opportunistically. Most hunting is reported to take place outside the Sanctuary, though incursions into it are perhaps not uncommon. Nevertheless, local farmers report that they most frequently hunt in their own temuda (in the game seasons), where they

often plant certain crops as an attractant to wild game. Hunting success is given in **Table 2.**

Table 2 : Average number of animals obtained per hunting trip

Area	Average number per trip			
	Wild Boar	Deer	Barking Deer	Other Animals
Ulu Kanowit	3.4	1.4	1.7	1.5
Ulu Ngemah	1.4	3.0	2.0	0.0
Ulu Katibas	1.6	1.3	1.4	1.6
Ulu Engkari	1.0	0.0	0.0	0.0
Overall	1.8	1.9	1.7	1.5

7.0 Fishing

Subsistence fishing is one of the most important activities of the longhouse communities, which usually depend on a consistent catch (about 2-3 kg/day) as the protein supplement to daily meals of rice. Intensive fishing is done via cast nets, gill nets and rarely through the use of poison.

Fish catches are reported to have declined significantly. Certain kinds of highly prized fish (*e.g., ikan tenggadak*) are now uncommon, their scarcity reflected in their market price of RM60-70 per kg.

8.0 Use of Wild vegetables

In addition to hunting and fishing, high percentage of longhouse residents depend on wild vegetables as an important component of their diet. **(Table 3)**

Table 3 : Percentage of households involved in collection of wild vegetables

Wild Vegetables	Upper Katibas		Upper Ngemah		Upper Katibas		Ulu Engkari		Total	
	Freq	%	Freq	%	Freq	%	Freq.	%	Freq.	%
Daun sabung	81	95	58	81	14	23	n.a	0	153	67
Kepayang	43	51	41	57	16	26	n.a	0	100	43
Paku	57	68	68	94	50	81	n.a	0	175	76
Miding	77	92	70	97	29	47	n.a	0	176	76
Tubu	78	93	70	97	51	82	n.a	0	199	87
Kulat	46	55	30	42	22	35	n.a	0	98	43
	n=84		n=72		n=62		n=12		n=230	

n.a. - Data not available

*Daun sabung (*Gnetum gnemon*) , Kepayang (*Pangium edule*), Paku (*Athyrium esculentum*), Miding (*Stenochlaena palustris*), Tubu (*Saccharum* sp.), Kulat (Edible fungi).

9.0 Community relations

9.1 Attitudes towards the forest

Forested areas are still viewed positively as a source of stability and sustenance. However, since the Iban community has no tradition of planting trees, and since land rights might appear threatened, people of the Lanjak-Entimau area remain suspicious of large scale estate or agroforestry developments. Nevertheless, they generally support preservation of virgin areas as long as they retain some harvesting rights over local forest products.

9.2 Attitudes towards regulations and enforcement

Limited opportunities to earn a living cause a dependence of Sarawak's interior people on the surrounding forests not only to supply their basic needs, but to supplement their diet and income. For this reason the longhouses in closest proximity unconsciously exercise informal control over their immediate areas to ensure a constant supply of food and other jungle products.

Interestingly, seventy per cent of respondents in the LEWS survey supported strict enforcement of regulations regarding the Sanctuary, including a ban on logging. On the other hand, for some more densely populated areas such as parts of ulu Ngemah and ulu Katibas, residents expressed interest in agricultural development schemes.

Other perceived needs were more involvement of locals in administration of the area, and a desire for more Wildlife Ranger (NPWO) posts. In addition, there were requests for more areas of communal forest (e.g., *pulau kampong*), and the direct participation of longhouse leaders, or *Tuai rumah*, as (paid) honorary wardens of the Sanctuary.

10.0 Local infrastructure

Lanjak-Entimau is still relatively isolated, and is not yet accessible by road. Travel to the Sanctuary involves links by either by air or by road to particular access or "jumping off" points, from which the boundary can be reached in varying lengths of time, from about half an hour to approximately one day **(Table 4)**.

The Lemanak River is the only non-navigable gateway to Lanjak-Entimau, but the boundary at Lemanak is accessible by timber road (via the STK Stolak Camp, Pakan).

River travel is possible in most months of the year except during the northeast monsoon, when rivers can experience dangerous flash floods. Travel during the dry season of July-August can also be difficult when water levels drop too low, and longboats have to be dragged with great difficulty over numerous shallow areas.

