Biodiversity Survey

In the Sub Watershed Embaloh, Betung Kerihun National Park

ITTO PD 617/11 (F) Rev.3

Promoting Biodiversity Conservation in Betung Kerihun National Park (BKNP) as a Transboundary Ecosystem between Indonesia and state of Sarawak, Malaysia (Phase III)

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Editor:
Yani Septiani
Dr. Hiras Sidabutar

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Introduction

A survey in order to update data and information on biodiversity in Betung Kerihun National Park (BKNP), especially in the Sub Watershed Embaloh, which is one of the activities in: "Promoting Biodiversity Conservation in Betung Kerihun National Park (BKNP) as The Trans-boundary Ecosystem between Indonesia and State of Sarawak Malaysia (Phase III) - PD 617/11 (F) Rev.3". The project is a continuation of the ITTO Project 26/93 with the title "Development of Bentuang Karimun Nature Reserve as a National Park, Phase I" which was conducted by WWF Indonesia together with the Directorate General for Forest Protection and Nature Conservation during 1995 – 1999. This project aims to provide field activities in order to establish a program of conservation and community based development that can maintain the continuity of the integrity of BKNP. This first project was followed by a phase II project entitled "Implementation of a Community-Based Transboundary Management Plan for the Betung Kerihun National Park, West Kalimantan, Indonesia". Phase II of this project aims to build an effective model for managing cross-border national park with Lanjak Entimau Wildlife Sanctuary (LEWS) in Serawak, Malaysia.

The result of updating of the data and information on biodiversity of BKNP is expected to be the basis for the development of BKNP biodiversity conservation efforts as well as supporting socio-economic development initiatives of local communities. In addition, the data and information obtained could support the process of strengthening the sustainable conservation management in BKNP as transboundary ecosystem between Indonesia (West Kalimantan) and Malaysia (Serawak).

On this occasion, we would like to thank all those who have helped since the preparation, the implementation of field activities until the completion of this report. We also recognize that this report is still not yet perfect so that constructive criticism and suggestions will be very beneficial for the implementation of future activities.

Hopefully this report may be useful, especially for strengthening the management of BKNP biodiversity.

Jakarta, March 2015

Yani Septiani
Project Coordinator of ITTO PD 617/11

Foreword

Thank God we the Drafting Team pray to the Almighty God for all his blessings so the implementation of the activity through to the preparation of the report was completed in time. Biodiversity survey was carried out in order to Update Data on biological diversity in Sub Watershed Embaloh in the Betung Kerihun National Park area.

The Drafting Team realized that the implementation of the activities through to the compilation of the report often experienced constraints and shortcomings so that it is still far from perfect. We very much welcome any constructive suggestions and criticisms from all parties concerned in order to improve the quality of the implementation of similar activities in the future.

Hopefully this report will be useful.

Implementing Team

Implementing Team

1. **Consultant**	:	Wandojo Siswanto
2. **Implementation Team**		
• **Flora**	:	Aripin
	:	Ahmad Godjali Garda
	:	Feri Iswanto
• **Mamals & Primates**	:	Lulu Sutrisno
	:	Aris Munandar
	:	Wresni Endrata
• **Birds**	:	Tulus Pambudi
	:	Syarief M. Ridwan
	:	Suka Prandika
• **Herpetofauna**	:	Nur Rohman
	:	Hari Ramadhani
	:	Damiati
	:	Mustarudin
• **Fish**	:	Irawan Hadiwijaya
	:	Sabarudin
• **Insects**	:	Ruhyat Hardansyah
	:	Fajar Setiawan
	:	Arifudin
3. **Supervisor**	:	Achmad Zaini
	:	M. Wahyudi
	:	Andi M. Khadafi
4. **Advisors**	:	Secretariat of Directorate General PHKA
	:	Head of Balai Besar BKNP

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Introduction

1.1 Background

Betung Kerihun is an area of pristine tropical forests, covering 800,000 ha situated between 112°15'-114°10' longitude East and 0°0' - 1°35' latitude North, along the border of Indonesia (District of Kapuas Hulu, West Kalimantan province) with Malaysia (*State of Sarawak*). Earlier, in 1982, the Minister of Agriculture has designated the place as a Nature Reserve with an area of 600,000 ha and named it *Bentuang Karimun*. Then, in 1992, the Ministry of Forestry expanded the area of the Nature Reserve to 800,000 ha by Decree No. 118/ Kpts-II/1992 dated February 11, 1992[1]. In line with the development of the cooperation between Indonesia and Malaysia in the field of forestry, especially related to the importance of the conservation of biodiversity and the management of transboundary protected areas, the Government of Indonesia changed the status of the area to become a National Park through a Decision by the Minister of Forestry No. SK. 476/Kpts-II/1995 dated 5 September 1995 with the name Bentuang Karimun National Park[2]. However, due to the difference in the name of the location in the Decree and the name that is known by the local communities, then by Decree No. 510/Kpts-II/1999 of 30 June 1999, the Minister of Forestry and Plantation changed the name of Bentuang Karimun National Park to become the ***"Betung Kerihun National Park"*** (TNBK).

Given its location on the border of the country, then in addition to the border region, TNBK was also established as part of the trans-boundary reserve first in Asia, along with the *Lanjak Entimau Wildlife Sanctuary* (LEWS) and *Batang Ai National Park*/BANP located in the State of Sarawak, Malaysia. In addition, TNBK is also an important part of the "*Heart of Borneo*", that is the rain forest region covering an area of 220,000 square kilometers which crosses the boundaries of Indonesia, Malaysia and Brunei, covering lowlands up to the hills and is interconnected, consisting of conservation areas and areas of cultivation which are managed in a sustainable way, to ensure the protection and preservation of biodiversity and water resources for the well-being of various parties at local, national, and international levels[3].

The topography of BKNP (TKNP) is hilly and largely mountainous with at least 20% of its area having an elevation of over 700 m above sea level. Hills and mountains are part of a complex of mountains with the highest peak Muller 1,790 m above sea level, which is the peak of Mount Kerihun located at the eastern part connected by mountains and hills with Mount Betung (1,150 m above sea level) in the western part of the area. Conditions of the pristine forest with hills and mountains makes this area as the rainwater catchment area as well as the headwaters of the rivers and it is important in the region which is also part of the Watershed (DAS) of the Kapuas. As a hydrological area BKNP is divided into 5 (five) Sub DAS, namely Sub DAS Embaloh in the West, Sub DAS Sibau-Menjakan and Sub DAS Mendalam in the middle, as well as Sub DAS Hulu Kapuas/Koheng and Sub DAS Bungan in the East[4].

The diversity of the ecosystem of the BKNP area is high with good vegetation conditions which is relatively intact. Based on the results of the survey/analysis of the vegetation/flora that has been done before, there are eight types of forests in this area, namely: Low Land Dipterocarp Forest, Alluvial Forest, Swamp Forest, Old Secondary Forest, Hill Dipterocarp Forest, Limestone Forest, Sub-Mountain Forest, and Mountain Forest[4]. Although the topographic conditions are hilly and mountainous, most

[1] Regarding Taman Nasional Betung Kerihun. http://betungkerihun.dephut.go.id/tentang_kami.html.

[2] Betung Kerihun Transboundary expedition - Batang Ai/Lanjak Entimau. http://www.wwf.or.id/?29160/Ekspedisi-Lintas-Batas-Betung-Kerihun-Batang-AiLanjak-Entimau

[3] HoB (Heart of Borneo).http://www.wwf.or.id/program/wilayah_kerja_kami/kalimantan/heart_of_borneo/

[4] National Park Management Plan/RPTN Betung Kerihun Periode 2000-2024, Buku I.

types of forest ecosystems found here are Lowland Dipterocarp forest which is dominated by the genus Dipterocarpus, Dryobalanops, Hopea, Parashorea, Shorea, and Vatica.

Diverse ecosystem types as well as topographic and hydrological conditions of the area strongly support the growth of various types of vegetation making it an extremely rich diversity of plants (flora). Based on the results of an earlier plant survey as many plant species as 1,217 were identified which belong to 418 genuses and 110 families, of which 75 species are endemic to Borneo. Those surveys also found 14 new species of plants among others a new species of forest (wild) banana *Musa lawitiensis* Nasution & Supardiyono Spec. Nova, and new species of palm *Pinanga bifidovariegata* Mogea Spec. Nova. The types of trees identified that grow in the area are totaling 695 species belonging to 15 genus, and 63 of them native of which 50 tree species are endemic to Borneo. In addition, also various species was found of palms, orchids, epiphytes as well as mosses and ferns which have been collected so that the richness of the flora of the National Park area became very high, thus among others it can be described with a high diversity of mosses that numbered 87 species, which are much higher than in the tropical forests of Kilimanjaro, Africa that has only 20 species of epiphytic lichens as well as the Latin American region (Siera Maestra in Cuba and the Andes in Bolivia) where only 28 species were found.

The diversity of animal species in the BKNP area is also quite high, both of which are protected or not protected. This area is home to 48 species of mammals including rare species according to *International Union for Conservation of Nature and Natural Resources* (IUCN) categories which is also known as the *World Conservation Union*, among others there are Clouded leopard (*Neofelis nebulosa*), Asian Leopard Cat (*Felis bengalensis*), Malayan sun bear (*Helarctos malayanus euryspilus*), Red muntjac, common muntjac or barking deer (*Muntiacus muntjak*), Bornean yellow muntjac (*Muntiacus atherodes*), Sambar deer (*Cervus unicolor brookei*), and Mousse Deer (*Tragulus napu borneanus*) as well as Hairy-nosed otter (*Lutra sumatrana*). Other species of mammals that can be found are 18 species of bats (Chiroptera), 17 species of rodent groups, and 11 species of squirrel/ chipmunks. In this area 7 species of primates can be found, Orangutans (*Pongo pygmaeus*), Gibbon (*Hylobates muelleri*), White-fronted surili (*Presbytis frontata*), Maroon leaf monkey, or Red leaf monkey (*Presbytis rubicunda rubicunda*), Pig-tailed macaque (*Macaca nemestrina*), Long-tailed macaque, or Crab-eating macaque (*Macaca fascicularis*) and Tarsiers (*Tarsius bancanus borneanus*)[5].

The diversity of bird species in the region is also quite high as 301 species has been identified belonging to 151 genus and 36 clans (families), and 24 of them are endemic to Borneo and 63 species are included among the protected species. Bird species of the family *Bucerotidae* is the most prominent in this area, there is the Wreathed Hornbill (*Aceros undulatus*) and the Helmeted Hornbill (*Rhinoplax vigil*) which is the mascot of West Kalimantan Province. In addition, 103 species of herpetofauna (amphibians and reptiles) have been successfully identified which is composed of 51 species of amphibians, 26 species of lizards, 2 types of crocodiles, 3 types of turtles, and 21 species of snakes. From the identification of the fish species known to exist 112 species of fish belongs to 41 genera and 12 families. For insect species only, as many as 170 species could be identified, including 25 species of ants that belongs to the genus *Hagaiomyrma, Myrma, Myrmhopha* and *Polyrhachis*.

The purpose of the designation of Betung Kerihun as a national park is to protect and to preserve the riches of species of plants and animals to use sustainably for a variety

[5] Betung Kerihun National Park. http://www.dephut.go.id/INFORMASI/TN%20INDO-ENGLISH/tn_betung.htm

of purposes, both for the current and the future generations. Therefore, the riches of the biodiversity that has been revealed through analysis of previous surveys need to be monitored regularly and updating through inventory activities. This activity is a collection of data and information on biodiversity that will be the basis for further operations, in accordance with the principles of conservation.

For this purpose, *International Timber Trade Organization* (ITTO) through the "ITTO Project – PD 617/11 Rev.4 (F) Phase III: *Promoting Biodiversity Conservation in Betung Kerihun National Park (BKNP)*" provided funding among others, to update data and information on the conservation of biodiversity in the ecosystem of the border areas of BKNP (*Updating data and Information on Biodiversity Conservation in Boundary Ecosystem of BKNP*).

1.2 Inventory Activity Plan

Inventory of activities were carried out under the draft prepared by taking into account various factors, such as the purpose, species of plants or wildlife that are being targeted, the characteristics of the studied area, as well as the availability of funds, manpower and time. In the carrying out this inventory, the planning was done to prepare the Technical Implementation Plan of Activities in the field which included[6]:

1. Determination of the exact location of the observations;
2. Determination of the route of survey;
3. Determination of the method of data collection;
4. How to observe, measure and calculate;
5. Determination of the starting and ending time of observation;
6. The distribution of works and duties of each member of the team;
7. Determination of goals, objectives and minimum target to be achieved; and
8. How to process, analyze and synthesize the observed data.

The design is an activity on the table (desk work) it is an important stage in the implementation of the activities of the inventory because it is determining the techniques that will be used and how the activities will be carried out in the field. Preparation of the implementation strategy of this activity can provide benefits, namely: a) the data obtained can be accounted for and represent a description of the conditions of the area of research; b) the inventory can be done more effectively and efficiently. Effective activity means it is carried out by using resources optimally as well as providing maximum results, whereas efficient means the results obtained provide a high level of trust by spending minimum costs; and c) the resulting data can be analyzed by using statistical techniques.

1.3 Purpose and Objectives

In accordance with the agreed *Project Document*, updating of data and information on biodiversity in the Betung Kerihun National Park is intended to update the existing survey data collected in a previous survey in the context of ecosystem conservation as a trans-boundary ecosystem.

The purpose of the implementation of the activities of this inventory is the next part of the implementation efforts of the *Strategic Plan* on Biodiversity conservation of transboundary ecosystem.

1.4 Scope

Given the limited resources, particularly available funding for this project, the activities would focus on an area of 200,000 hectares (of the National Park covering 800,000 ha), namely the Sub Watershed (DAS) Embaloh which is the Western part of the National Park. According to the administrative management of the area the working area is the management area of the

[6] Muin, Abdul. 2014. Draft methodology of an inventory of plants and wildlife

National Park of Region I Mataso, Balai Besar Betung Kerihun National Park. Activities to be undertaken included:

1. Data collection and compilation and related information, including:
   a. Desk study: reports related to the biodiversity BKNP, either written or electronic reports from various sources;
   b. Focus on the area of 200,000 ha the Western part of the BKNP as the area of the studies, namely Sub Watershed (DAS) Embaloh;
   c. Mapping and compilation of sample units/plots measurements for each *Taxa*;
   d. Preparation of a list of plants and animal species based on the results of field survey.
2. Applying the methodology that has been formulated, including:
   a. Designing a methodology for the analysis and inventory of plants and wildlife;
   b. Identify the richness and abundance of plants and wildlife in the study area;
   c. Establish sampling intensity, i.e. 0.1% or 200 ha for the vegetation survey;
   d. Selecting methods of line transect-quadrate method for analysis of the vegetation;
   e. Implement an inventory method which is appropriate for each *taxa*;
   f. Applying *index* methods for the richness, diversity and evenness types.
3. Implementation of the field survey (updating and validation), covering:
   a. The survey was conducted in June, 2014;
   b. Method specified in the various reports of each *taxa*;
   c. Field team consisted of 6 groups, namely: Flora, Mammals and Primates, Birds and *Herpetofauna* (amphibians and reptiles), Fish, and Insects.

Chapter 2
Plants

2.1 Introduction

BKNP is known as the area that has rich ecosystem diversity and biodiversity, of both flora and fauna which is high. The diversity of forest flora of this area is exceptionally high. Based on the results of a survey that has been done previously, 1,217 species of flora have been identified belonging to 418 genus and 110 families, including 75 species which are endemic to Borneo (TNBK 1999).

Dipterocarpaceae lowland forest ecosystem which is the biggest part of the BKNP, has a high diversity of species and generally includes the genus *Dipterocarpus*, *Dryobalanops*, *Hopea*, *Parashorea*, *Shorea*, *Vatica*. There are at least 695 tree species that belongs to 15 genus and 63 families of which 50 species are endemic to the island of Borneo/Kalimantan (Partomiharjo et al. 1998 in the TNBK 1999).

In an effort to area management with extremely high biodiversity, the ecosystem needed to be understood correctly. Information on species richness in each watershed (DAS) in the region does not only reflect the forest unity type in question, but also a variety of data for management and research efforts. Information of species resources and the type of ecosystem is becoming increasingly important in the study of the biodiversity of the area. Updating data and information on the diversity of species of flora that are distribute throughout the watershed (DAS) need to be done periodically to find out the changes in the conditions. In addition, the results of updating the data can be used to update and may be able to add to the list of species of flora that grows in the BKNP area.

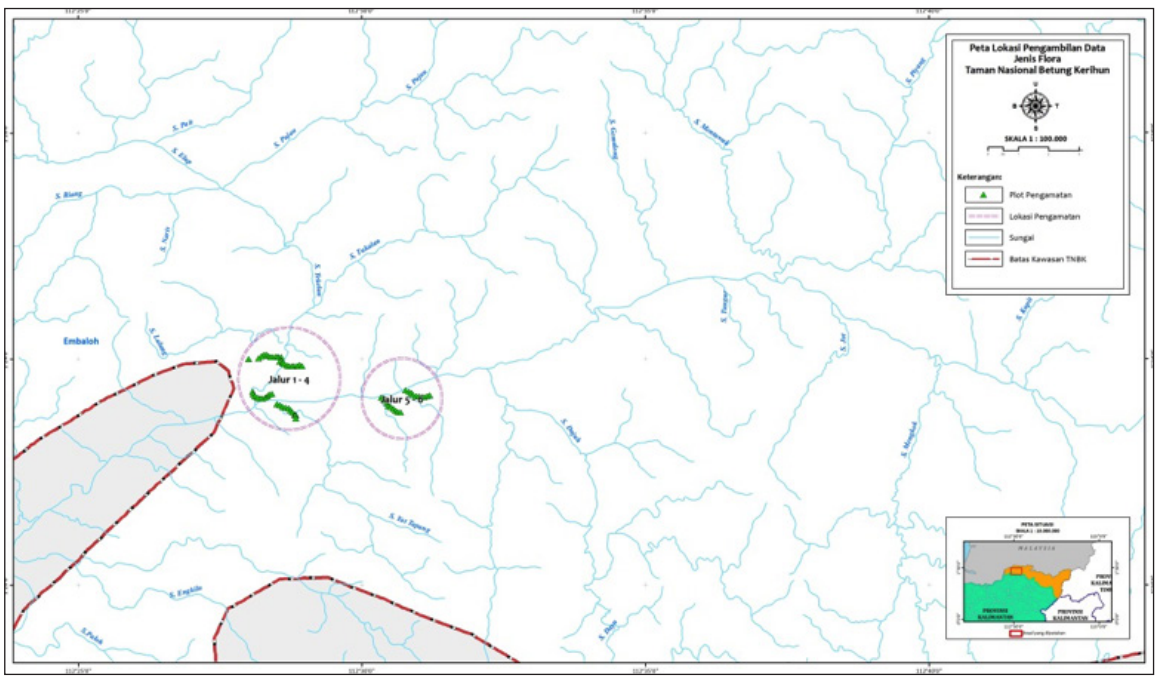


Figure 1. *Location of strips/lines for collecting of flora samples*

2.2 Methodology

2.2.1 Location and Time

Implementation of data updating activities on the diversity of the Flora was done in Sub DAS Embaloh, namely in the working area of the Field Management Unit of the National Park Region (Wilayah) I Mataso, Balai Besar Betung Kerihun National Park. The implementation time of data collection activities was carried out effectively for 10 days in June 2014.

2.2.2 Tools and Materials

Tools and materials used in the activities of updating data on Flora diversity in the Sub DAS Embaloh, were: map with the scale of 1 : 10.000, compass, *Global Position System* (GPS), camera, measuring tape, 100 meter long rope (marked nodes every 2 meter, 5 meter, 10 meter, 20 meter), stationary, tally sheet and guidebook for identification of Flora.

2.2.3 Data collection Techniques and Species

The data collected related to the species of flora found along the location of the strip/transect, include:

1. Name of Flora species (local name or scientific name/genus, family);
2. Total number of individuals per species found in the measured plots (plot observations);
3. The coordinates of the location at the beginning and at the end of the data collection of each strip/transect.

The method used is a combination of strip/sectioned transects, i.e. observing directly the species of the flora along the observation strip by making observation plots at the flora level. The total number of strips/transects of observations in this activity were 6 strips/transects, with a length of 1 km strip with a width of 40 meters. The design of the strip/transect for observation is shown in Figure 2.

Plot observations were made along the 1 km long strip/transect consisting of observations on 2 x 2 m plots for the seedling stage, 5 x 5 m plots for saplings, 10 x 10 m plots for poles and 20 x 20 m plots to the level of the trees. At every 100 meter of the strip/transect 1 sample unit was established consisting of 5 plots/sample plots. At interval distances 1 sample unit with other sample plots with a distance of 100 meters were established so that in 1 strip/transect along the 1 km line there were 5 sample units and 25 sample plots.

2.2.4 Data Analysis

Data analysis was done with a qualitative descriptive analysis of the approach which was divided into 2 parts, namely identification of the species and identification of the value of the benefits of the flora species/vegetation encountered. Identification of the species of flora was done visually in the field at the level

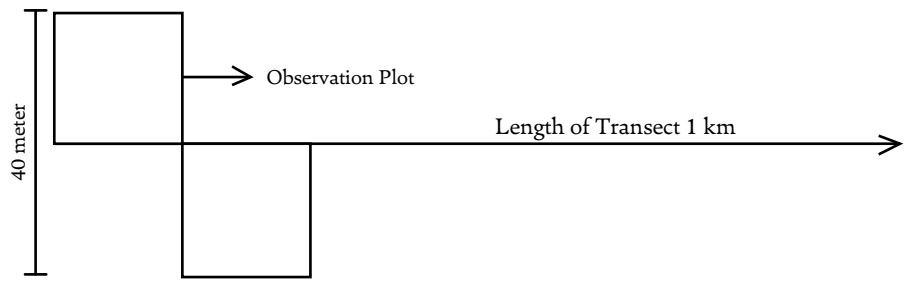


Figure 2. *Length and Width of Observations Strips of the Transects*

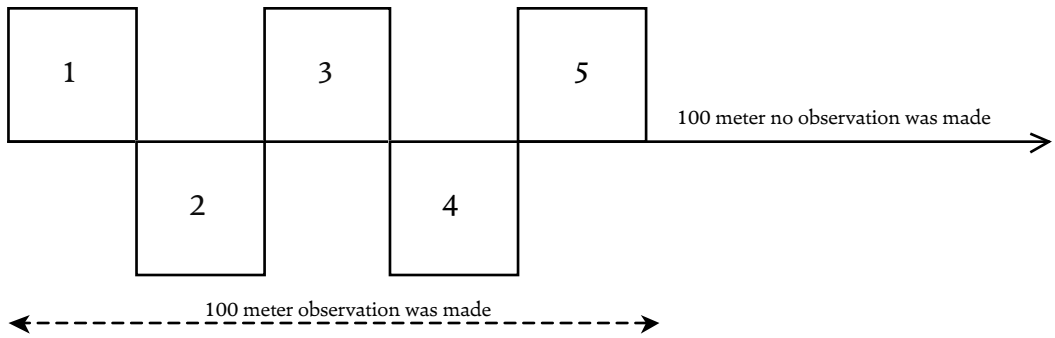


Figure 3. *Sample and measuring units of observations along the strips/transects*

of seedlings, saplings, poles and trees, also assisted by photographing the species of Flora found for later identification using the *Field Guide Book Flora*. The second analysis, namely the identification of the value of the benefits of the flora was performed using quantitative data collection of flora species the findings of which are presented in tabulated form and identified the value of their benefits.

2.3 Results and Discussions

2.3.1 Identification of Flora Species

Although this survey only focused the activities in Sub DAS Embaloh, namely over an area of 200,000 ha with a sampling intensity of 0.1% or 200 ha of vegetation surveys, but have managed to identify 227 species of plants belonging to 46 families. In the previous data on Flora, 1,217 plants species we identified belonging to 110 families and 418 genus of which 75 species are endemic to Borneo. Thus some of the plant species that have been identified previously has successfully recovered or its existence is still ensured in the area of BKNP. But it should be noted that there are 3 different plant species which have not yet been identified by scientific name because according to the field team it has really not yet been identified. A complete list of the results of the identification of flora species can be seen in Annex 1.

On the sample plot area of 200 ha, about 20% of the total number of plant species has been found that have been identified previously. Identification was only done on the sample plots with no observations along the strips/transects. The largest number of species found is a member of the family *Dipterocarpaceae* (34 species) shown in Figure 4. The lowest number of species, i.e. one species only was found of each species that belongs to the families *Anisophyllaceae, Araliaceae, Begoniaceae, Connaraceae, Gleicheniaceae, Olacaceae, Pandanaceae, Pentaphylaceae, Rhamnaceae, Simaroubaceae, Stemo-nuraceae* and *Vitaceae*.

Ecosystem in the BKNP area is representative of the forest ecosystems from tropical rain forest dominated by dipterocarp species upto the mountains which has a high level of diversity of plants and animals. The specificity of the ecosystems and topographic variations provide support for growth of a wide variety of flora, including some species that grow well in several types of ecosystems.

The species which are abundantly found in the lowland dipterocarp forest ecosystem and belong to the family *Dipterocarpaceae* are *Kapur Keladan* (*Dryobalanops beccarii Dyer*). Other species which are also found, among others *Hopea/*Merawan (*Hopea dryobalanoides* Miq.), *Light Red Meranti/*Meranti (*Shorea ovalis Blume*), *Apitong/*Keruing (*Dipterocarpus*

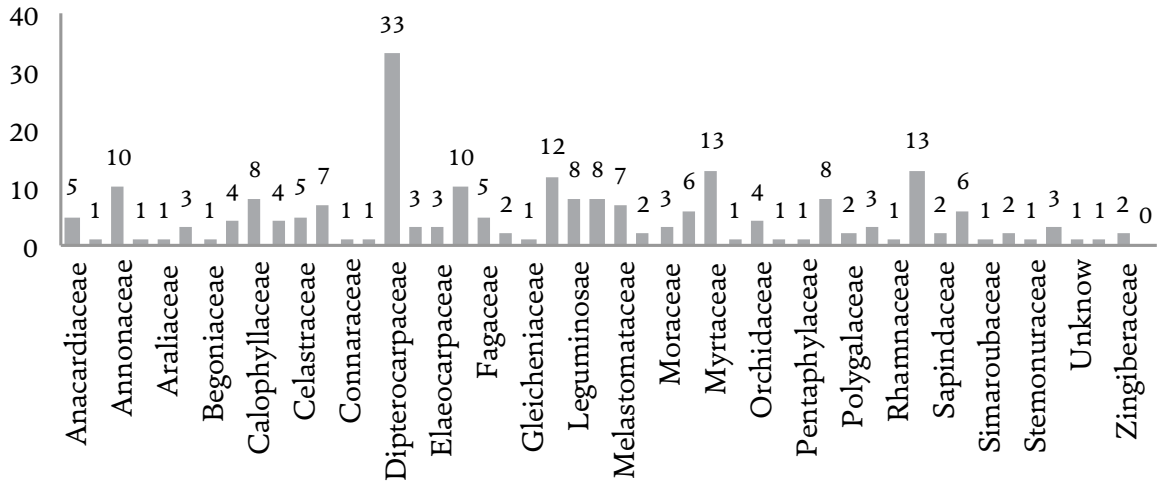


Figure 4. *Total numbers of species per each family*

grandiflorus (Blanco) Blume), *Vatica/*Resak (*Vatica sp*), Ubah (*Syizigium sp*), Medang (*Litsea sp*), *Borneo-mahogany/*Bintangor (*Callophyllum inophyllum*), and *Durian paya/*Durian burung (*Durio carinatus*). This shows that the Sub DAS Embaloh is dominated by species which belong to the family *Dipterocarpaceae* so it can be called a *Dipterocarpaceae* forest (*Dipterocarp forest*) which typically have a high economic value. Apart from the *Dipterocarpaceae* species that often were found there were various Rattan species (*Calamus sp*).

In the mountainous ecosystems still many meranti species (*Shorea sp*.) is found. A typical tree species in this vegetation type is Brush cherri (*Syzigium sp*). The characteristics that could be seen clearly in this type of vegetation is the amount of moss that grew on the tree trunks. At the top of the mountainous vegetation type, the size of the plants and mosses getting smaller and more dense the moss clings to the tree trunk, among them Bantas (*Cephalomappa malloticarpa J.J.Sm*), Scarlet Bean/Pau (*Archidendron sp*.), Perupok/Bajan (*Lophopetalum sp*.) and Rotan (*Calamus sp*).

Figure 5. *Species Kapur Keladan (Dryobalanops beccarii Dyer)*

2.3.2 Identification of the Benefits

Various flora species that grows in the area of BKNP also have values and direct benefits for the community, both for those who residing inside or around the area to support daily lives. The utilization of these flora species are grouped according to their use as foodstuffs (food and drink), and drugs (medicinal plants).

2.3.2.1 Foodstuff (Edible Materials)

Based on the results of the analysis, 36 of plant species could be identified which belong to 15 families that have the benefits as foodstuff (mixing in food and beverages) and was used in everyday life as well as in traditional ceremonies, like the feast *gawai* (custom event after harvest). The most often used species for food ingredients belonging to the *Lauraceae* family totaling 7 species (19%), the mangosteen species of the *Clusiacea* and the *Fagaceae* family totaling 5 species (14%). The list of species that are used as foodstuff can be seen in Annex 2. Whereas the percentage number of the species that often was used as food ingredients are shown in Figure 6.

Parts of the plants that are often used by the local society, especially communities of dayak around Betung Kerihun National Park area as foodstuff are the fruits, leaves and sticks/edible topmost and innermost frond of a palm (Albertus Tjiu, 2008). The Begonia species (*Begonia spp*) from the family *begoniaceae* is often utilized as an ingredient for cooking fish, which gives a sour taste of the cuisine. These begonia leaves could be also eaten raw to relieve the feeling of the thirst while in the wilderness. The *Fagaceae* family is represented by various species of *Lithocarpus* spp. (Mempening, Chinese oak) the fruit of which also was collected as an ingredient in food. The taste seems deliciously piquant and fatty like peanuts if being boiled, could replace the need for carbohydrates and fats, moreover the *Moraceae* group is also an important family in the life of the Dayak community, in addition to the fruit used, in the past time the bark of the *Artocarpus* spp. (terap) was used as a wooden skin vest.

Moreover, species from the family *Arecaceae/ Palmae*, that is the rattan species (*Calamus scipionum*), has an important role in the everyday's life of the Dayak community. This species has double benefits, apart from as a food ingredient it is also used for webbing, rope, and as material for handicrafts.

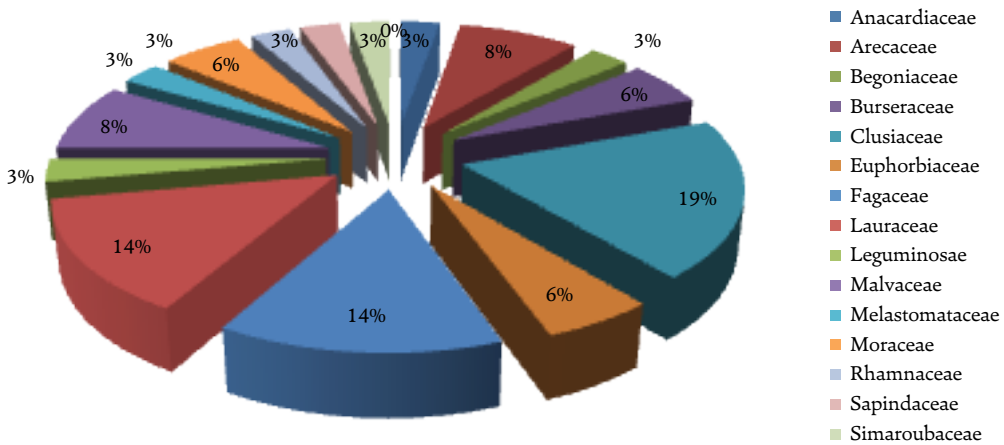


Figure 6. *Number Of Plant Species Used As Foodstuff*

2.3.2.2 Building Materials

In this survey, 86 plant species was found belonging to 10 families which have high benefits as building materials. These species are dominated by the family *Dipterocarpaceae*, as many as 33 species (38%), especially the species of *Shorea* spp. (meranti-merantian), *Hopea* spp. (merawan), *Dryobalanops* spp. (kelansau and keladan), and the *Dipterocarpus* spp. (keruing, tekam). Other species are also widely used as a building material coming from the *Myrtaceae* family (13%), such as Brush cherri/Ubah (*Syzygium* sp.) and *Calophyllaceae* (8%), such as Bintangor (*Calophyllum* sp.). List of identified species that had been used as building material can be seen in Annex 3. For the dominance of each family which has value as building material is shown in Figure 7.

Wood Group of the *Dipterocarpacea* family is traded worldwide (decision of the Minister of Forestry Number 163/Kpts-II/2003), particularly the meranti species (*Shorea* spp) are known by some specific names, namely meranti merah, meranti kuning, meranti putih, and balau/selangan batu. This species belongs to the commercial timber Group 1 (one). Red meranti species is most sought after because of its good quality, the next one is the yellow meranti and balau/selangan batu. White meranti species is less desirable because the wood is generally soft and light.

Other species which are also sought after as building material/wood coming from the family *Calophyllaceae* which consists of a mixed forest timber group or commercial wood group 2 (two) is bintangor (*Calophyllum* spp.). Although this species is rather difficult to work with because of its yellow latex that is sticky, but it is liked because the quality of the wood is very good and hard. The wood species that has a tough and beautiful fibrous flesh is the wood from the families *Myrtaceae* (ubah) and *Anonacea* (semukau) which is in great demand by local people as building materials.

The economic potentials of different tree species that grow inside the BKNP can trigger the onset of felling the forest without permission (*illegal logging*). Therefore, safeguarding efforts of the area must continue and be enhanced especially in the area where wood skidding could be carried out easily, like near the big river flows. The involvement of local communities in the area of safety efforts of the threat of illegal logging will be the matter that is worthy to be further developed.

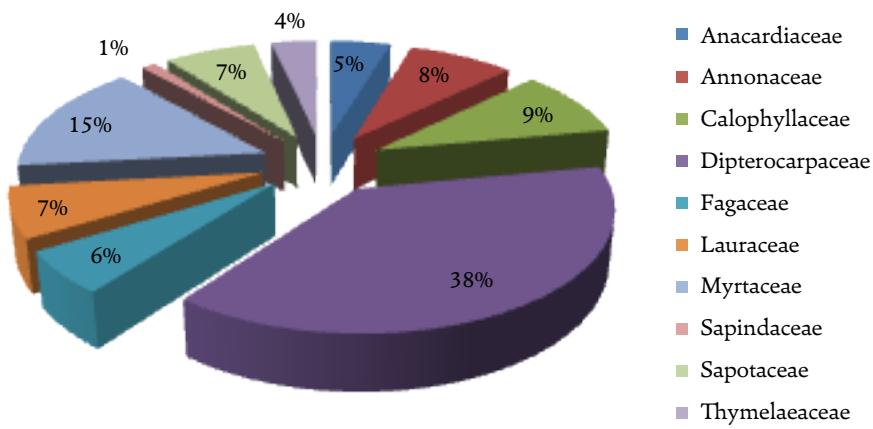


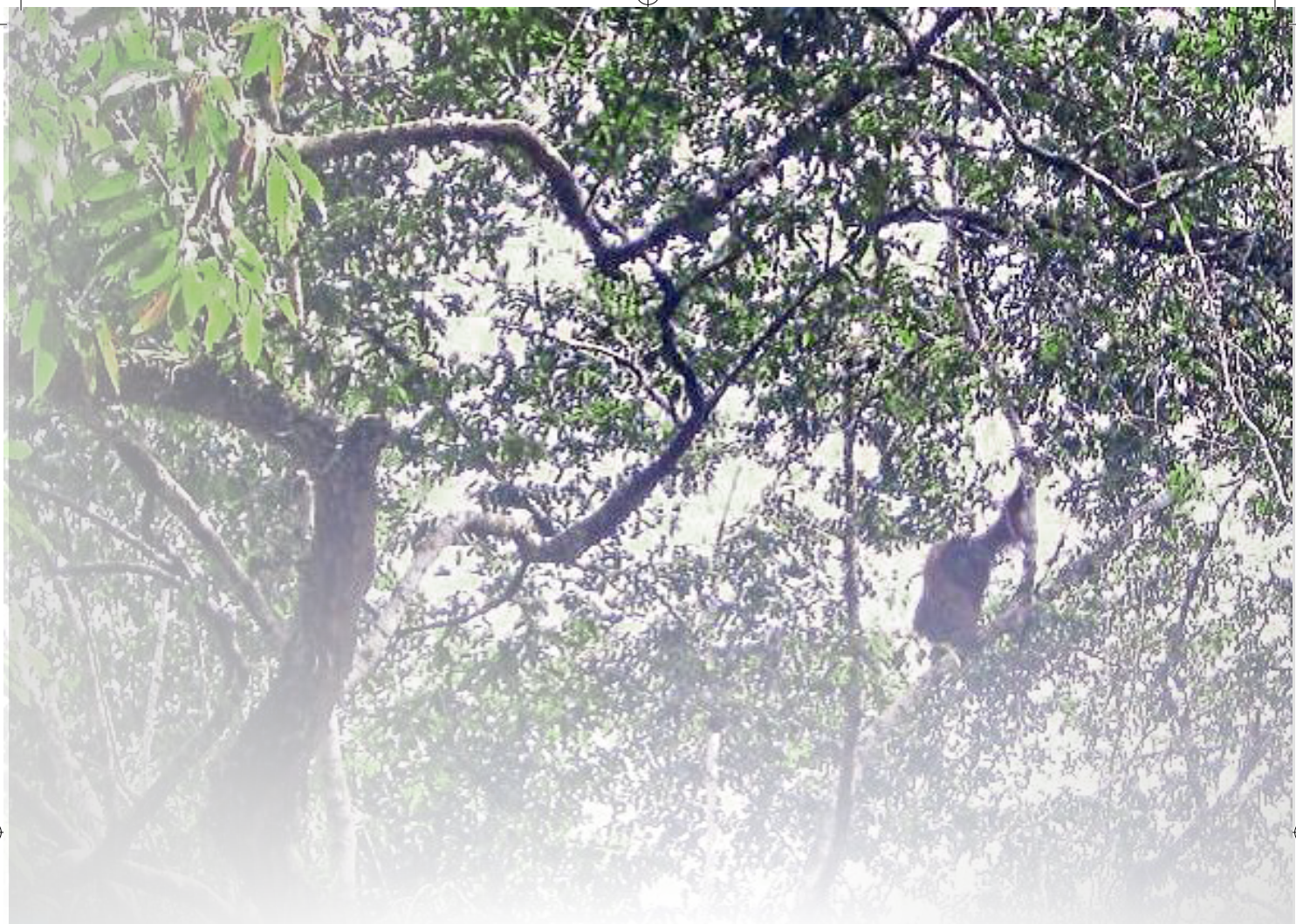
Figure 7. *Number of Plant Species Used As Building Materials*

2.3.2.3 Materials for Medicine/Drugs

Figure 8. *Pasak Bumi Species (Eurycoma longifolia)*

The use of these plant species as an ingredient in traditional medicines has been developed since a long time ago. In this observation 32 species of plants were recorded belonging to 17 families which have been used as raw materials for medicine. The species of plants that were used as drugs can be seen in Annex 4. Parts of the plants which are often used as ingredients in traditional medicines is part of the roots, leaves, stems and fruits. The Dayak community that live around the BKNP area have utilized herbs and forest plants for generations to cure various diseases/illnesses because traditional medicine did not have any side-effect on the health.