Table 4 : Transportation access points to Lanjak Entimau Wildlife Sanctuary as of 1995

Area	Access Point	Forms of transport	Travel Time to LEWS boundary from staging point	Form of transport
ulu Engkari ulu Batang Ai	Lubok Antu	Road	6 hours (Ng Segerak) 2 days (Ng Giling)	Longboat Longboat (through Btg Ai National Park)
Sg Skrang	Pakan-STK Stolak Camp	Road	3 hours (Ng Serembuang)	Landcruiser & longboat (Sg Skrang)
Sg Mujok & ulu Ensirieng	Kanowit	Road	1 day (Jemarang)	Longboat
ulu Poi	Kanowit	River	5 hours (Ng Bilat)	Longboat
ulu Ngemah	Sibu	Air road or river	1 day (Rantau Lugai)	Longboat
ulu Katibas Sg Latong & Sg Ngemang	Song	River	1 day (Ng Bloh)	Longboat

APPENDIX VII

CONCLUSIONS

Biologically, Lanjak-Entimau Wildlife Sanctuary is one of Sarawak's richest natural areas. Its stable climate, wide range of topographical features and mosaic habitats created a range of unique and diverse communities.

Conservation prospects for biodiversity in this part of interior Borneo have been greatly enhanced by the inclusion of Lanjak-Entimau with the Bentuang-Karimun Reserve in West Kalimantan, Indonesia. The two reserves form a trans-border protected area of pristine tropical forest which is one of the largest in the world.

Thousands of species of plants and over eight hundred species of vertebrate animals live within the Lanjak-Entimau Sanctuary. Insects contribute additional thousands of species. In less than one year, three species of plants, two species of reptiles, two species of fish and a crab, all new to science have been discovered

Beyond these discoveries, which have merely scratched the surface, is the role of the Sanctuary as a permanent reserve for seed stock and seedlings.

This bank for genetic material from ancestral varieties of timber and fruit trees, and other biological resources, provides for the renewal or improvement of genetic quality of commercial species. This forms a crucial backup system for the agriculture and forestry sectors of the State and National economy.

Research into ecological processes within the forest will advance our understanding of the principles important for sustainable forest management.

Lanjak-Entimau also serves to protect the watersheds of two of Sarawak's main rivers, and to preserve and maintain water quality for the Batang Ai Reservoir. A supply of clean water will be an increasingly important resource for the future.

Finally, the Sanctuary forms an important spiritual heritage for the people of Sarawak as one of the last great virgin forests of the interior. Its magnificent beauty optimizes Borneo's dynamic strength, pristine natural beauty and remarkable diversity, as one of the world's oldest and most majestic tropical rain forests.

Lanjak-Entimau, along with Sarawak's other protected natural areas, will inspire a sense of community and common heritage for the people of Sarawak, Malaysia and the region.

APPENDIX VIII

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APPENDIX IX

SUMMARY OF THE INBIO PROGRAMME, COSTA RICA*

1 BACKGROUND

On June 5, 1989, a Presidential Executive Decree established the INBio Planning Commission with representatives from different government agencies, institutions of higher education, and conservation NGO's. This Commission recommended that INBio be created as a non-profit, private organization for the public good. This legal structure enabled INBio to satisfy the critical need for an organisational flexibility specifically designed to handle the very rapidly expanding field of biodiversity management and confront many of INBio's tasks - such as the large and complex inventory process, publicising Costa Rican diversity, the promotion of non-destructive use of biodiversity by the commercial world, networking internationally with a multitude of other biodiversity management institutions, and the urgency of planning and fund-raising.

The INBio Association was legally registered on 26 October 1989 and is governed by an Assembly of Founders and a Board of Directors. Many of INBio's activities involve close and harmonious integration with a large number of different public and private institutions both Costa Rican and foreign.

Operating under the assumption that a tropical society will conserve a major portion of its wild biodiversity only if protected areas can generate enough intellectual and economic income for its own upkeep. INBio, based on a partnership of cooperative support and guidance with the Ministry of Natural Resources, Energy and Mines (MIRENEM), has agreed to carry out the processes of inventory, biodiversity prospecting and information management and dissemination on Costa Rica's biodiversity in accordance with the existing legal framework. INBio anticipates being able to conduct the national biodiversity inventory within a decade of receiving its first inventory funding, and to continue organizing and using the information generated by the inventory into perpetuity.

Only by understanding biodiversity can we protect it, manage it, and help society use it without destroying it. Today we understand only a minute fraction of Costa Rica's species and how they interact. What do they eat? What do they produce? Where are they/ How fast do they replace themselves? On whom do they depend? How can we grow them? How tolerant are they of perturbation? Where else can they grow? These and many more management and production questions require a very focused, on-site, day-in and day-out examination of the biodiversity in a country's conserved wild lands. And that examination will only be carried forth with care, enthusiasm, dedication and perseverance by the people of the nation where this biodiversity lives.