Utilization of roots for medicines, especially coming from those species which belong to the family *Leguminosae*, *Menispermaceae*, namely akar kuning (*Fibraurea tinctoria*) and *Simaroubaceae*, that is pasak bumi (*Eurycoma longifolia*). Utilization of these plant species for medicines could also be further developed for community empowerment towards the conservation efforts of the BKNP.



Chapter 3
Mammals and Primates

3.1 Introduction

The existence of the population and diversity of wildlife species is an indicator of the quality of the ecosystem or habitat. Among the group of animals that serve as indicators are mammals, including primates. Mammals are vertebrates that have the characteristics of *homoitherm* (warm-blooded) with typical breastfeeding, giving birth and have fur.

Survey activities on biodiversity are required to demonstrate the existence or nonexistence of the values of the quality of ecosystem and conservation, such as animal species which are regionally and globally endangered by its population. A survey of mammals and primates is an important step for the collection of data and information on their existence in the BKNP area. Getting the picture of the potentials and information on mammals and primates must be carried out for updating of the data and subsequent decision making for their management.

3.2 Methodology

3.2.1 Location and Time

Location of the implementation activities was situated in Sub DAS Embaloh, namely in the working area of the Field Management Unit of the National Park Region (Wilayah) I Mataso, Balai Besar Betung Kerihun National Park, which is known as a habitat for mammals and primates. The implementation time of data collection activities was carried out effectively for 10 days in June 2014.

3.2.2 Tools and Materials

Tools and materials which were used comprised: binocular, compass, GPS, map of location, field book, camera DSLR or pocket, camera trap, time measuring/watch, stationary, and tally sheet.

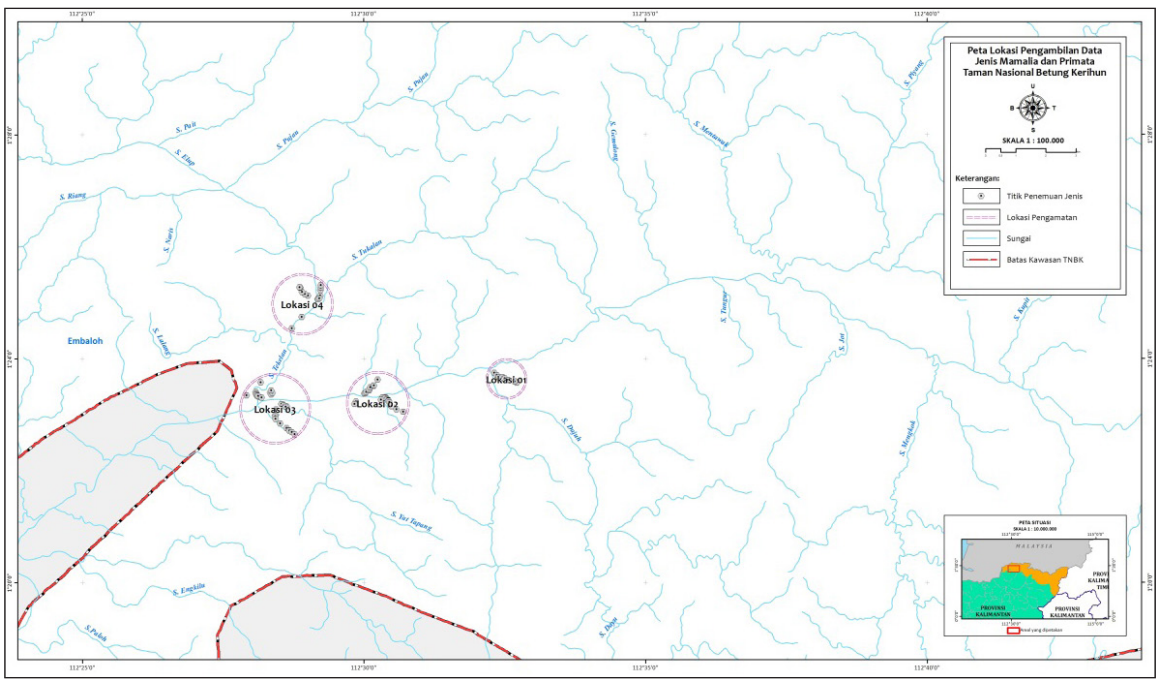


Figure 1. *Locations of Survey for Data Collection of Primates and Mammals*

3.2.3 Species and Data Collection Technique

The type of data gathered in this activity is the location of the encounter, species, image/ photograph and other supporting information. Data collection techniques were carried out as a quick observation, using a camera trap and interviews.

3.2.3.1 Rapid Assessment Method

This method was used to determine the different species of mammals found in the observation sites and not necessarily on a particular line or special location. Observers simply took note of the different species of mammals which were found, for example when doing the survey at location, walking outside the time of observation, and so on. The recording of any wildlife mammals found in the field included the name of the species, number as well as description of the general conditions of habitats and mapping of the location with GPS (*Global Positioning System*).

3.2.3.2 Method of Using the Camera Trap

The use of cameras in the identification of animals was carried out in order to get the data without the presence of the observers. The camera must have a good sensor (incl. autofocus) as well as a good type of battery to be installed for a long-term observation (could be a month). The camera was placed in locations that were suspected to become the area of cruising and the trail of the movement of the animals to be identified.

Wildlife observation was made, either directly or indirectly, by recognizing: (1) voice; (2) signs of eating, scratches and wallow; (3) hair/ feathers, nests, and smell; and (4) footprints. The observations were carried out in the morning, afternoon and evening because of the daily activities of the mammals some of which are *diurnal* and some *nocturnal*. Observations of mammals were conducted in the morning at 05.30-10.00 am (WIB) and afternoon at 15.00 – 18.00 pm (WIB), observations could also be done during the night, i.e. from 19.45 – 22.00 pm (WIB).

3.2.3.3 Interviews

Interviews with local communities or field officers were conducted to gather additional data regarding the existence of different mammal species found in the location of the observation. Information from the communities or field officers was verified with existing data and matched with the guide book manual introduction of mammal species.

3.2.4 Data Analysis

3.2.4.1 Species Identification

Identification of the species was done by descriptive analysis covering the species composition and the frequency of the encounter, as well as supporting factors. The composition of the species covered taxonomy from species to family. The frequency of encounter was based on the results of findings, either directly or indirectly. The supporting factors that were gathered covered the description concerning the condition of the habitat and the topography of the location of the encounter of the wildlife, as well as information from the community

3.2.4.2 Level of Tropical Mammals

The category of tropical level of mammals is based on the type of the food the species eats that can be differentiated into three (3) groups of animals, which is herbivorous, carnivorous and omnivorous. Further, the Herbivores were distinguished grass eaters (grazer), eaters of leaves and shrubs and eaters of seeds and fruits (graminivora) (Alikodra 2002).

3.2.4.3 Species Diversity

1. Diversity Index of Shannon-Wiener Type

$$H' = -\Sigma \frac{ni}{No} ln \frac{ni}{No}$$

where:
ni = Total number of individuals of a species
No = Total number of individuals
H' = Diversity Index of Shannon-Wiener

2. Index of Evenness

Index of Evenness functions to find out the evenness of each species encountered in each biotic community. The value of the Species Index of Evenness (E) is also used as an indicator of the existence of the dominance among species in a community. The higher value of the index of evenness obtained, that meant that the level of dominance of the species available in one location is more evenly distributed, meaning that it is less certain that one species is dominating the area of observation. If the index of evenness of a species has an indicator value of E= 1, it means that there is no mammal species that dominates the habitat.

$$E=H^{'} / ln S$$

where:
E = Index of evenness (value between 0–1)
H' = Diversity index of mammal species
ln = Natural logarithm
S = Total number of species

3. Species Richness Index

Species richness functions to determine the richness of the species in every biological community that was found (Krebs, 1989), and is calculated by the formula:

$$H' = \Sigma (Pi) (ln Pi)$$

where:
Pi = ∑ni/N
H = Diversity Index of Shannon-Wiener
Pi = Total number of individuals of a species/Total number of all species
ni = Total individual species to-i
N = Total number of individuals
Shanon-Wiener index has the following indicators:

$$Dmg = (S-1) / ln (N)$$

where:
Dmg = Species richness index
S = Total number of species
N = Total number of individuals of all species.

3.2.4.4 Status of Protection

Analysis of the status of the protection is carried out using rules that apply globally. The status for the global protection used is the *Redlist* issued by the IUCN and lists wildlife species which are included in the rare categories and are listed in *Appendix* CITES (*The Convention on International Trade in Endangered Species of Wild Fauna and Flora*). In addition, for the status of the protection at the national level, applicable laws and regulations are used.

3.2.4.5 Important Species

Criteria for assessment of important species was based on some level of intensity of the needs of the animals concerned, both for the local community and other communities. The decision was made based on the results of the interviews for the intensity of the requirements needed for various things, such as food, clothing and pleasure (hobby), as well as an assessment of the habitat of the conditions and the presence of these animals in the nature.

3.3 Results and Discussions

3.3.1 Species Identification

3.3.1.1 Species Composition

The number of species of mammals found in these observations, either directly or indirectly, was a total of 17 species belonging to 13 families. The number of species for each family was: *Cercopithecidae* (3 species), *Scuridae* (3 species), *Petauristinae* (2 species), *Ursidae* (1 species), *Hystricidae* (1 species), *Felidae* (1 species), *Hominidae* (1 species), *Hylobatidae* (1 species), *Tragulidae* (1 species), *Cervidae* (1 species), *Muridae* (1 species), and *Manidae* (1 species). The complete list of the mammal species encountered can be seen in Annex 5.

3.3.1.2 Species Frequency

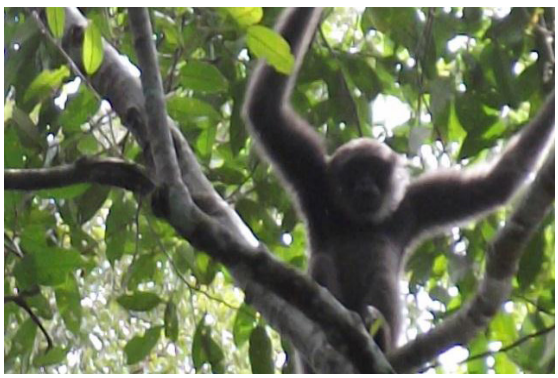


Figure 2. *Gibbon (Hylobates muelleri)*

The frequency of encounters of mammals varies both in terms of quantity and species at each observation point. Mammals found are generally scattered in multiple locations of observations. Gibbon/Kelempiau (*Hylobates muelleri*) can be found in almost all observation location, while the Borneo Orangutan (*Pongo pygmaeus pygmaeus*) are found in the rivers Santo, Senentang and Riak Tapang.

This primate species have a relatively high frequency of encounters or as much as 77 individuals which were encountered in various locations and was most widely found at Tekelan, where 26 individuals were encountered. This is because in Tekelan many fruit trees are growing at the time of the observation was done. Many trees had fruits, like the forest durian (*Durio sp*), Asam kandis – tree with small sour fruit (Santiria sp), guava (*Syzigium spp*), as well as other fruits. This wildlife species is relatively easy to find, especially in the morning, or at 04.30 – 05.30 am (WIB) through the voices shouted at each other.

Gibbon usually lives in groups with a total of 6-8 individuals per group, usually they are one family consisting of females, males and children. Kinship between members of these groups is very close and they always trying to protect each other, especially the weak members of the group, for example a parent with her baby. Easy encounter with gibbon is indicating that this area was the preferred habitat of this animal species.

Figure 3. *Bearded Pig (Sus barbatus)*

The bearded pig (*Sus barbatus*) was the second most commonly encountered species in observation locations, i.e. as many as 37 individuals. Most of these animal species were found in the Dajo river, i.e. a total of 10 animals. Bearded pig is a type of mammal that

is widely sought by residents of the surrounding forests for their meat which is utilized as food ingredients.This also was linked to the ease of the inhabitants to find this species, beginning with the trail, mark's done after bathing or wallowing/washing places and breeding places at night. In general in the customs of ritual events, the communities surrounding the forest using this animal as a sacrifice.

Figure 4. *Scratches of Sun Bear (Helarctos malayanus)*

The species that was least encountered was the species of the Tufted Ground Squirrel (*Rheithrosciurus macrotis*); the Greater Mouse Deer (*Tragulus napu*); Sambar deer (*Cervus unicolor*) and the Rajah Spiny Rat (*Maxomys rajah*) 1 individual respectively. Mammals that could not been found directly was the Sun Bear (*Helarctos malayanus*) and Clouded Leopard (*Neofelis nebulosa*). The two mammals were found at the observation locations of the river Senentang and the river Riak Tapang. The team found scratches of the Sun Bear on meranti trees that have been torn apart and destroyed. The Sun Bear is clawing or destroying trees in search for ants as additional food to other foods such as fruits. While regarding the Clouded leopard, the team only heard a roaring sound which was only a few meters away. Interestingly, there is the presence of the Borneo Bay Cat (*Catofuma badia*) which is endemic to Borneo in this Embaloh Watershed. This data was obtained based on the interviews with local communities around the Sub DAS Embaloh area. A more in-depth survey is needed related to the presence of these mammals.

3.3.1.3 Supporting Factors

1. Habitat

The existence of mammal species is very much related to the condition of the habitat that provides the food and water that can support their needs. Habitat conditions which are maintained and relatively undisturbed will provide a positive influence on the existence of the mammals. According to Shannon et al. (1975), the selection of habitat by a wildlife species can be influenced by three factors, namely: availability of prey (food), to avoid competitors and to avoid predators.

Figure 5. *Vegetation at river bank of Riak Tapang*

Habitat is the key component that is essential for the survival of the wildlife. The main components of the wildlife habitat are food, water, space and the structural characteristics. The availability of food is the most dominant constraints for a number of species. At six observation locations it was mentioned that the vegetation on the edge of the observation location was a more open forest, with the surface and the layer of the main canopy that was irregular rarely with gentle slopes but with

steep slopes. Around the river Santo, located at an altitude of 700 m above sea level, with a good forest condition and high trees is a suitable habitat for mammals. Observations of ecosystems directly at six locations showed that the condition of the vegetation was still relatively intact and not showed any signs of damage caused by human activity (i.e. illegal logging). Changes that happen occur naturally (such as fallen trees because of the age factor).

2. Topography

Topographic factor of alluvial soil with hilly terrain with a high level of sloping grounds is quite complicated for mammals, especially those which are terrestrial looking for food at ground level. Unlike the case with most of the primates which are arboreal (spending time on top of the tree). However, in some observation locations some mammals can still be found at a fairly high degree of slope. The altitude of the place influenced on the existence of the species of the mammals, where with increasing altitude of the observation location increasingly fewer mammals were found. This in accordance with MacKinnon in Alikodra, 2002, that is the increase in the altitude of a place was followed with the decline in species richness.

At the location of observations with an elevation above 400 m above sea level, i.e. around the river Santo still several mammal species was found like Sambar deer (*Cervus unicolor*), Greater Mouse Deer (*Tragulus napu*), and Bearded pig (*Sus barbatus*). Mammals species found below the altitude of 400 m above sea level were, among others Pigs (*Sus* sp.) at 89 m above sea level, Sambar deer (*Cervus unicolor*) at 150 m above sea level, Gibbon (*Hylobates muelleri*) at 190 m above sea level. The Maroon leaf monkey, or Red leaf monkey (*Presbytis rubicunda*) is a primate that is easily found at various altitudes as they often are on the banks of the river.

3. Interviews

The interviews were carried out with local people who usually enter the area of BKNP for various purposes such as hunting (traditional) fishing, looking for Agarwood (Gahuru). The knowledge of this people and their experiences supported, while accompanying the staff of the Balai BKNP, the researchers, and the students that came to monitor the conditions as well as doing wildlife inventory. Based on the results of interviews by using the Field Guide of Mammals in Kalimantan, Sabah, Sarawak and Brunei Darussalam, almost all types of mammals found in Kalimantan which were in the book were found in the area of BKNP, except for the small mammal species and flying mammals like (rats, shrew (mouth like species), and other species of bats). But public knowledge regarding the protected wildlife species is still very limited. This can be evidenced by the presence of the people who is still doing poaching for certain wildlife species that is protected.

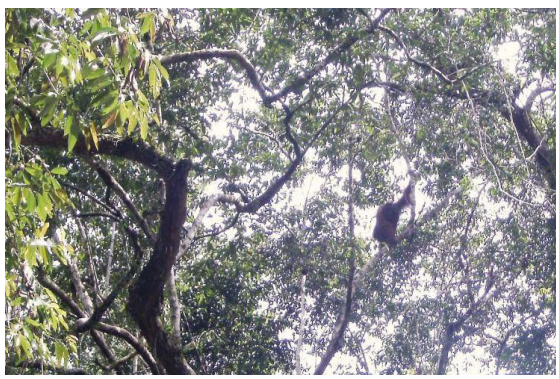


Figure 6. *Orangutan in the river Riak Tapang*

One of the species that are categorized as protected in the Sub DAS Embaloh is Bornean Orangutan (*Pongo pygmaeus pygmaeus*). Based on the IUCN status these animals are included in the critical category (Endangered), while according to CITES this species is included in Appendix I category, and according to the laws of the Republic of Indonesia it is a protected

species. The status of the species makes the Orangutan a wildlife species that require action for its protection. Orangutans were not the wildlife species which were hunted by the people in Sub DAS Embaloh. This condition would greatly assist efforts to the protection of Orangutans as well as the potential for the development of wildlife-based ecotourism in Sub DAS Embaloh.

4. Vantage Point

Criteria for assessment of an important area are based on the assessment of the existence of important species and the diversity of mammal species as well as the early detection of the possible threats and the possibility of the damaging impacts arising in the future. In addition, conservation efforts which have been and are being made as well as the potential for further development has been taken into consideration in the determination of this important area.

1. Important location (*Tekelan*)

   Judging from the number and variety of mammal species which were encountered, *Tekelan* can be said to be an important location. The mentioned species including the Gibbon (*Hylobates muelleri*) consisting of several groups with total number of individuals ranging between 6-9. Starting around 4:30 in the morning, one will begin to hear the sounds of multiple groups of Gibbons forming mutually a unit to each other. On the footpath behind the camping ground Tekelan, Bearded pig (*Sus barbatus*) can be easily found, either directly or indirectly. This species can also easily be found by doing a reconnaissance on the cruise line or in place of wallowing which is numerous at this location. In the deeper part of the forest from the camping ground, the nest of the Pangolin (*Manis javanicus*) can be found, which is at the roots of the large trees. In addition to the mammals, in Tekelan various species of birds can also be found, including Helmeted Hornbill (*Rhinoplax vigil*) and Great Argus pheasant (*Argusianus argus)* which makes nest in the footpath. The relatively flat topography as well as its natural beauty and the presence of various wildlife species at this Takelan location can be the capital for the development of ecotourism with special interest.

2. Santo River

   The river Santo which has a width of approximately 7 meters with water flowing all year round is a river in the upper reaches of the river Tekelan. This location can be reached via a footpath from the camping ground Takelan in about 1 hour's walking. On this observation site various types of mammals can be found, especially during the fruit season, during the months of June to October each year. The existing plants at this location are dominated by fruit trees which are the preferred food and liked by the primates. Therefore, many primate species can be found here, such as Gibbon (*Hylobates muelleri*), Maroon leaf monkey, or Red leaf monkey (*Presbytis rubicunda*), Long-tailed macaque or Crab eating monkey (*Macaca fascicularis*) as well as Orangutan (*Pongo pygmaeus pygmaeus*). Other mammal species that can be found in this area, among others Bearded pig (*Sus barbatus*), the Pangolin (*Manis javanica*) and Malayan Porcupine (*Hystrix brachyura*).