* (Source: InBio Internet Resource)

The biodiversity inventory of Costa Rica's wildlands builds on a long history of specialised inventory of fauna and flora conducted by national and international researchers. It is intended to gather information about all taxa and to involve broad national participation in the process of gathering such information. The basic field work is being conducted by a small army of lay people trained into the vocation of the "parataxonomist". The paratoxonomist is not merely a collector, but is also the initial cataloguer of specimens and a more immediate link to the communities which live in and around Costa Rican wildlands teaching them about their local environment. Parataxonomists receive feedback, planning and guidance from INBio's staff of curators who work within a larger network of national and international curators and taxonomy experts.

The first goal is to accumulate the specimens necessary to clean up the taxonomy of Costa Rica's biodiversity in both a national and international context (completing and taxonomically organising already existing collections) with the knowledge of at least one site of occurrence in Costa Rica for a given organism. "Taxonomic cleanliness" will take the form of identified reference collections, field guides a^Nd electronic identification services such as expert systems. In the long-term, the inventory will establish species' ranges in more detail and begin the process of understanding their natural history and other properties.

The parataxonomists come from many different sources, both private and governmental. They work out of biodiversity offices scattered across the country's habitats and conserved wildlands. The parataxonomist supplies the specimens and other field data which flow into INBio where they are processed into the collections of the National Biodiversity Inventory, the National Biodiversity Information Management System and out into the international network of taxonomists and collections while simultaneously developing local expertise. All information on the identities, geographic distributions, and natural history are in the public domain and will be freely networked with the world-level exchange system for biodiversity information.

2 BIODIVERSITY PROSPECTING PROGRAM

The search and developing of interesting new chemicals and genes is critical to INBio's biodiversity conservation efforts. At present, these efforts are focused on the search for chemicals produced by plants, insects and micro-organisms that may be of use to pharmaceutical, medicinal and agricultural industries. Through biodiversity prospecting activities, INBio intends to facilitate the flow of Costa Rican wildland biodiversity information into the research and development process where the investigation of potentially valuable natural substances can being.

The biodiversity prospecting and research processes are carried out in collaboration with labour and international research centers, universities and the industrial sector. These relationships offer important opportunities to quickly and effectively train Costa Rican scientists and personnel for laboratory and field work. At the same time, these collaborations generate income to support the country's conservation activities and promote market driven research and sustainable economic

development. The research budgets given by the user contribute to the proper care and maintenance, through the Ministry of Natural Resources, Energy of Mines (MIRENEM) for Costa Rican conserved wildlands, as well as support INBio's inventory and biodiversity information management processes.

Typical research agreements include a minimum ten percent donation to the Ministry of Natural Resources, Energy and Mines to help defray the direct cost of biodiversity upkeep, technology transfer in equipment, training of local scientists, compensation for services and information as species identification, sample collection and preparation, voucher collections, data management, administration, etc. The remainder of the research budget supports the in-country science and processing infrastructure and continues the biodiversity inventory of all kinds of users. In the event that other benefits were derived from a successful research product, fifty percent of the royalties awarded to INBio would be donated to the Costa Rican National System of Conservation Area through MIRENEM and the other half would be used to continue the INBio process. The landmark partnership between INBio and Merck & amp. Co., Inc. is an example of this.

Costa Rica's wildlands are in effect an enormous library we are just learning how to read. As the investigatory process of biodiversity prospecting continues, the world's pharmaceutical, medicinal and agricultural fields will advance significantly while Costa Rica itself benefits from continued financial support for its protected wildlands and an eventual contribution to its economic development.

INBIO's biodiversity information (specimen data, literature and field data) is rapidly growing, and when coupled with relevant supporting information such as topographic maps, soil maps, climate data, land use, and much more, the data package is extremely complex. This data package requires a capacity of analysis, management, presentation, distribution and integration not yet achieved by any set of biodiversity users in the world. INBio is now bringing cutting edge technology in GIS and data base management and development to bear on this challenge. The basis of this is a new partnership with the Intergraph Corporation of Huntsville, Alabama, USA, and a close companionship with many ongoing efforts (by a wild array of scientific and conservation organisations) at computerising and networking biodiversity information. This process will seek out promising new technologies, including artificial intelligence and field data collection devices such as GeoPositioning Systems.

INBio's goal is to become a highly capable in information management for its own internal operation as well as being able to present information in appropriate formats for an extremely wide range of users throughout society. In addition, INBio accepts the responsibility of adjusting its interface to the user's level of computer literacy and making potential system users aware of what INBio has to offer.