3.3.2 Levels of Tropical Mammals

Based on the type of food, mammals can be divided into three trophic levels (position in food cycle), namely herbivorous, carnivorous and omnivorous. Herbivores can be divided into grass eaters (*grazer*), eaters of leaves and shrubs (*browser)* and fruit and seed eaters (*graminivora*) (Alikodra, 2002). If then the number of mammal species described are based on the position in food cycle (trophic) level that will form a

pyramid. With this classification it is shown that the balance of the ecosystem in Sub DAS Embaloh is still good. The number of species based on the level of trophic is presented in Figure 15. According to Solihin (1997), a stable community will have a pyramid pattern at its trophic level. Meanwhile, Noerdjito et.al. (2005) in Gunawan (2007) stated that the balance of the ecosystem have been regulated naturally by the supply chain mechanism and the balance of the food network. If the number of carnivorous species is more than the number of herbivores, then the food network in the ecosystem will become unbalanced and cause disturbed ecosystem habitat which in turn will give rise to constraints, for example the development of pests.

3.3.3 Variety of Species

3.3.3.1 Species Diversity

The Shannon-Wiener index values are greatest at the observation site at the River Riak Tapang with H 'value of 1,644 and the lowest at the observation location of Tekelan with H' value equal to 1,150. The calculation of the index was based on direct encounters with the mammal species, more details are shown in Figure 16.

The level of diversity of mammals in Sub DAS Embaloh is relatively moderate that is reflected in the value of the species diversity index which is greater than 1 (Odum, 1971). This indicates that all observation sites have the same quality of observations in terms of species variation. Thus it can be said that almost all observation location is the right place as the natural habitat of wildlife species found in the Sub DAS Embaloh.

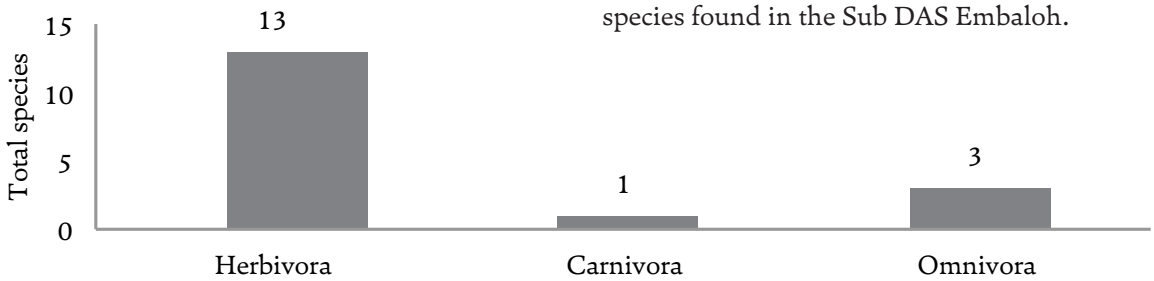
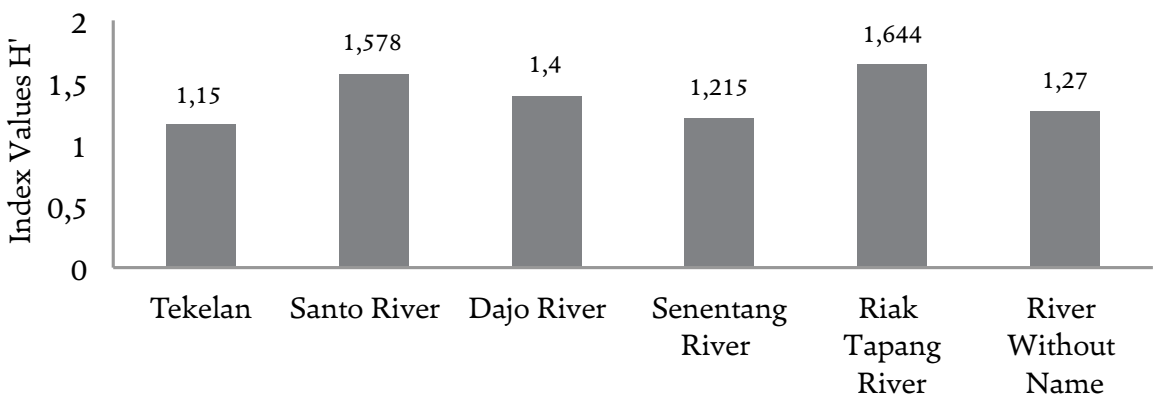


Figure 7. *Number of mammal species based on trophic (position in food cycle) level*



Sungai = River, if you want to change it but it's not necessary

Figure 8. *Graph of Index H ' In Every Observation Location*

The most frequent mammal species found are the Bornean Grey Gibbon (*Hylobates muelleri*) as many as 77 individuals, the Bearded pig (*Sus barbatus*) as many as 37 individuals, and Maroon leaf monkey, or Red leaf monkey (*Presbytis rubicunda*) as many as 15 individuals. The number of individuals per mammal species in each location can be found in Annex 7.

3.3.3.2 Species Evenness

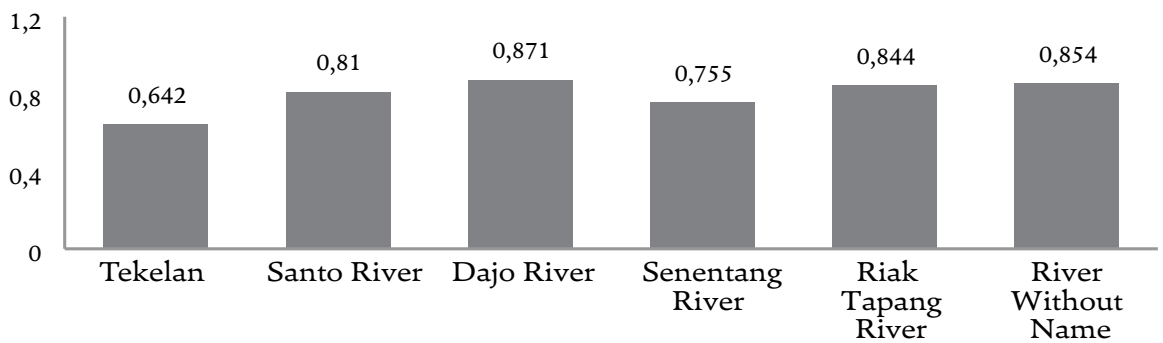
The obtained Evenness Index values ranges between 0,642–0,871. The observation location at River Dajo has the largest Evenness Index with a value of 0,871 while the lowest Evenness Index was at the Tekelan observation. This means that at the observation area of Tekelan there is still several mammal species that dominates in the number of individuals per species. Figure 17 shows the species evenness at each observation location.

It can be seen that in almost all observation locations, there is no animal species that dominates, that is evenly distributed in each observation location. This is because at the time the activity took place it coincided with the summer fruit season that has just got under way.

3.3.3.3 Species Richness

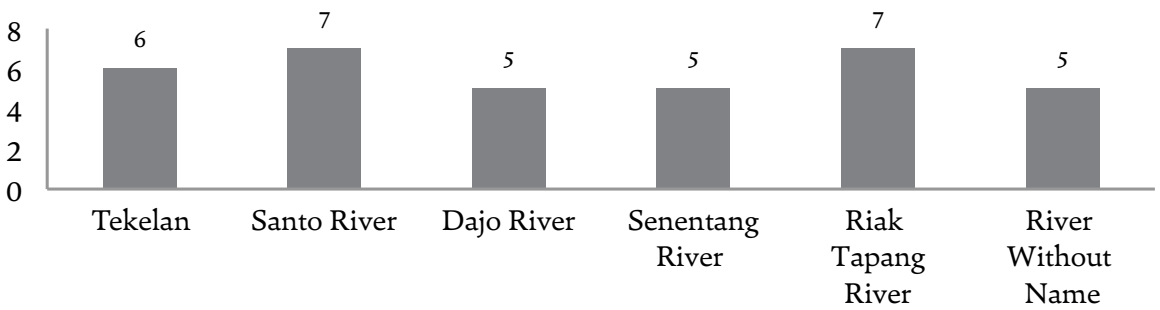
The Species Richness Index is the measurement of the biological diversity that was simple because it only took into account the difference in the number of species at a certain area. The number of species encountered in each observation location is shown in Figure 18. The mammal species that was found at each location was almost evenly balanced, which indicates that the distribution of mammals in Sub DAS Embaloh has a fairly high level of similarity. All mammals that exist in this area can live anywhere as long as food is available and there are no predators as well as the flow of the river divides the plains/hills.

The number of mammal species, along with the number of individuals found in a given area will affect the value of the Margalef Species Richness Index. An increase in the number of species will lead to a higher value of the Margalef index. However, when the number of individuals of each species increases, it will decrease the value of the Margalef index. The Species Richness Index value was used to encounter data directly. The values of Margalef Diversity Index for each observation location are presented in Table 1.



Sungai = River, if you want to change it but it's not necessary

Figure 9. *Graph of Index 'E' at each Observation Location*



Sungai = River, if you want to change it but it's not necessary

Figure 10. *Graph of Encounter of Mammals At Each Observation Location*

Table 1. *Values of Margalef Diversity Index (Dmg)*

No	Observation Location	Total species	Total individuals	Dmg
1	Tekelan	6	42	1,3373
2	Santo River	7	35	1,687
3	Dajo River	5	33	1,143
4	Senentang River	5	14	1,515
5	Riak Tapang River	7	17	2,117
6	River Without Name (Tanpa Nama)	5	30	1,176

The above table shows that the highest species richness was in the river Riak Tapang with a total Margalef (Dmg) Diversity Index Value of 2,117 and the lowest was in the River Dajo with Dmg value of 1,143. The interesting thing to explore deeper is on the rivers Dajo, Senentang and the river without name. In these three areas of observations 5 mammal species were found in each location, but there is a difference in the number of individuals found at the three observation sites namely River Dajo 33 individuals, River Senentang 14 individuals and the nameless River 30 individuals. So as it is causing the Dmg to be different from each other at each location. These differences are strongly affected by the total number of individuals found in a particular area. So, the values of Dmg at these three locations are very different although the same number of species was found. The values were obtained by processing the data from direct encounters with the mammals.

3.3.3.4 Protection Status

Eight among the mammal species that were encountered are protected by the Government of Indonesia according Presidential Regulation No. 7 of 1999 regarding the Preservation of Plants and Animals. In addition, 3 mammals are also listed in the IUCN *Red-List* Data Book with endangered status. While according to CITES Appendix I includes (3 species) and Appendix II (3 species). It should also be noted that six species of mammals are found is endemic to Kalimantan, namely the Plain Pigmy Squirrel (*Exilisciurus exilis*), Tufted ground squirrel (*Rheithrosciurus macrotis*), White-fronted leaf monkey (*Presbytis frontata*), Maroon leaf monkey, or red leaf monkey (*Presbytis rubicunda*), Bornean/Kalimantan orangutan (*Pongo pygmaeus pygmaeus*) and Gibbon (*Hylobates muelleri*).

3.3.3.5 Important Species

1. Primates

   Almost all primates in the Sub DAS Embaloh are protected species and are assets

to BKNP for the development of ecotourism in conservation areas. Orangutan (*Pongo pygmaeus pygmaeus*) is the wildlife species that is the main attraction (*Umbrella species*) for the conservation of the tropical rainforest. The presence and the density of the population of Orangutans can also be used as a measure of the tropical rain forest conservation. Orangutans are one of the best mascots or flagship species to raise awareness and support the protection of tropical rain forest biodiversity which is endangered (Meijaard et al, 2001).Besides orangutans, Gibbon, Long-tailed porcupine, Pig-tailed Macaque, White-fronted Langur, Red leaf monkey, Tarsius (*Diana tarsier*) and The Greater slow loris are important species that need to be preserved.

2. Artiodactyla (Cloven-hooved mammals)

   Several species from the Artiodactyla family like Samba deer (*Cervus unicolor*), the mouse deer (*Tragulus kancil*), Indian muntjac or barking deer (*Muntiacus muntjak*) and the Bearded pig (*Sus barbatus*) are the species hunted by the community. The hunting of the wildlife species of these families will greatly affect the population. The location of the observations is relatively far from residential areas, making this animal population still relatively safe from the threat of poaching. Same thing with Java Mouse Deer (*Tragulus javanicus*), Greater mouse-deer or napu (*Tragulus napu*), Barking deer or Indian muntjak (*Muntiacus muntjak*), although the intensity of the hunting of these wildlife is not as high as for the Samba deer (*Cervus unicolor*) and the wild boar (*Sus sp*.), but the conditions remain the same when one of the components of the ecosystems is missing that will have an effect on other components, especially the loss of their habitats.

3. Carnivores

   Sun bear (*Helarctos malayanus*) is a large mammal in Kalimantan. This species is included in CITES Appendix 1 category. This mammal is devoted to honey and this is one of the unique mammals. Similarly, the Clouded Leopard (*Neofelis nebulosa*), which is also included in Appendix I category of CITES, the presence of these animals in the wild is scarce and rarely found. There is also one species of new findings (*new record*), the Borneo Bay Cat (*Catopuma badia*) in BKNP. However, the data was obtained based on interviews with the public. It would be interesting to do a follow-up survey of the existence of the limited spread of the Borneo Bay Cat on the island of Borneo and the status of the IUCN classification as threatened.

Chapter 4
Birds

4.1 Introduction

BKNP is a conservation area which is categorized as one of the *Important Bird Areas* in Asia by *Birdlife International*. As an important area for birds, this area has the function of protecting and preserving the biological diversity, especially of birds. The protection and preservation of the diversity of bird species becomes important because it is one of the Animalia branches that have various values, ranging from economic, ecological and also for entertainment (Norris et al., 2002).

One indicator of success in the protection and preservation of the diversity of bird species in BKNP is the availability of up-to-date data on the existence of the bird species. Until now, the bird species data in BKNP refers to the data of the National Park Management Plan (RPTN) 2000-2024. According to RPTN data 300 bird species have been identified, which belong to 151 genera and 36 families (Raharjaningtrah Proyogo, 1998). The total number of bird species, equivalent to 57% of the total number of bird species in Kalimantan, numbered 522 species (Sukmantoro et al., 2007).

In an effort to carry out the protection and conservation of the bird species in question, monitoring and evaluation must be carried out, both towards the presence, the distribution and the condition of the population. Therefore, updating of the data and information of the bird species in BKNP must be carried out periodically to update and add data to the existing ones. The required information includes any new record of bird species, global and national conservation status as well as the addition of photographs of some bird species.

4.2 Methodology

4.2.1 Location and Time

The survey was done during 10 days from 19–28 June 2014 in Sub DAS Embaloh, namely

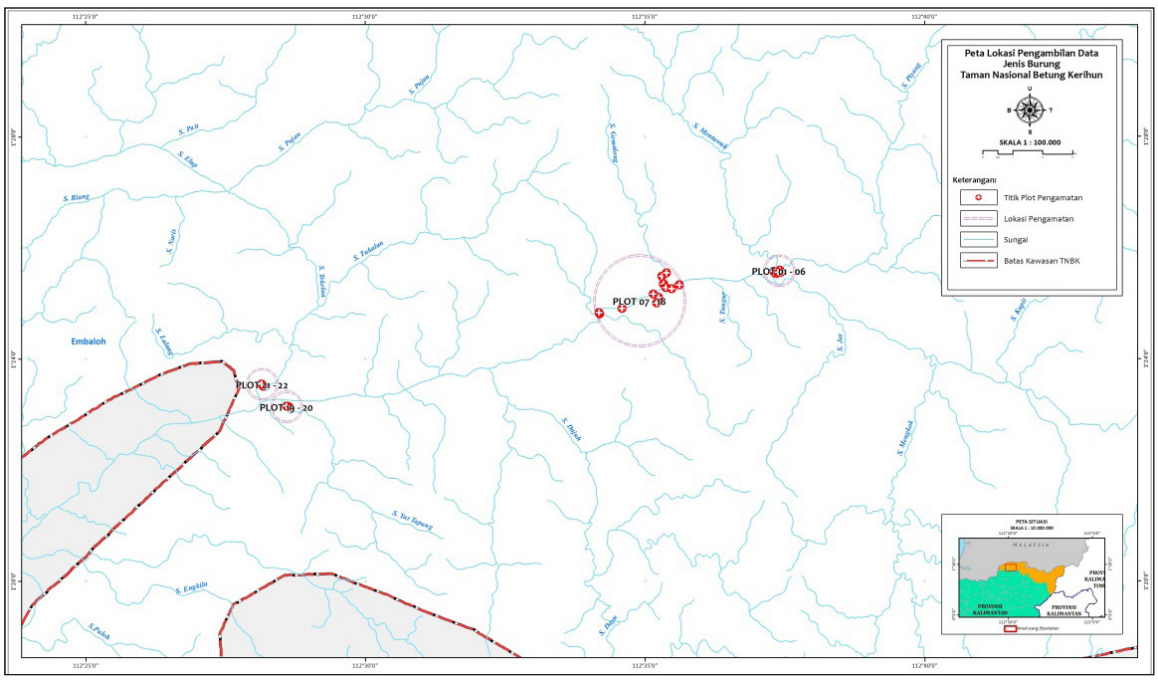


Figure 1. *Locations of Sample Plots For Data Collection Of Birds*

in the working area of the Field Management Unit of the National Park Region (Wilayah) I Mataso, Balai Besar Betung Kerihun National Park.

4.2.2 Tools and Materials

Tools and materials in the activities of updating data on the diversity of Birds in the Sub DAS Embaloh, were: working map of scale 1: 10,000, Canon Binocular 18x50 IS, DSLR camera, Lens Canon EF 200-400 mm f/4 l IS USM, fog nets 2 inches and 5 inches (6x2 meters), Bird Field Guide Book in Sumatra, Kalimantan, Java, Bali and books and stationery, *Global Positioning System* (GPS) Garmin Oregon 550.

4.2.3 Species and Data Collection Techniques

The data collected composed of 1) species; 2) photo of the species; and 3) the location of the encounter. Data collection was carried out from 06.00 – 17.00 WIB with Scanning Method and with Fog Nets by making 23 Observation Stations in the form of observation points (except for station-23 which was a strip in the river Embaloh) which were placed purposively from the Peyang River to the Tekelan River (see map). The following observation techniques were conducted at 23 observation Stations:

4.2.3.1 Observation according to Scanning

Scanning observation was done thoroughly from a single point of observation (Bibby, et al., 1992) and recorded successfully identified bird species from both the visual appearance and voice. For some species which allowed to be photographed, the identification of the species was done through using the photo references from the Bird Field Guide Book in Sumatra, Kalimantan, Java, Bali.

4.2.3.2 Installing the fog net at the observation station

The Fog Net method is a powerful survey technique for the study of bird species (Bennun, et al., 2002). The fog netting was done throughout the observation stations, except for the station-23. Identification of bird species with this technique was carried out on birds caught in the installed fog nets. For some species which allowed to be photographed, then the identification of the species was done through the photo, using Bird Field Guide Book in Sumatra, Kalimantan, Java, Bali.

4.2.4 Data Analysis

4.2.4.1 Total Bird Species

Data on the total number of bird species was analyzed descriptively by graphing each encountered bird species in each observation station as well as making a species curve in the survey area.

4.2.4.2 Identification of the Conservation Status of Bird Species

For identification of the Conservation Status of these Bird Species the *Red-list* data Book IUCN was used for global status and PP No. 7 of 1999 for national status.

4.2.4.3 Interesting Bird Species in Survey

In determining the interesting species in this survey the following criteria was used: (1) have a high global Conservation Status and nationally protected; (2) have a relatively high frequency of encounter, from the calculation of the data obtained; 3) sensitive species; (4) as *Top Predator* in the ecosystem (*Raptor* species has the role as top predators); (5) Threat by local hunting in BKNP (this criterion was obtained from the interview process with several local communities).