APPENDIX X

TERMS OF REFERENCE : INTERNATIONAL CONSULTANTS

PROJECT LEADER

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

(i) Initiate and direct the implementation of the Lanjak Entimau Wildlife Sanctuary Entimau Management Plan in collaboration with the Sarawak Forest Department

(ii) Oversee the construction of the Sanctuary facilities

(iii) Recommend appropriate international and local experts to work in Botany, Zoology and Community Development programmes

(iv) Supervise and coordinate research work in the Sanctuary.

(v) Organise and implement a programme of community consultation for the Sanctuary

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

(vii) Produce mid-term and final progress reports for Phase II

(viii) Produce a Ten-Year Plan and vision statement for the development of Lanjak Entimau as a Totally Protected Area

Duration: 30 person-months, International

BOTANIST

(i) To set up permanent experimental plots in the major vegetational habitats of Lanjak, provide instructions for data acquisition and initiate permanent data/record keeping format

(ii) Supervise local consultants, data gathering and technique and be responsible for reporting the results of the botany-related projects.

(iii) Monitor all botanical studies with regular visits to field sites and discussions with local experts.

(iv) Identify seed bank areas for economically significant tree species and in conjunction with the local consultant develop a monitoring and protection programme for the latter

(v) Supervise entry of all botanical data into the data into the Project's GIS data base

(vi) Provide interpretive information on selected botanical communities for the Field Centre educational programme

(vii) In consultation with the local experts, make recommendations on the best methods to manage sensitive rare or important species and communities.

(viii) In collaboration with local consultants, produce a summary report on all significant research findings and the results of community-related work in botanical diversity and ethnobotany. ,

(ix) Identify potential areas for future research and monitoring effects.

Total duration: 8 person-months, International

ZOOLOGIST

(i) Advise and coordinate the zoological studies in the Sanctuary, including preparation of experimental design and data gathering techniques in consultation with local experts.

(ii) Monitor all zoological studies with regular visits to field sites and discussions with local experts.

(iii) oversee data analysis and its entry into GIS format.

(iv) In collaboration with the local consultants produce a summary report on all significant research and all results of community-related work in zoological diversity.

(v) Identify potential areas for future research and monitoring efforts.

(vi) Organise and compile relevant information on vertebrates and invertebrates for the Sanctuary's interpretative/training programmes.

(vii) In consultation with local experts, make recommendations on the conservation and management of the Sanctuary's vertebrate species.

Duration: 8 person-months, International Consultant.

COMMUNITY DEVELOPMENT CONSULTANT

The terms of reference for the Community Development Consultant will be to:-

(i) In collaboration with local experts and the staff of the National Parks and Wildlife Section of the Sarawak Forest Department initiate and maintain consultative discussions with local communities on the boundaries of the Sanctuary concerning management and training activities.

(ii) In consultation with the Project Botanist and Zoologist, design and conduct workshops in biotechnical skills (ecology, taxonomy, conservation, experimental management) and ecotourism for NPWO staff and members of the local community

(iii) In consultation with local experts and members of participating communities, develop ethnobotanical gardens and the cultivation of non-timber, biodiversity-based resource of selected sites within the Buffer Zone.

(iv) In consultation with the Project Botanist and Zoologist and local experts, produce simple manuals for the successful cultivation of the above biodiversity resources which are suitable for use by other all communities on the boundaries of the Sanctuary.

(v) Ensure that all data from development project relevant to the GIS record is entered into the Lanjak Entimau database

(vi) Be responsible for the mid-term and final reports on all Community Development Projects for the Sanctuary.

Duration: 8 person-months, International Consultant

HYDROLOGIST

In the context of the construction and operation of the Hydrological/climatological stations in Lanjak Entimau, the Hydrologist will:-

(i) Supervise construction and installation of climatological stations, and prepare instructions for data collection and ensure personnel are instructed in and available to make collection of data and its storage

(ii) Supervise all data collection and be responsible for reporting the results, as well as instruct Forestry staff in the writing of such reports

(iii) Develop a format and operation manual for permanent data collection from the hydrological/climatological stations in Lanjak Entimau

Total duration: 3 person-months, Local

GAME MANAGEMENT SPECIALIST

As part of the research programme for Lanjak Entimau, the Game Management Specialist will:-

(i) Obtain estimates for densities of game species (*Cervus unicolor, Muntiacus* spp. and *Sus barbatus*), in specific areas of the reserve

(ii) Determine through consultative discussions with local communities the rate of removal (harvest) of the most important game species in the buffer zone

(iii) Submit a written report on the research findings to the Project Zoologist.