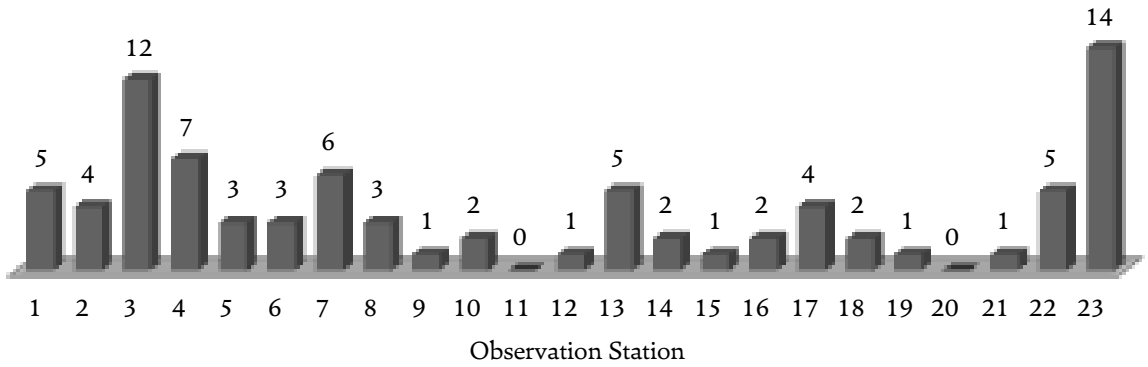


Figure 2. *Total Bird Species Identified At Observation Stations*

4.3 Results and Discussion

4.3.1 Total Bird Species

The diversity of bird species in the BKNP area is high because the previous surveys identified 301 species belonging to 151 genera and 36 families, with 24 of them are endemic to Borneo and 63 species are protected. From the most prominent *Bucerotidae* family in the area is the Wreathed hornbill (*Aceros undulatus*) and the Helmeted hornbill (*Rhinoplax vigil*) which is the mascot of West Kalimantan Province. In the limited time and place available for the implementation of this survey, 52 bird species were found belonging to 23 families. Although the time for the implementation of this survey was very short (10 days), however the encountered species represented almost all the identified families that live in the BKNP area, i.e. 23 of 24 families (95.8 %). The number of species that were found were also quite numerous, i.e. 52 out of 301 species (17.3%) with an additional encounters of 2 (two) bird species that has not yet been identified as existing in the BKNP area, namely the little green-pigeon (*Treron olax*) and the mustached hawk-cuckoo (*Cuculus vagans*) which was successfully documented by photographs. The total number of recorded bird species in this observation can be seen in Annex 8. The following chart illustrates the number of bird species recorded at each observation station.

The diagram above shows that Observation Station-23 (river strip) has the highest encounter i.e.14 species of birds, whereas Observation Station-11 and Observation Station -20 there were no encounters of any bird species. At any other Observation Station which encountered bird species the number has varied from 1 to 7 species of birds. Variation of the numbers at all stations averaged at an encounter of 3.65 bird species.

In addition to the number of bird species in the diagram for each observation station, it is also necessary to make the observation curve of the species, in order to illustrate the relationship between the cumulative numbers of species of recorded birds at each observation station, so it looks like a curve of the observed bird species. Steepness of the graph is created to reflect the richness of the species and is also useful for determining the likelihood of encounters with other species in the survey area (MacKinnon *et.al*. 2000). Figure 21 shows the value curve of every bird species at each Observation Station.

The curve above also shows the increase of high-value species found in Observation Stations-3 with 10 observed species and Observation Stations-23 with 9 species. The curve also shows that almost in every observation

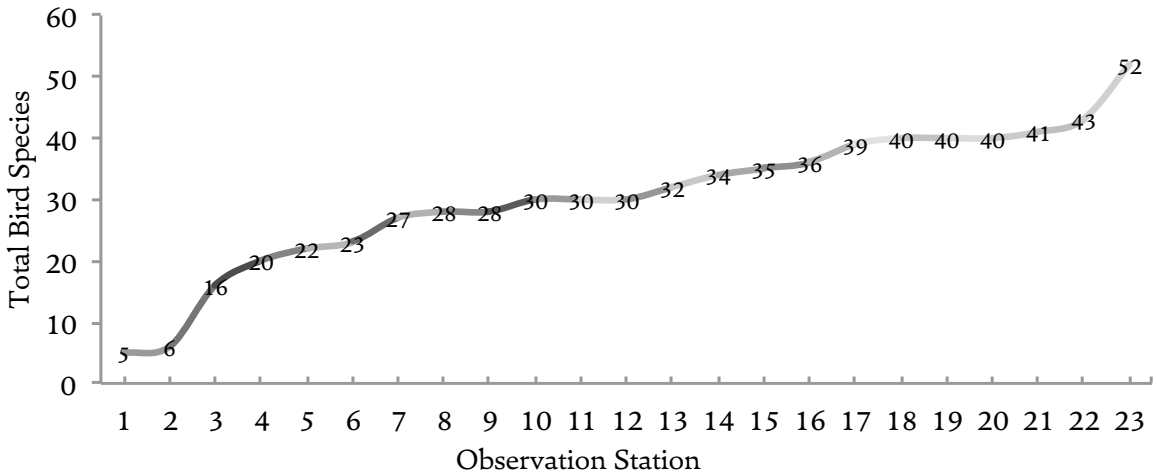


Figure 3. *Growth Curves of Bird Species in Survey Area*

station the increase in species occurs on the average of 2.26 bird species per station. Based on the average and the shape of the curve in the graph, it can be concluded that it is still possible the increase the species in the survey area if further observation is done.

4.3.2 New Record Of Bird Species In BKNP

Figure 4. *Mustached Hawk-Cuckoo (Cuculus vagans)*

Based on the results of the comparison of bird species data in 2014 with the data of bird species in the RPTN of Betung Kerihun it can be noted that there are two new species of birds that have been record in BKNP, namely the Little Green-Pigeon (*Treron olax*) and Mustached Hawk-Cuckoo (*Cuculus vagans*). According to (Mac Kinnon, 2000) the species *Treron olax* has the habit to live in groups or live in pairs and is a common species of Kalimantan while the species *Cuculus vagans* has a habit of being in the forest edge and are among those which are rarely encountered (the MacKinnon pass et al., 2000).

With the addition of these two bird species, the number of bird species recorded in BKNP until 2014 is 302 bird species. Of the two new records of bird species it is just the species *Cuculus vagans* which has available documentation in the form of photos, whereas for the species *Treron olax* it is not available.

4.3.3 Conservation Status Of Bird Species Which Have Been Identified

On the Global scale, the determination of the priorities in conservation was carried out by IUCN starting from 1960 to provide ranking endangered species which were was entered in the Red-list Book Data (Norris *et.al.*, 2002). The following is a ranking made by IUCN in

the *Red-list Data Book* for species which have already been evaluated starting from the highest conservation status: *Extinct, Extinct in the wild, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern*.

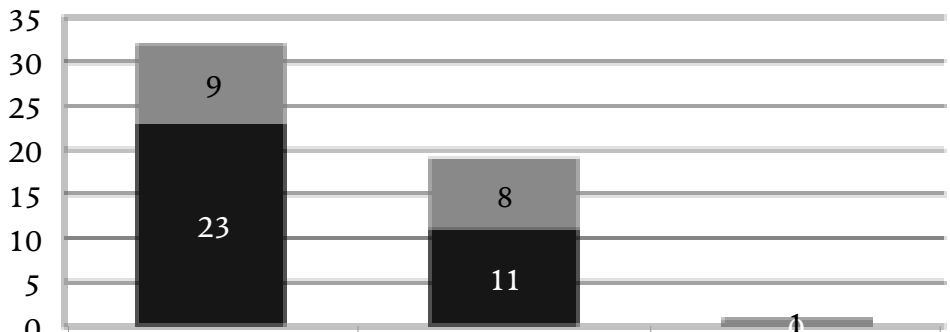
The conservation status of a species on a national scale refers to Government Regulation (PP) No. 7 of 1999 about the Conservation of Plants and Animals which is the implementation of Law No. 5 of 1990 concerning Conservation of Natural Resources and their Ecosystems. Government Regulation contains 294 species of Vegetation and Protected wildlife. For birds, there are 124 bird species which are protected.

The determination of the status of conservation of the bird species which has been recorded in this survey used the two references above, namely the *Red-list Data Book* IUCN and *PP No. 7 of 1999*, which describes the status of the global protection and the national protection. Information related to the conservation status can provide the latest information of the data of the bird species which are in the BKNP. Figure 23 shows the status of 32 species *Least Concern*, 19 species with status *Near Threatened*, 1 species with status *Vulnerable* and 18 species to be protected PP-7 of 1999 (Figure 23; Annex 9).

From Figure 23, there is one species which is included in the *Vulnerable* status and is protected by PP-7 of 1999, namely the species of *Alcedo euryzona*, this species needs to get a serious conservation concern. However, attention to the conservation of the species which are included in the status of *Near Threatened* should also have been started, because their status is very likely to turn into *Vulnerable* or even higher in the next few years. For the other species which are listed in the Status *Least Concern* globally these are still abundant, but from existing data, there are 9 bird species which need to be protected and also need to get attention.

4.3.4 Interesting Bird Species in Survey

In determining the species of interest for this survey several criteria needed that can be used as a tool of approach. The following were the criteria for determination of species of interest in this survey, i.e. (1) has a high global Conservation Status and nationally protected; (2) has a relatively high frequency of encounters, from the calculation of the data obtained; (3)



	Least Concern (Redlist IUCN)	Near Threatened (Redlist IUCN)	Vulnarable (Redlist IUCN)
Protected	9	8	1
Not Protected	23	11	0

Figure 5. *Total Bird Species Identified in Observation Stations*

species which are sensitive; (4) as *Top Predator* in the ecosystem (species *Raptor* has a role as *top predators*); (5) has a threat of being hunted/ poached locally in the BKNP (this criterion was obtained from the simple interview process from several local communities). If the bird species meet one or more of the four criteria established, then the bird species can be classified as an interesting species in this survey.

4.3.4.1 Blue-banded kingfisher (*Alcedo euryzona*)

Alcedo euryzona is a species that has the highest global conservation status namely *Vulnerable*, in addition this bird species is also protected according to PP-7 of 1999. MacKinnon *et.al.* (2000) stated that *Alcedo euryzona* is a species that is not common in Kalimantan. In this latest survey, the species which is included in *Alcedinidae* (Kingfishers) were found only at Station 10 and Station 23.

Figure 6. *Blue-banded kingfisher (Alcedo euryzona)*

Pycnonotus melanoleucos is a species with the highest frequency of encounters among other species. In addition, the species which is included in *Pynonotidae* (Bulbuls) has a global conservation status of *Near Threatened*, which means this species is already approaching a high level of threatening.

4.3.4.2 Black-and-white bulbul (*Pycnonotus melanoleucos*)

Figure 7. *Black-and-white bulbul (Pycnonotus melanoleucos)*

4.3.4.3 Helmeted hornbill (*Buceros Vigil*)

According to information from the community, *Buceros Vigil*, is a bird species of the family *Bucerotidae* which is most often hunted for its head. Therefore, the threat of the local population to this species is quite high. In addition, globally this species is already approaching endangered level as it is included in the status *Near Threatened* (IUCN). In these observations, note of encounters is only obtained at station-6 but no photo could be taken.

Figure 8. *Great argus (Argusianus argus) photo taken by trap camera survey team of mammals*

4.3.4.4 Great argus (*Argusianus argus*)

Of the 52 species of birds recorded in this observation, only the species *Argusianus argus* was recorded from an indirect encounter (voice) and the photographic documentation was taken from the trap camera used for mammals by the survey team. It is difficult to directly encounter with this species, because of the species is shy. According to Meijaard *et al.* (2006) *Argusianus argus* is a species that live in primary forest and it is intolerant against disturbance. The characteristics of *intolerant* towards disturbances described that *Argusianus argus* is the species that is sensitive to changes in the forest conditions so the global conservation status is approaching *Near Threatened*.

4.3.4.5 Grey-headed fish eagle (*Ichthyophaga ichthyaetus*)

Figure 9. Grey-headed fish eagle (*Ichthyophaga ichthyaetus)*

Ichthyophaga ichthyaetus is one of the prey bird species which was identified. This bird is often found in the vicinity of large and small rivers and waterfalls (Birdlife International, 2014). The presence of birds of prey like the *Ichthyophaga ichthyaetus* whose position is a *top predator* indicates that the conditions of the river ecosystem particularly which exists in this survey are still good. However, with increasing global threat to their river habitat, resulting that this species is included in the *Near Threatened* status. No photo was obtained of this species during observation and recorded encounter was only in station-5 and station-23.

Chapter 5
Herpetofauna

5.1 Introduction

Indonesia has large tropical rain forests with a varied ecosystem causing to have a reach herpetofauna (reptiles and amphibians of a particular region, habitat, or geological period) that is quite advanced. BKNP has many forms of territorial river waters with good forest ecosystem which is still a good place of life for a wide variety herpetofauna species. Therefore, it is necessary to identify the species regularly to get the latest data on the herpetofauna species as well as to formulate the management and conservation efforts further of the herpetofauna species. According to Stuart et al. (2004), since 2004 more than a third of the herpetofauna population, especially the amphibians, in various parts of the world are experiencing a quite significant decline in the population. This population decline is widely linked to the global climate change which is very much affecting the condition of the wetlands. Related to this, the identification becomes extremely important to know the condition and whereabouts of herpetofauna species today. Although identification of herpetofauna species in BKNP had previously been done as set forth in the RPTN, but the possibility of new records are still very high.

5.2 Methodology

5.2.1 Location and Time

The survey was done during 10 days from 19 – 28 June 2014 in Sub DAS Embaloh, namely in the working area of the Field Management Unit of the National Park Region (Wilayah) I Mataso, Balai Besar Betung Kerihun National Park.

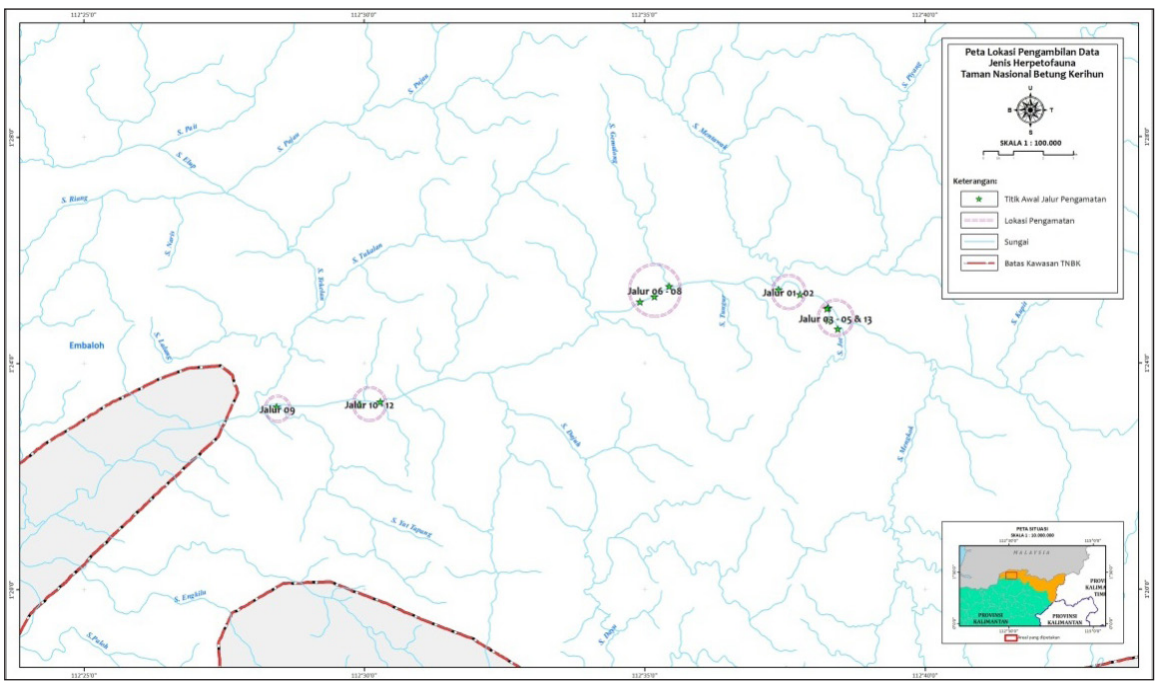


Figure 1. *Locations of Sample Stripes/Lines for Collection of Herpetofauna Data*

5.2.2 Tools and Materials

Tools and materials used for identification of herpetofauna species comprised of flashlight, bucket, camera, ruler, book, GPS, stick, plastic, stationery and gloves.

5.2.3 Species and Data Collection Techniques

The type of data collected in this activity included the location of encounter, species, images/photos, and other supporting information. Technically the data collection was carried out by making and determining the strip/track of the observation and time of observation, as well as the observation method, described in the following.

5.2.3.1 Create and determine the locations of the strips of the observations

The preparation of the observation tracks was carried out through a *desk study*, considerations, in the making these observation strips, were based on the existing river flows in the Sub-DAS Embaloh.

5.2.3.2 Determination of the observation time

Visual encounter surveys (VES) method or visual encounter survey is a method that is limited by time, then in this survey observations were carried out in the morning and evening. Observations in the morning were carried out between 07.00 –11.00 and in the evening between 18: 00 – 22: 00.

5.2.3.3 Observation Method

The observers were walking and looking for herpetofauna species for 15 minutes along a length limit of 50 meters and a width of 5 meters on either side of the river. If a herpetofauna species was found or seen within the limit then the name of the species was recorded. And so on until the time limit expired.

5.2.4 Data Analysis

Data analysis was done qualitatively and quantitatively through description of herpetofauna, including species, location of the images and other supporting information. Quantitative analysis was done of the relative abundance of species and families, and of the species diversity and evenness index in the observation location.

5.2.4.1 Qualitative Analysis

Qualitative analysis was conducted for the herpetofauna species including composition of the species, analysis of habitat and environmental factors which may affect the existence of the population of relevant species.

5.2.4.2 Quantitative Analysis

1. Relative Abundance

   The relative abundance was calculated to determine the abundance of herpetofauna that was encountered based on the range (duration) of the observation time. The relative abundance can also be used to predict the chance of encounter if the observation of herpetofauna will be carried out in the river.

   In addition the overall relative abundance (total) also was analyzed for analyzing the relative abundance of each species. To calculate the relative abundance per species referred to almost the same formula was used as for the total relative abundance, namely:

$$\text{Psi} = \frac{n1}{N} \text{ x } 100\%$$

   where:

   Psi = Value of the percentage abundance for species to i

   n1 = Total individual species to 1

   N = Number of individuals of all species

2. Species Diversity Index

   For species diversity index (H ') or Shannon Wiener diversity, the calculation was done using the formula:

$$H' = \sum\left(\frac{n1}{N}\right) \log\left(\frac{n1}{N}\right)$$

   where:

   H' = Species diversity index (diversity Shannon Wiener)
   n1 = Number of individuals of one species to i
   N = Number of individuals of all species

3. Species Evenness Index

   Species evenness index was used to identify the existence of species dominance in one location. The formula used to calculate the value of evenness (Odum, 1993) was:

$$Psi = \frac{H'}{Log\ s}$$

   where:

   e = Species Evenness
   H' = Species diversity index (diversity *Shannon Wiener*);
   s = Total species

5.3 Results and Discussion

5.3.1 Qualitative Analysis

5.3.1.1 Species Composition

Surveys of Herpetofauna in Sub DAS Embaloh were done along 12 strips/lines of aquatic habitats and it succeeded to get 33 species of herpetofauna which consisted of: 21 species of amphibians and 12 species of reptiles. Amphibians are divided into 5 families, namely: *Dicroglossidae* (3 species), *Bufonidae* (4 species), *Ranidae* (5 species), *Rhacophoridae* (3 species) and *Megophrydae* (3 species) as well as 1 species frog which could not be identified. As regards Reptils it consisted of 5 families, namely: *Agamidae* (1 species), *Colubridae* (5 species), *Gekkonidae* (2 species), *Scincidae* (3 species) and *Geoemydidae* (1 species). List of herpetofauna species that were found during the observations and their conservation status can be seen in Annex 10.