(iv) Recommend a game management (including a registration) programme for hunters of the Buffer Zone areas on the periphery of Lanjak Entimau

(v) Enter all relevant data into the Project GIS data base

(vi) Provide on the job technical training local workers and Forest Department staff involved in the game management programme

Duration: 6 person-months, Local

MAMMALOGIST (Small mammals)

In conjunction with the biodiversity inventory of Lanjak Entimau, the mammalogist will:

(i) Conduct an inventory of the small scansorial and flying mammals of Lanjak Entimau

(ii) Investigate the socio-economic importance of the small mammals of the Sanctuary

(iii) Identify major seed predators and fruit dispersers among the small mammal community

(iv) Train the local counterpart on the identification of small mammal species

(v) Make a synoptic collection of the small mammals of Lanjak Entimau

(vi) Enter all relevant data into the Project GIS data base

(vii) Be responsible for writing the report on the findings of the survey (and a checklist of the small mammals of the Sanctuary)

Duration: 6 person-months, Local

ENTOMOLOGIST

In conjunction with the biodiversity inventory of Lanjak Entimau, the entomologist will:-

(i) Continue and expand the surveys begun under Phase I of the project

(ii) Survey canopy insects at a minimum of one site

(iii) Make a reference collection of insects for Lanjak-Entimau and enter all relevant data into the Project GIS data base

(iv) Train a local counterpart in identification and other relevant taxonomic techniques

(v) Make a list of insects with potential for research into bioactive compounds

(vi) Be responsible for the report on the findings of the surveys/inventory

Duration: 8 person-months, Local

HERPETOLOGIST

In the context of the biodiversity inventory of Lanjak Entimau, the herpetologist will:-

(i) Continue and expand the inventory of the herpetofauna begun during Phase I, at new sites

(ii) Make a reference collection of herpetofauna for Lanjak Entimau and enter all relevant data into the Project GIS data base

(iii) Make a check list of the herpetofauna of Lanjak Entimau

(iv) Make a list of herpetofaunal species with potential for research into bioactive compounds

(v) Identify and initiate monitoring of populations of several key herpetofaunal species

(vi) Be responsible for producing a report on the findings of the surveys

Duration: 6 person-months, Local

ICHTHYOLOGIST

In conjunction with the biodiversity inventory of Lanjak Entimau, the ichthyologist will:-

(i) Conduct surveys of the fish fauna in rivers and streams of the Sanctuary

(ii) Collaborate with the Project Herpetologist on the collection of amphibian larvae

(iii) Make reference collections of the fish collected from Lanjak Entimau, produce a check-list of species and enter relevant data into the Project GIS data base

(iv) Estimate fish stocks of major rivers of the Sanctuary via empirical sampling and consultative discussions with local residents

(v) Produce a plan for sustainable use naturally occurring fish stocks, and advise on the local species appropriate for fish culture (in collaboration with Forestry and Agriculture Department officials)

(vi) Be responsible for writing the report on the findings of the surveys

Duration: 6 person-months, Local

ETHNOBOTANICAL-HORTICULTURALIST

In conjunction with the Lanjak Entimau community development programme, the Ethnobotanical-horticulturalist will:-

(i) In collaboration with the Plant Taxonomist, identify plant species of traditional importance or medicinal value to be cultivated in the secondary forests of the buffer zone or within special plots adjacent to local settlements

(ii) Assist in the development of ethno-botanical gardens of herbs and medicinal plants as a business venture for local communities

(iii) Develop a manual for the cultivation of local herbs or medicinal plants with economic potential

Duration: 12 person-months, Local

FORESTER/NON-TIMBER PRODUCTS SPECIALIST

In conjunction with the Lanjak Entimau Community development programme, the non-timber forest products specialist will:-

(i) Assist to develop the cultivation of saleable non-timber products (biodiversity resources) such as forest fruits, rattan and in the buffer zones surrounding the Sanctuary involving local communities

(ii) Assist in the development of products derived or manufactured directly from non-timber raw materials from the forest

(iii) Develop marketing strategies for such products in cooperation with community leaders and officers of the Sarawak Forest and Agriculture Departments

(iv) Enter relevant information on the kinds and suitable areas for cultivation of non-timber resources in the Buffer Zone.

(v) Produce a report on the potential of local products and their marketing strategies.

Duration: 6 person-months, Local

TRAINING CONSULTANT ; ECO-TOURISM

(i) Develop and implement courses in ecotourism development for local communities, involving the Buffer Zone or designated areas on the periphery of the Sanctuary

(ii) Produce a manual for the exploitation of eco-tourism opportunities by local communities

(iii) Liaise with Lanjak Entimau scientific consultants for relevant interpretive materials

Duration: 4 person-months, Local Consultant