Of the species found during the observations, 1 species falls into the category *vulnerable* (VU), namely the Malayan flat-shelled turtle (*Notochelys platynota*) which belongs to the family *Geoemydidae*. Some frog species encountered also belong to the category of *Near Thereatened* (NT), namely the Rough-backed River Frog or Tributary Wart Frog (*Limnonectes ibanorum*) which belongs to the family *Dicroglossidae*, Long-fingered slender toad (*Ansonia longidigita*), and **Short-nosed Tree Frog** (*Rhacophorus gauni*) which belongs to the family *Rhacophoridae*.

ITTO survey of 1998 stated that the herpetofauna that was successfully identified was as many as 103 species, comprising 51 species of amphibians, 26 species of lizards, 2 species of crocodiles, 3 species of turtles, and 21 species of snakes. Among the herpetofauna species, there are 2 species which are endemic to Kalimantan/Borneo, i.e. gecko species/Malayan bent-toed gecko (*Cyrtodactylus malayanus*) and one species of snake/Slender-tailed wolf snake (*Lepturophis bornensis*).

In addition, endemic species, in the area of BKNP also new herpetofauna species was found, meaning that its existence has not been identified in previous surveys, i.e. 1) *Kurixalus appendiculatus*, small-sized tree frog with a triangular shaped head with cone-shaped spots on the snout; 2) *Lepturophis bornensis*, a snake that has dark colors without motive, has a tapered tail and can reach up to two meters in length; 3) *Aplopeltura boa*, this snake is active at night (*nocturnal*) and generally live in the trees (arboreal) has a shape of a shield on top of the black head, eyes are clear and the dominating eyes (pupil) are rounded, and 4) *Rhabdorphis chrysargos*, the venomous snake, has 139-175 ventral scales, sub-caudal 60-96, nine upper lips, scales fourth to sixth touching the eyes,

two anterior temporal scales. The discovery of the new species in the BKNP area needs to be followed up in order to determine its distribution as well as the health of the ecosystem in the areas concerned. Because in general, the herpetofauna species were found not far from the small stony stream and crystal clear water. Changes that occur in the habitat as this will greatly affect the population and its existence.

A comparison of the number of herpetofauna that were found in BKNP is not much different when compared with the results in the forest villages of Piasak Village and the Jongkong Kiri Hilir Village where as many as 34 species were found (Mediyansyah, 2012). The existence of differences in the results of species is influenced by several factors, including the factors of effort which was done in search for wildlife, amphibians and reptiles. The calculation of effort usually is based on the length of time in the field and the extent of the area surveyed (Kusrini et al, 2007). Methods used also affect the results of the species. This method consisted of an active search, which searched the wildlife directly and passive search, i.e. using traps to catch animals, both with bait or without. To get the maximum results the biodiversity survey of amphibians and reptiles it is recommended to use both active and passive approaches (Kusrini et al, 2007).

5.3.1.2 New Species Found in BKNP Area

1. *Kurixalus appendiculatus*

Figure 2. *Small-sized tree frog (Kurixalus appendiculatus)*

A small-sized tree frog with a triangularly shaped head, and with cone-shaped spots on the snout part. The two front toes are webbed at the base, the third back leg until the fourth webbed toe some parts of the rear leg tip exceeded the membrane but others not. Skin texture on the upper part is covered by small elongated and prominent lines, expanded on the sides.

The outside of the front and back legs are small notched on the skin side, small cover from the thigh to the ventral (abdomen). Upper body color is gray greenish to brown, the sides of the head and body whitish, slightly yellowish. Size SVL: maximum: 41, minimum: 29 mm. This species lives in the area of primary forest and lowland old secondary forest to mountain forest.

2. *Lepturophis bornensis*

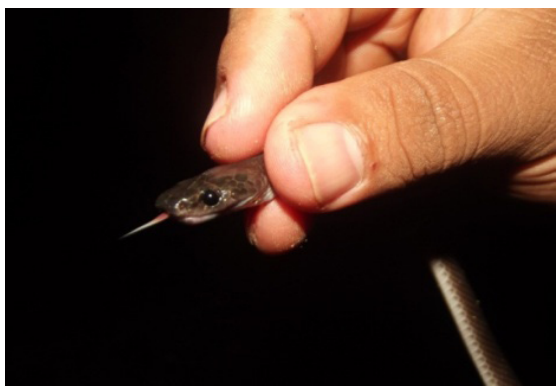


Figure 3. *Snake (Lepturophis bornensis)*

This snake has a dark-colored scale without motif with a tapered tail. According to information obtained by the team, this snake can reach a length of up to two meters. Commonly found on top of the twigs or tree branches but sometimes found swimming in small rivers with clear water.

3. *Aplopeltura boa*

Figure 4. *Snake (Aplopeltura boa)*

This snake has an almost rectangular shaped head with black head shield, clear eyes and dominated pupils are rounded. The upper jaw has an orange color. White milky body, green spotted body, brown and black spots (like tree bark). Head length is 125 mm, width 7 mm, head height is 65 mm, length of body is 290 mm, body diameter 7 mm, length of tail 130 mm, diameter of tail 3 mm. The habitat of this snake is the lowland and mountainous tropical forests. These snakes are active at night (nocturnal) and generally are living in the top of the trees (arboreal).

Figure 5. *Snake (Rhabdorphis chrysargos)*

4. *Rhabdorphis chrysargos*

These snakes are not venomous, has ventral plates of 139-175, subcaudal plates 60-96, nine upper lips, the fourth to the sixth plates touching the eye, temporal anterior plates are two. Color is brown or greenish with a pair of bright spots at rear side section, dark brown head, yellow lips are bordered by a dark color, the yellow line is frequently connected and meet at the nape of the neck, yellowish ventral with two pairs of black colors on the body. The main food is small frogs. This snake can reach a length of 80 cm. It lives in the primary and secondary forest, bamboo, shrubs, ponds, swamps, even often encountered around the settlements.

5.3.1.3 Condition of Strips/Trails of Aquatic Habitat

Habitat of herpetofauna in the BKNP area can be divided into two major habitats, i.e., Aquatic and Terrestrial. This observation only focused on aquatic habitat, namely 12 aquatic strips/trails as the places of observations. According to Iskandar (2008) most of the herpetofauna are living around rivers and others never leave the water. The aquatic habitat includes rocky/stony rivers with a width that varies between 2-11 meter, a depth of 10-50 cm and water conditions along the whole strip is very clear. Table 2 is an overview of the aquatic habitats.

Figure 6. *Picture of aquatic habitat strip*

Table 2. *Overview of aquatic habitats*

Strip	Clarity	Substrates	River Width (m)	River Depth (cm)
1	100%	sand, medium to large stones	2-6	10-50
2	100%	sand, medium to large stones	2-7	10-50
3	100%	sand, medium to large stones	6-11	10-30
4	100%	sand, medium to large stones	3-4	10-30
5	100%	sand, medium to large stones	8-11	10-40
6	100%	sand, medium to large stones	8-11	10-40
7	100%	sand, medium to large stones	8-11	10-40
8	100%	sand, medium to large stones	6-10	10-30
9	100%	sand, medium to large stones	9-11	10-40
10	100%	sand, medium to large stones	6-10	10-40
11	100%	sand, medium to large stones	6-9	10-40
12	100%	sand, medium to large stones	4-5	10-40

5.3.1.4 Environmental Factors (Temperature, Humidity, pH and weather)

The data obtained during field measurements showed a range of daytime temperature between 23-24°C and water temperature 23°C indicating that this environmental is in accordance with the life of the herpetofauna. This is in accordance with that was proposed by Berry (1975) which stated that amphibians get optimum growth at a temperature between 26-33 ° C and Van Hoeve (2003) which stated that the reptiles are active at temperatures between 20-40 ° C. Aquatic habitat at the observation sites showed that the water had a pH of 6 which indicates that the condition of the water is almost neutral. The value of the pH is good for the condition for the life of the amphibians, so on these field observations no defects were found that could occur in the amphibians. Payne (1986) in Darmawan (2008) stated that the water pH ranges, which are in the tropics, between 4.3 to 7.5.Sunny weather during the observations in the morning and in the evening made the implementation of observations much easier.

5.3.1.5 5.3.1.5 Ecological Distribution

Along the entire line of observations of the aquatic trails, some species of herpetofauna was always found in great numbers not far from the river. The species was often found in a medium-sized stony river, crystal clear water and small stony streams (Inger, 2005). Some of the herpetofauna species found are commonly encountered in river waters as well as at the mouth of the river, or twigs, leaves, and stones which were adjacent to river water. This relates to the life of herpetofauna, one class of amphibians, which are always associated with water (Iskandar, 1998).

Family Ranidae which were encountered on the observation sites included one of the most numerous species of its kind. Most aquatic habitats were found, among others, *Staurois latopalmatus, Hylarana raniceps, Odorrana hosii*, *Hylarana picturata* and *Staurois guttatus*. Species of the family *Bufonidae* were more often found in aquatic habitats, such as *Phrynoidis aspera*, *Ingerophrynus divergens*, *Pedostibes hosii*, *Ansonia spinulifer* and *Ansonia longidigita*, but some of them also were found in terrestrial habitat. These species were often found perched on rocks, leaves, twigs, wood, decayed wood and above-ground on the edges and in the middle of the river. *Bufo asper* is usually found along the river banks (Iskandar, 1998) and rarely seen in the water but is usually located on the ground at the edge of the river at a distance of 0.3 m to 8 m from the water (Inger, 1966), while the *Ansonia spinulifer* is in stony streams in primary forest where there is clear water (Inger, Stuebing, 2005).

Lebtobrachella mjobergi and *Megophrys nasuta,* which is a *Megophryidae* family more often found in terrestrial habitats camouflaged with litter on the forest floor. Family *Megophryidae* a litter frog species that is still considered to be primitive and live among litter and dry leaves (Perforated, 2003). This species has relatively short legs making this frog slow moving (Alexander,

1998). But there are also species of the family megophrydae found in aquatic habitats, in stony river and clear water namely the *Leptobrachella mjobergi*.

Rhacophorus gauni, Kurixalus appendiculatus and *Rhacophorus sp* from the *Rhacophoridae* family was found on the river banks and a few on the ground. *Rhacophorus gauni* were found perched on top of a small tree trunk and branches a few meter above the ground and about 2 m from the surface of the water. This species lives in primary to secondary forest, sometimes found on the flooded areas of former logging roads (Perforated, 2003).

In the Agamidae family, there are species like *Gonocephalus grandis* which can be found on a tree branch, in vegetation under large trees. During the day they are more difficult to find because they are easy to run and hide in the litter which resembles the color of their skins and of the stem of the tree.

Of the family Gekkonidae four species were found, among others *Crytodactylus malayanus, Cyrtodactylus consobrinus.* This species is found in the forest, which is on the river cliffs, stones, leaves and on the roots of the tree. The species found at night in a sleeping state.

Three (3) species of the family Scincidae were encountered, i.e. *Sphenomorphus sp 1, Sphenomorphus sp 2, Tropidophorus cf beccari*. The *Tropidophorus cf beccari* it can be found very easily when they are sunbathing (basking) in the morning sunlight on the litter. This species is a lizard that can be found on the edge of stony river banks or at the time sleeping in tree branches and on top of leaves with a height of 50 meters. During this observation 2 species of lizard was found which has not been identified, namely *Sphenomorphus sp 1* and *Sphenomorphus sp 2* and both of these lizards are found between sandy stones on the edge of the river.

Five species of snakes of the family Colubridae were encountered, namely *Aplopeltura boa, Lepturophis bornensis, Amphiesma flavifrons, Ahaetulla prasina, and Rhabdophis chrysargos*. The *Aplopeltura boa* snake is found on stones and it is active during the day, while the *Lepturophis bornensis* is found on stones near the river and more active at night. *Ahaetulla prasina* snakes are active at night, are often found on the leaves at a height of 50 meters and at this observation it was also found in the branches of trees at a height of 5 meters above the ground. *Amphiesma flavifrons* is a species that was most widely found during these observations, namely on twigs, stones on the edge of the river and sometimes were found crossing the river. *Rhabdophis chrysargos* encountered was eating baby frogs of species phrynoidis aspera on top of stones at the lip of the river along the line of observations. According to Tweedie (1983), snake species of the Colubridae family living mostly in terrestrial habitats and partly aquatic habitats.

This observation also found 1 species of turtle - freshwater turtle of the family Geoemydidae, i.e. *Notochelys platynota*. Freshwater turtles usually inhabit rivers with clear water, shallow fast flowing and slow flowing waters. The main food of freshwater turtles is foliage, fruits, snails, small fish and shrimps.

5.3.2 Quantitative Analysis

5.3.2.1 Relative Abundance

The relative abundance of species of herpetofauna is aimed at knowing the abundance of herpetofauna species that were encountered in the field. Table 3 represents the relative value of abundance of the species and the family of herpetofauna for each strip of the aquatic habitat.

Table 3. *Value of Relative Abundance*

Strip	Dominant Species	Relative Abundance
1	*Limnonectes ibanorum*	28%
2	*Limnonectes kuhlii*	27%

Strip	Dominant Species	Relative Abundance
3	*Limnonectes kuhlii*	27%
4	*Staurois guttatus*	39%
5	*Limnonectes leporinus*	19%
6	*Staurois guttatus*	47%
7	*Staurois guttatus*	18%
8	*Hylarana raniceps*	26%
9	*Staurois latopalmatus*	50%
10	*Staurois guttatus*	24%
11	*Hylarana hosii*	36%
12	*Phrynoidis aspera*	50%.

5.3.2.2 Species diversity and evenness index

The calculation of the diversity (H ') and evenness index of species (e) was based on the observations along per strip. The aquatic habitats strips 1-12 had diversity (H ') and evenness (e) index of species which varied. Figure 34 shows the calculation of the two indexes. The diversity of species or the species is a measure which states the variation of the species of the community that is affected by the number of species and the relative abundance of each species. In general there are three categories of diversity measurements of the species i.e. richness, abundance, and size of evenness of the species. Species diversity tends to be lower in the ecosystem which was physically restrained (i.e. strong chemical-physical target limiting factor) and high in the regulated biological ecosystem. Species diversity has several components that may react differently to the factors of geography, developmental or physical (Odum, 1993).

The species diversity was based on the observations of aquatic habitats per strip of the species' diversity index (H '), the highest value was found in the observation strip 7 of the aquatic habitat with a value of H '= 1.04 and followed by the lowest diversity index in aquatic habitat 9 with a value of H '= 0.66. As for the species evenness value (e) the highest value of observation was at aquatic habitat 5 with a value of e = 0.98 and followed by the lowest evenness value of species at aquatic habitat 6 with a value of e = 0.73.

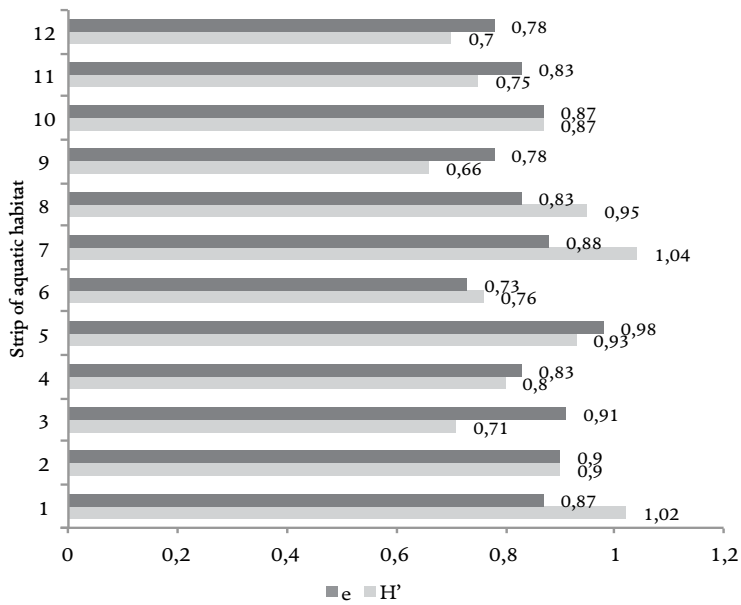


Figure 7. *Species diversity (H ') and evenness (e) index*

Chapter 6
Fish

6.1 Introduction

Based on the hydrological conditions, BKNP area is divided into six Sub-Watersheds (DAS). This shows that the BKNP area has a network of rivers that is very long and complex. Five major rivers in the area have a total length of 300 km, not including its branches (TNBK 2009). The results of spatial analysis shows that the length of the river in the BKNP area at least has a length of approximately 5,700 km. The conditions indicate the river along its length is a potential habitat for the presence of the fish.

Rachmatika & Haryono (1998) identified that there are 112 fish species, consisting of 12 families, 41 genera and 5 orders. The most abundant species in the sub DAS Embaloh and Sibau belongs to the family *Cyprinidae* (51 species), *Balitoridae* (26 species), and *Cobitidae* (11 species). In the Sub DAS Mendalam 69 species were found, consisting of 12 families, 39 genera, and 5 orders with the dominating species of *Cyprinidae* (47,88%), *Balitoridae* (14,08%) and *Cobitidae* (12,67%) (Rachmatika 2001). The diversity of fish species present in the Kapuas River and its several tributaries cumulatively recorded was 303 species (Robert, 1989 and Kottelat, 1993 in Rachmatika & Haryono, 1998). In the implementation of the activities of the *Resort Base Management* (RBM) in May 2012, the obtained information showed that one new species was found based on results of data collection in the field, namely Striped Wallago Catfish (*Wallago lerii*). However, the data and information of this fish species have not been fully documented.

Data and information of fish species which are currently documented is as many as 118 species. These species are divided into 16 families with most species identified in the families of *Cyprinidae*, *Balitoridae*, and *Cobitidae*. The above data and references show many species which have not yet been identified and has not been fully documented. Therefore it is necessary to

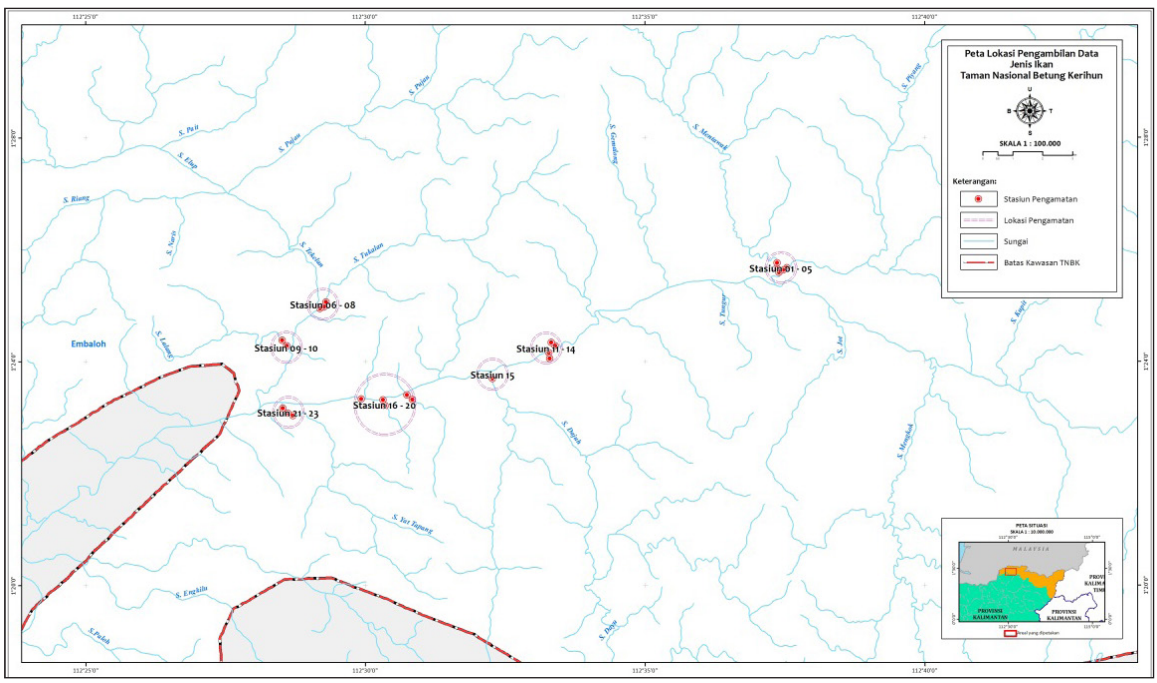


Figure 1. *Location of Sample Data Collection Stations for Fish*

update the data of fish species in the BKNP area. This update is for the completion of the data and information about the fish species found in BKNP as well as the possibility of additional new species.

6.2 Methodology

6.2.1 Location and Time

The location of the implementation of the updating activity of the biological diversity of the fish species was done in Sub DAS Embaloh in the BKNP area from June 19 to June 28, 2014 in 23 points of observation (station). The stations are located in the river tributaries (Figure 35). These tributaries are, namely Embaloh river (Peyang river, Rambing river, Dajo river, Senentang river, Gong river, and Riak Tapang river), tributaries Tekelan river (Santu and Sabung rivers), and small river Peyang (Mentawak river). Data were collected in the morning until the afternoon between 8:00 am to 14:00 pm.

6.2.2 Tools and Materials

Tools and materials used included nets, trawl, specimen boxes, caliper, plastic bags, camera, *Global Positioning System* (GPS), identification book, tools for measuring the physical and chemical composition of water, and stationery.

6.2.3 Species and Data Collection Techniques

Species data collected was the species of the fish. Such data included the name of the species, location, and a general description. Species identification was done with the help of the species identification book and for each species the length was measured and the total number counted per species. In addition to species, some physical-chemical parameters of water such as pH, temperature, flow was collected at the research station.

Data collection techniques used direct methods (direct count) and data collection was done intentionally (purposive sampling). Direct calculation was specifically using the *catch returns: Catch Per-Unit Effort (CPUE)* method. Data collection techniques were performed on the observation stations. Data collection of fish was done in each segment of the station along a segment of 50 m. In each tributary data collection was done in one to three stations, which started from the area around the estuary towards the upstream using gear mesh (mesh eyes 1 cm, length 3 m) which was operated at 10 times of the fishnet.

6.2.4 Data Analysis

Data analysis was done by dividing it into 3 main sections to achieve the goal. The three sections were: identification of species, diversity, and conservation status. Approach to research through research survey. The analysis used in the research was a descriptive and quantitative analysis of the data obtained. The scope of the data analysis in the study is listed in Table 4.

Table 4. *Scope of implementation of activities*

Purpose	Variable	Data Analysis	Output
Species Identification	Species Composition	Descriptive Analysis	Taxonomy of fish species, dominans, relative density
	Species Distribution	Descriptive Analisis	Distribution location of fish species
	Condition of Habitat	Descriptive Analisis	Physical and chemical condition of habitat
Species Diversity	Species richness	Margaleft Index	Richness category of fish species
	Species Diversity	Shannon-Wiener Index	Diversity category of fish species
	Species Evenness		Evenness category of species

Purpose	Variable	Data Analysis	Output
Conservation Status	*Red-list* IUCN and Legislation	Descriptive Analisis	Conservation category status of fish species

6.2.4.1 Species identification

1. Species composition

The composition of fish species was analyzed regarding taxonomy, abundance and frequency. A descriptive analysis of the taxonomy of the fish was based on using guidebooks (field guides). Taxa are divided based on *species, genus*, and *family*. In addition, the abundance and frequency of fish species composition of the species was described based on quantitative data.

2. Species Distribution

A descriptive analysis of the fish species distribution was divided up based on sighting location. The locations of observations in the rivers were used as sample data collection. The distribution of fish species was described based on the locations of the river.

3. Condition of Habitat

Habitat conditions were described based on the physical and chemical conditions. The physical and chemical conditions included vegetation, water temperature, velocity, pH, and DO. Habitat conditions were described in accordance with the sampling conditions in the field

6.2.4.2 Species Diversity

1. Species Richness

Species richness is the total number of species in a community. Fish species richness used the approach of the richness index of Margalef (Krebs 1978). Margalef richness index equation is, namely:

$$Dmg = (S-1)/(1n\ N)$$

where:

Dmg = Richness Index Margaleft
S = Total number of observed fish
N = Total number of individuals observed

2. Species Diversity

Shannon-Wiener index is the concept of relative diversity is best known and most widely used, which is calculated by the equation (Magurran 1988):

$$H' = -\sum_{i=1}^{S} (pi)(ln\ pi)$$

where:

H' = Shannon-Wiener
P_i =Proportion of individual species to-i

The level of Shannon-Wiener diversity Index is divided into 4 criteria. Barbour at al. (1987) in Kalima and Jasni (2010), criteria of the index value, i.e. if H '<1 categorized as very low, H '> 1-2 categories of low, H'> 2-3 medium category, H '> 3-4 high category, and if H'> 4 category is very high. The higher the index value H ' the higher is diversity of the species, ecosystem productivity, pressures on ecosystems, and ecosystem stability.

3. Index of Evenness

Index of Evenness functions is used to find out the evenness of each species in each community that was found with the value of the indicator between 0-1. If the value of E = 1 it means that there is no dominant species in the habitat. The evenness equation of the species, i.e. (Ludwig 1988):

$$E = \frac{H'}{ln\ S}$$

where :

E = Evenness Index
H' = Diversity of Mammal Species
Ln = Natural Logarithm
S = Total number of species

6.2.4.3 Conservation Status

Conservation status identifies the conditions of protection about the fish species that were found. Identification of conservation status was based on a global and national scale. Identification of conservation status used as reference the *Red-list data Book* IUCN for global status. Government Regulation (PP) becomes as a reference of the species status at the national scale.

The *Red-list data Book* IUCN version 3.1 was used for Endangered category. This version was published in 2001 and has undergone data updates a number of times up to version 10.1, which was issued in 2013 that included more detailed criteria of version 3.1. Endangered status is divided into 9 categories.

The conservation status of a species at the national scale can refer to PP 7/1999. PP contains which species of fish are protected. The number of fish species that are protected under this regulation is as many as 7 species.

6.3 Results and Discussions

6.3.1 Species Identification

6.3.1.1 Species Composition

Based on observations in the Sub DAS Embaloh, as many as 22 species of fish were identified which consisted of 5 families and 17 genera. The proportion of the number of fish species that were found was 20% of the database of the fish species which was included in the previous ITTO project (112 species). 22 species were obtained from 23 observation stations. Figure 36 shows the number of observations in each river. Gong river and Rambing river were the locations with the most number of observation stations, namely 4 stations. The river Senentang and the river Dajo were the locations of the observation stations with the least number, i.e. 1 per each station.

The composition of fish species found in the observation locations from family to species can be seen in Annex 12. The following families were found *cobitidae*, *cyprinidae*, *gyrinocheilidae*, *mastacembelidae*, and *tetraodontidae*. Most fish species encountered was of the family *cyprinidae* with a total of 16 species, divided into 12 genera. Of the *Gyrinocheilidae* and *Mastacembelidae* families only one fish species was found, namely *Gyrinocheilus pustulosus* (genus *Gyrinocheilus*, family *Gyrinocheilidae*) and the fish species *Macrognathus aculeatus* which belongs to the family Mastacembelidae. 1 fish species is a new data recording at BKNP. This new species, namely *Buntal Sabang* (*Monotrete sp.*) has not yet been identified by a scientific name.

The frequency of occurrences of fish in each river varies. Fish species at each observation location was found on an average of 10 species with different composition. The fish species that has the largest frequency, which was commonly found, was *Rasbora volzii* and *Lobocheilus bo*.

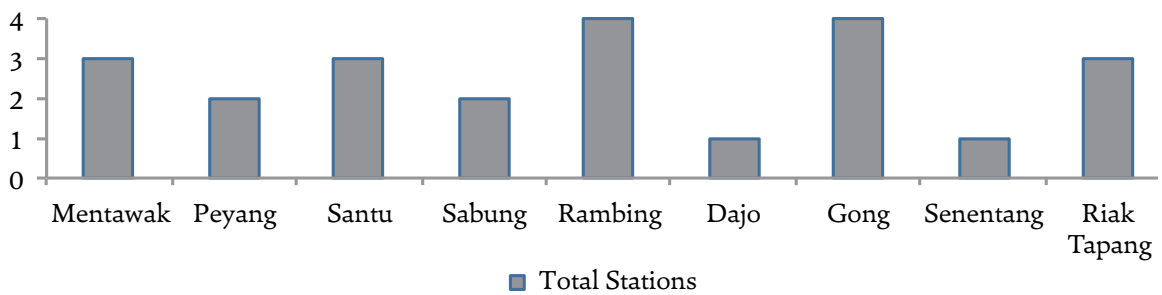


Figure 1. *Number of Observation Stations in Each River*

Both of these species were found throughout the observation locations of the river.

The least frequency of occurrences of fish, namely 9 species of fish was found only in one location. The abundance of individuals on the observation sites were dominated by several species of fish. 3 fish species with the largest individual abundance was, i.e. *Lobocheilus bo* (16 individuals/river), *Rasbora volzii* (15 individuals/river), and *Luciosoma setigerum* (13 individuals/river).The fish species which had the smallest number of occurrences was a total of 7 species of fish. Overview of the abundance of each species of fish is listed in (*something is missing here*)

Where is the figure?

The frequency of occurrences and abundance per river

6.3.1.2 Distribution of Species

The distribution of fish in 9 observation locations varied. The number of fish species most commonly found was in the Riak Tapang river and stream. The distribution of the species in the Senentang river was the location where the composition of the fish species found was the least. The following fish species was found throughout the observation locations, namely *Lobocheilus bo* and *Rasbora volzii*. Nine species of fish was found only in one of the rivers, namely *Acantopsis dialuzona, Anematichthys armatus, Labiobarbus fasciatus, Labiobarbus leptocheilus, Macrognathus aculeatus, Monotrete leiurus, Monotrete sp., Puntius binotatus,* and *Syncrossus hymenophysa.*

The distribution of fish species in each river observation location can be seen in Annex 13. The largest number of occurrences of species was found in the river Santu and Riak Tapang (15 species), while the smallest in the river Senentang (4 species). As regards to the occurrence of the number of individuals, the largest was found in the river Riak Tapang, as many as 192 individuals. Least number of individuals was found in Dajo river, which were 15 individuals.

6.3.1.3 Condition of Habitat

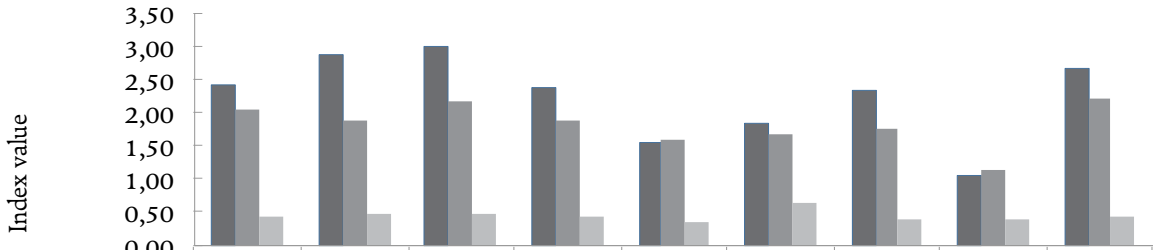
Habitat conditions were almost the same in all observation locations. Observation locations were situated in lowland forest (<300 meter above sea level). The ecosystem type is alluvial forest. The water temperature ranges between 20-25°C with an average of 23,39°C.Water flow velocity is between 0.10-0.60 m/sec with the largest velocity of the current in the Senentang river and the smallest in the river Mentawak.

The value of the degree of acidity (pH) of the water at observation sites varied between 6.5-7.5. The pH value has a neutral acidity. 19 stations have a pH value of 7. Three observation stations at the location of Mentawak river (2 stations) and Riak Tapang river (1 station) has a pH value of 6.5. 1 station which is located on the Senentang river is acid with a value of 7.5. Dissolved Oxygen/DO at each observation station has a value between 5-6 mg O_2/L. The pH and DO values indicate that the condition of the water is of good quality.

6.3.2 Species Diversity

Santu river has the largest species richness index value of 3.008. Senentang river has the least number of fish species (1,059). This condition is related to the size of the sample. The larger sample size of the species observed will increase the value of the richness index. The number of fish species in Santu river was 15 with a total of 105 individuals. In the Senentang river 4 fish species was found with a total of 17 individuals. Figure 37 illustrates the richness of fish species in each river observation location.

Fish species diversity at observation locations generally shows low diversity. The value of diversity index averages (1,823) indicating the degree of diversity of these conditions. That value is included into the low category. Figure 37 illustrates the diversity of conditions of fish species in each river observation location. The medium category (H ' > 2-3) diversity of fish species is located in the Mentawak river (2,058),



	Mentawak	Peyang	Santu	Sabung	Rambing	Dajo	Gong	Senentang	Riak Tapang
Richness	2,421	2,873	3,008	2,370	1,541	1,846	2,338	1,059	2,663
Diversity	2,058	1,905	2,157	1,899	1,584	1,691	1,751	1,149	2,214
Evenness	0,453	0,498	0,463	0,450	0,349	0,625	0,409	0,406	0,421

Figure 1. *Diversity Index Value*

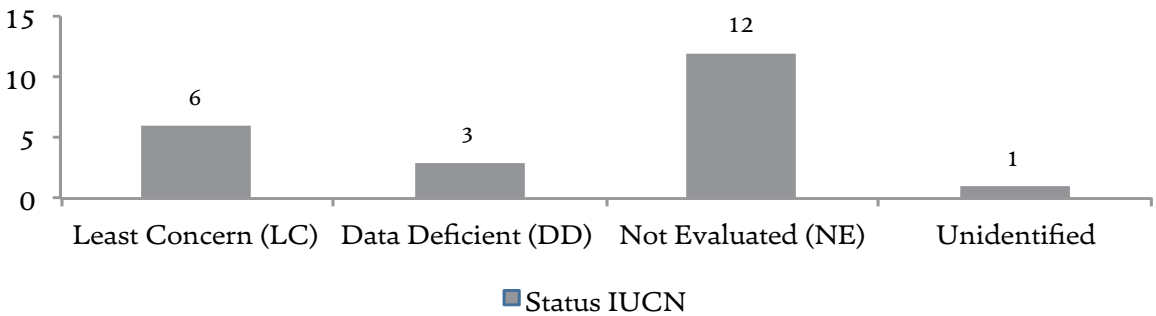


Figure 1. *IUCN Status of fish species observations*

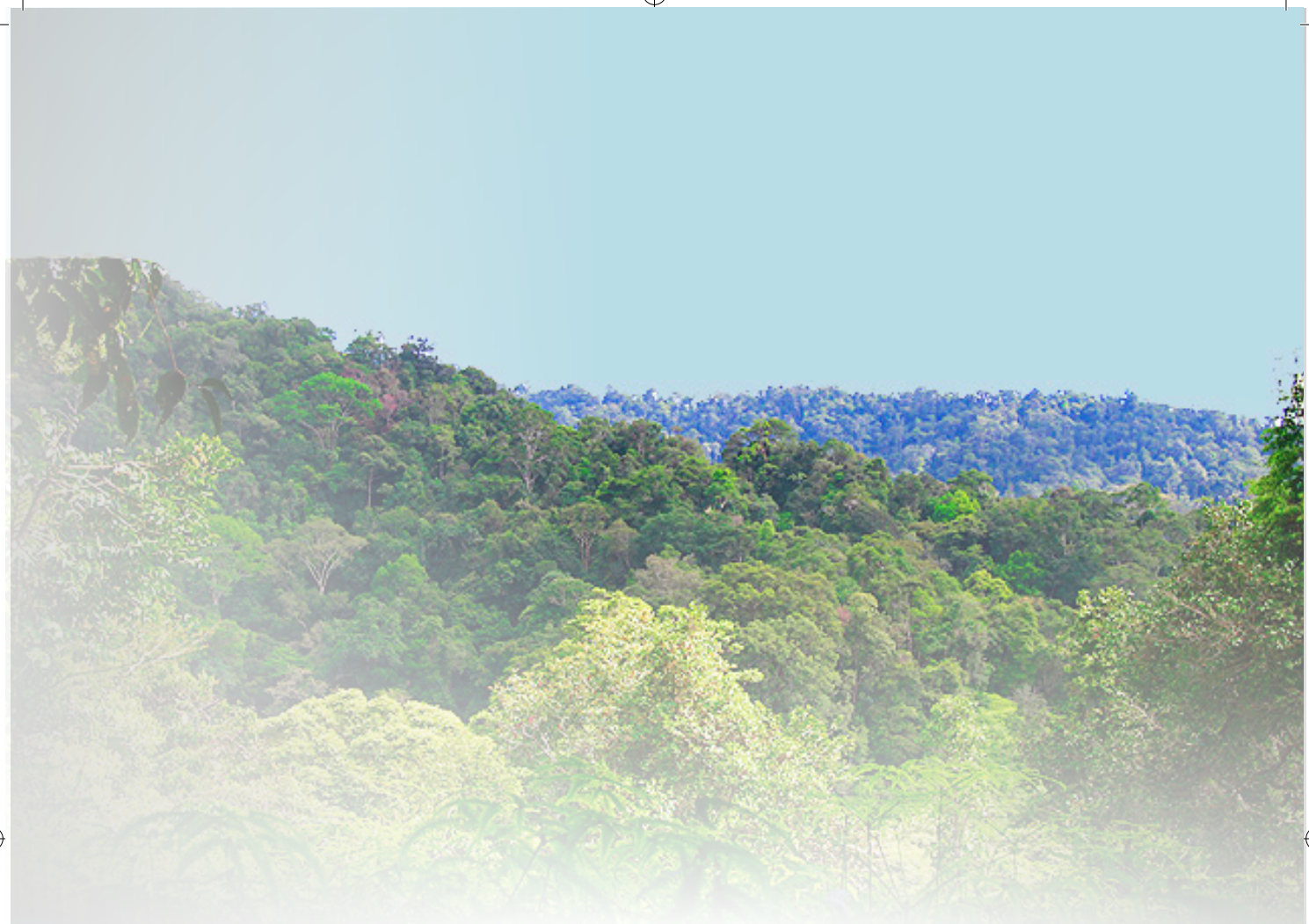
Santu (2,157) and Riak Tapang rivers (2,214). The Senentang river has the lowest diversity value of (1,149).

Evenness index showed that some fish species dominated in the observation locations. The average value of the evenness index for the entire observation location was 0.453. This value indicates that the evenness of fish habitat is dominated by certain species. Dajo river had the highest evenness index value (0.625) and the Rambing river the smallest value of 0,349 (Figure 6.4). Based on the number of individual species of fish in the Dajo river it can be said that the level of dominance is smaller than at other locations. Species of fish *Luciosoma setigerum* and *Rasbora volzii* dominated the habitats in the Rambing river, therefore its index value is small.

6.3.3 Conservation Status

Fish species found have not showed a high level of being threatened on a global as well as on a national level. Internationally, the fish species which has not yet been identified has not yet been at the threatened level.

Figure 38 shows fish species belonging to the category of *Least Concern*/LC (6 species), *Data Deficient*/DD (3 species), and *Not Evaluated*/NE (12 species). 1 fish species has not been identified because it is a new genus. Nationally, the conservation status of the 22 fish species found is not included among the protected species. Status refers to Regulation 7/1999, so that at the national level these fish species has not yet have a high threat level.



Chapter 7
Insects

7.1 Introduction

BKNP has a pristine ecosystem condition so that it can be said that the ecological system is still running well. One of the main constituent components of this ecosystem is the class of insects. Strong et al. (1984) reported that the insects have an important role in food chain, i.e. as herbivores, carnivores, and detrivora. In addition, the insect is also a bio-indicator for knowing the health condition of an ecosystem (Rizali et al. 2002).

Insects occupy the highest number of the biodiversity data of the fauna. Globally, the number of insect species that have been known reached over 750 thousand species (Permenhut 57/2008). Data on insects in Indonesia is still very limited, so is with the data in the BKNP. Based on the results of identification which has been carried out earlier, in the BKNP area not less than 170 species were identified and among them some new species (Reid 1966 in Soejito, 1998). This number is still far from the estimates because the identification of insects that was done was almost minimal and was not yet a priority. In addition, to date the results of the identification of the data, the name of the insects have not yet been entered into the database of the management unit. Therefore, the necessary updates of the diversity of insects in the BKNP area needs to be done to supplement the existing data, including the preparation of its data base.

7.2 Methodology

7.2.1 Location and Time

The location of the implementation of the activities for updating the biodiversity for the insect species was done in sub DAS Embaloh of the BKNP area from 19 June – 28 June 2014, i.e. in 21 site observations (transect). Transects were made to be around creeks (Figure 39) which is the habitat for insects. Data was collected in the morning until noon that is from 08.00 – 14.00 pm.

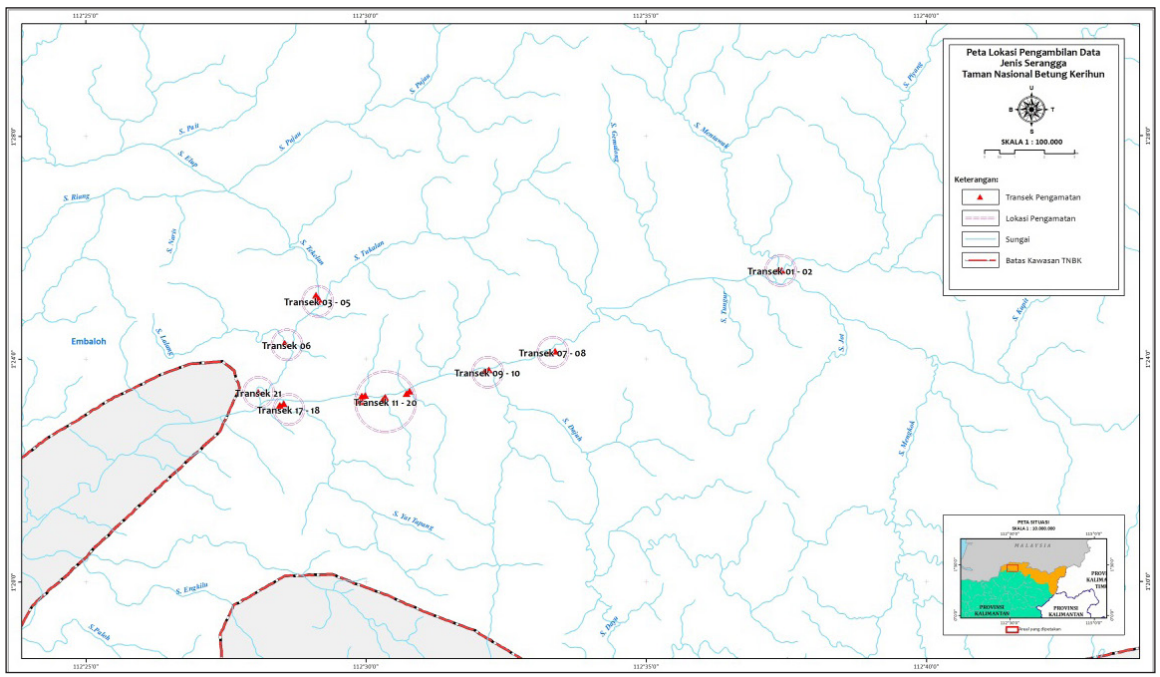


Figure 1. *Location of Transects for Collection of Sample Data for Insects*

7.2.2 Tools and Materials

Tools and materials that were used for the identification of the insect species were net, syringe, board setting, forceps, specimen boxes, camera, GPS, identification book, and stationery.

7.2.3 Species and Data Collection Techniques

The species data that was collected included name of species, location, and other general descriptions. Species was identified by using the identification book, related documentation, and *online* searches. Data collection was done along the transect lines which included composition of rivers and small stream flows with a distance of approximately 200 meters from the main river.

Insect species sampled was by following a predetermined strip which has ascertained the species that was above ground level. Stages in data collection were done by recording all the insects that were present within a fixed distance. Fixed distance of 1 meter on both sides along the transects. Recording of species (species that has been known) was done in the form of descriptions, quantities, activity, and other supporting information along the transect lines. Unknown species of insects were collected for identification.

7.2.4 Data Analysis

Data were analyzed by descriptive qualitative, i.e. including the composition of species, habitat conditions, and conservation status. The identification of species composition was based on taxonomic order, family, genus, and species, whereas the habitat conditions analyzed were the biophysical observation locations. The conservation status was judged as a global conservation status by using the IUCN *Red-list*, while for national conservation status, it was based on the legislation in force.

7.3 Results and Discussion

7.3.1 Species Composition

During these observations 82 species of insects were identified belonging to 11 order, 45 families, and 70 genera. The composition of the species as the result of the observations can be seen in Annex 17. However, all of these species have not yet been identified to the species level. The order of *Lepidoptera* is the order with most species found, namely 32 species.

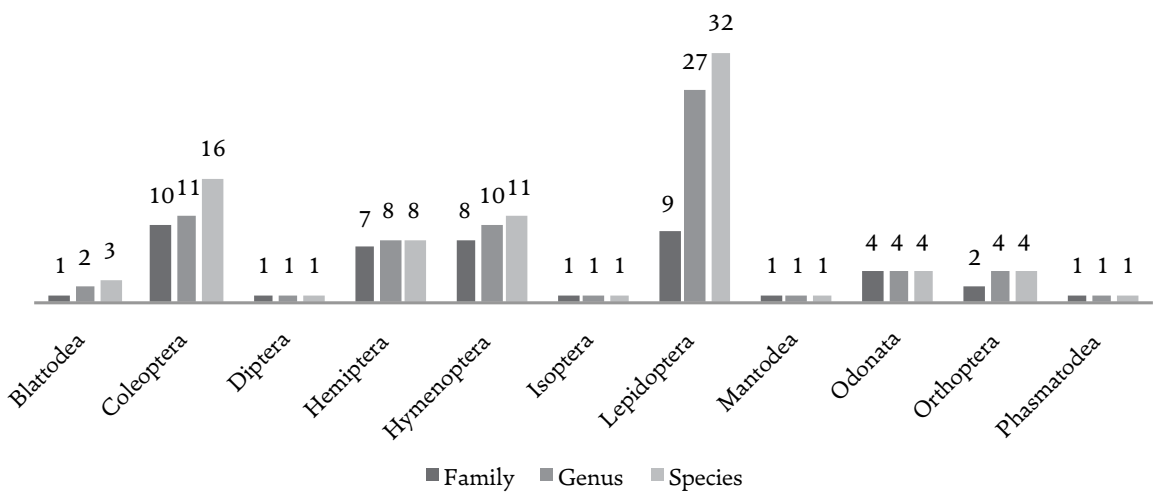


Figure 2. *Result of Composition of Insect Identification for Each Order*

The composition of the species found according to the order is shown in Figure 40.

The Order *Blattodea* is an insect species known as cockroaches. 3 species of this insect was identified. All of these species belong to the family *Blattellidae*. Genus identified for this order was, *Blattella* and *Celeriblattina*. 3 Species, namely *Blattella asahinai*, *Blattella germanica*, and *Celeriblattina major*.

The order of *Coleoptera* insect is known as a winged shield and 16 species of beetles belonging to 10 families have been identified. Most of these beetles can only be identified to the genus level and only 5 types which could be determined to the species level, namely *Aulacophora foveicollis, Geotrupes vernalis, Mordella aculeata, Haptoncus luteolus* and *Heliocopris dominus*.

Species of insects of the order *Diptera* are known as an order of flies. The species that could be identified in these observations is *Musca domestica* belonging to the family *Muscidae* and the genus *Musca*.

Order *Hemiptera* is a species of half winged insects and is known as ladybugs. From the results of the identification there are 8 species of ladybugs which belong to 7 families and 8 genera. In addition also 3 different species of ladybugs was found which recently have been identified to genus level. Species that were identified to species level, i.e. *Riptortus linearis, Proutista moesta, Spilostethus hospes, Dysdercus cingulatus* and *Eucorysses grandis*.

A total of 11 species have been identified of wasps, bees and ants that belong to the order *Hymenoptera.* These species belong to 8 families and 10 genera. One new bee species was found which was recorded but could only be identified to genus level.

Order *Isoptera* is known as the order of termites 1 species could be identified, namely *Macrotermes gilvus*. This species belongs to the family *Termitidae* and the genus *Macrotermes*.

Order *Lepidoptera* is an order which is the most widely known class of insects as it includes the butterflies and moths. Of the observations along the entire transects, 32 species was found belonging to 9 families and 27 genus. The most widely identified species belong to the family *Nymphalidae*, amounting to a total of 10 species. The species of the *Arctiidae* family could only be identified to genus level, all of which belonged to the genus *Amata*. *Trogonoptera brookiana* which is a type of butterfly that became the symbol of the BKNP belongs to the family *Pappilonidae* and the genus *Trogonoptera*.

Order *Mantodea* is an insect known as the order of mantids. Only one species was found of order *Mantodea*, namely *Manthis religiosa* belonging to the family *Mantidae* and genus *Manthis*.

Dragonfly is an insect species that belongs to the order *Odonata*. Results of identification showed there were 4 species of dragonflies which could be identified, namely *Anax guttatus* (family *Aeshnidae*), *Onychargia atrocyana* (family *Coenagrionidae*), *Dysphaea dimidiata* (family *Euphaeidae*), and *Prodasineura interrupta* (family *Protoneuridae*).

Order *Orthoptera* is a straight winged insect group. Identification of species of insects in the order resulted in 4 species, namely *Oxya chinensis*, *Phlaeoba fumosa*, and *Valanga nigricornis* which belongs to the family *Acrididae*, as well as *Gryllotalpa orientalis* which belongs to the family *Gryllotalpidae*.

Order *Phasmatodea* is a stick/cane insect or leaf insect. Species of *Phobaeticus chani* which was identified belongs to the family *Phasmatidae* and the genus *Phobaeticus*..

7.3.2 Habitat Condition

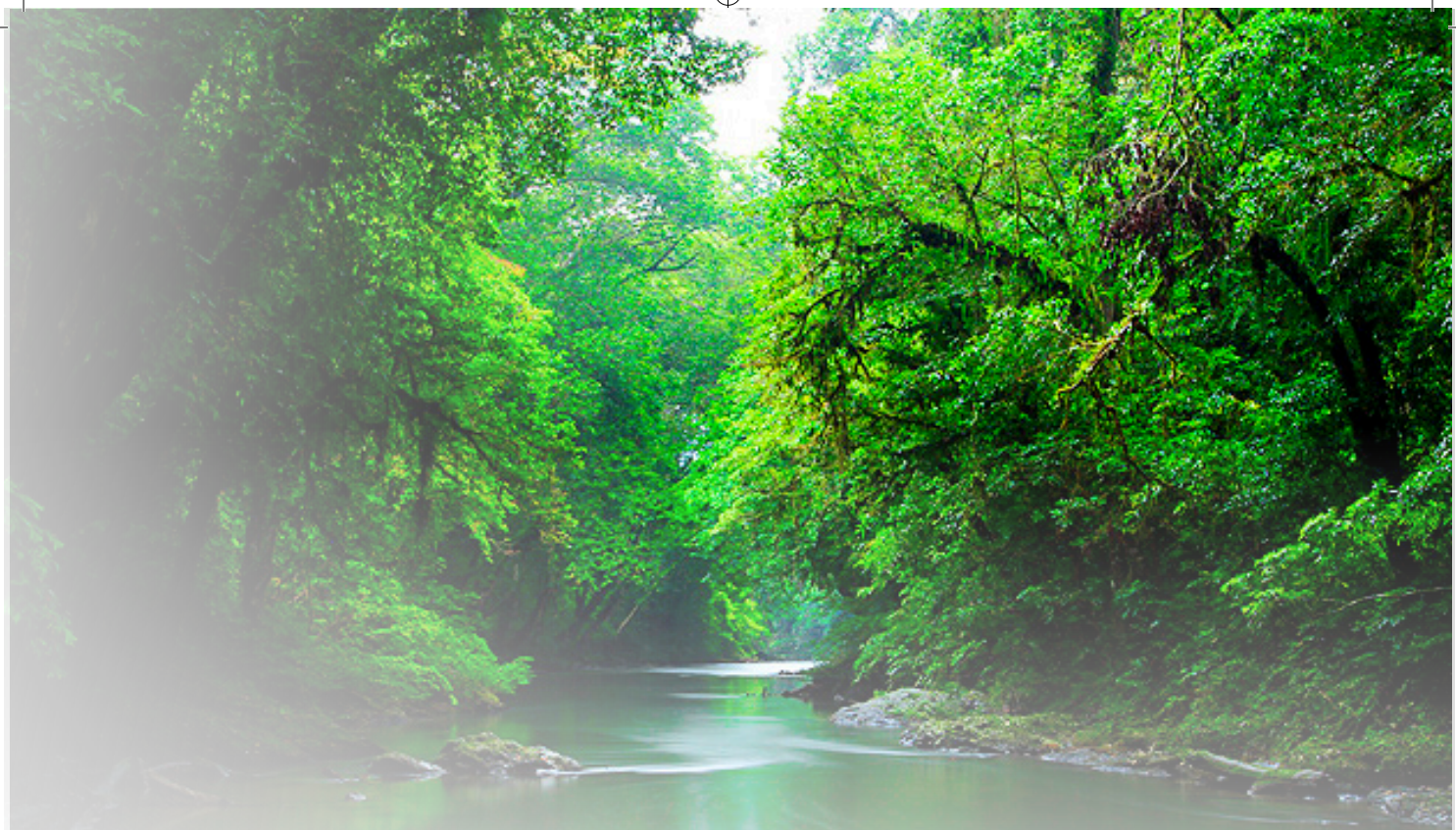
Insect observations were conducted on 23 strips of transects spread in the area surrounding the river. Most observations were made on the river Senentang and the river Gong because it was a location which was occupied by various species of insects. The locations of observation were situated at an altitude between 105 to 205

meters above sea level. This indicates that the location of the observation was in the lowland forests and alluvial forest ecosystem.

7.3.3 Conservation Status

Observations of insect species are not included in the scale of priorities for global conservation. Based on the IUCN *Redlist*, the insect species which were found are not included under the condition as being threatened with extinction. In general, all species identified can be divided into two categories, namely *Least Concern*/LC (3 types) and *Not evaluated*/NE (59 species). Whereas 9 other species has yet to be determined because the new category could only been determined to the genus level.

Nationally, one of the unidentified insects belongs to the protected categories, namely the butterfly Rajah Brooke's Birdwing (*Trogonoptera brookiana*). Protection of this species of butterfly is one of the factors making it as the logo of BKNP. In addition, the Government is considering this species to be included as one of the national conservation priorities from 2008 to 2018 for the group of insects.



Chapter 8
Conclusions and Recommendations

8.1 Conclusions

8.1.1 Flora

In the study area which was only covering 200 ha 227 plant species have successfully been found or about 20% of the total number of plant species that have been identified previously which were classified into 46 families. In previous vegetation survey, 1,217 species of plants were identified that belonged to 418 genera (genus) and 110 families with 75 species of them were endemic to Borneo. Although the identification is only performed on the plot (sample plots) without observation along the transects, the majority of plant species that have been identified previously successfully being found again or their existence was still being guaranteed in the BKNP area with 3 new plant species documented which has not yet been identified by their scientific names.

The highest number of species found is a member of the *Dipterocarpaceae* (34 species). The lowest number of species, only 1 species of each type belongs to the families *Anisophyllaceae, Araliaceae, Begoniaceae, Connaraceae, Gleicheniaceae, Olaca-ceae, Pandanaceae, Pentaphylaceae, Rhamnaceae, Simaroubaceae, Stemo-nuraceae* and *Vitaceae*. This indicates that Sub DAS Embaloh is dominated by species of the family *Dipterocarpaceae* so it can be called a *Dipterocarpaceae* forest (*Dipterocarp forest*).

According to the results of the identification of the value of the benefits from the plants that were found, of those which have been identified 36 plants species belonging to 15 families having value as foodstuff (food and drink). In addition, 86 plant species were recorded belonging to 10 families which have merits as building materials, and as many as 32 species belonging to 17 families have values as medicine.

8.1.2 Mammals and Primates

The number of mammal species which have been successfully encountered, either directly or indirectly, on the 6 observation locations was totaling 17 species which are members of 13 families, namely *Cercopithecidae* (3 species), *Scuridae* (3 species), *Petauristinae* (2 species), *Ursidae* (1 species), *Hystricidae* (1 species), *Felidae* (1 species), *Hominidae* (1 species), *Hylobatidae* (1 species), *Tragulidae* (1 species), *Cervidae* (1 species), *Muridae* (1 species), and *Manidae* (1 species). A total of 6 species of mammals are endemic to Borneo, namely Least pygmy squirrel (*Exilisciurus exilis*), Tufted ground squirrel (*Rheithrosciurus macrotis*), White-fronted surili (*Presbytis frontata*), Maroon leaf monkey, or red leaf monkey (*Presbytis rubicund*), Bornean orangutan (*Pongo pygmaeus pygmaeus*) and Gibbon (*Hylobates muelleri*).

Based on data from direct encounters, the value of richness index of mammal species at 6 observation locations were, namely Tekelan 1,333; Santo river 1,687; Dajo river1,143; Senentang river1,515; Riak Tapang river 2.117 and nameless river 1.178. Furthermore, Evenness Index Value at Tekelan 0,642; Santo river 0.81; Dajo river 0,871; Senentang river 0,755; Riak Tapang river 0,844 and nameless river 0,854. These values describe that at the 6 observation locations the area has species richness with an uneven distribution.

Kalimantan/Borneo carnivores species which live in the area of BKNP and fall into the category Appendix I in CITES, namely Sun bear (*Helarctos malayanus*) and Clouded leopard (*Neofelis nebulosa*), their existence in the nature begins to be difficult also to encounter them directly. In these observations, the existence of these two species could only be confirmed indirectly.

8.1.3 Birds

During the observations that was carried out in 23 observation stations, 52 species of birds could be identified which belong to 23 families. Among them, there are 5 species of particular interest or to be examined further based on

the criteria established in the analysis of data. In addition, there are two new records of bird species, namely little green pigeon (*Treron olax*) and Moustached hawk-cuckoo (*Cuculus vagans*).

Based on the number of encounters, Observation Station-23 (river strip), gave the highest number that is 14 species of birds, while at Observation Station-11 and Observation Station 20 not a single bird was encountered. Encounter of bird species at other Observation Stations ranged from 1 to 7 species. If making an even distribution, then the entire observation station has an average of 3.65 species of encounter.

The increase in the number of species was encountered at Observation Station-3 with 10 species and at the Observation Station-23 with 9 species. The average number of species for all observation stations was 2.26 species. Based on the average it could be concluded that it is still possible for species to be present in the area of observation if further observation is carried out.

8.1.4 Herpetofauna

The amphibious class is divided into 5 families namely; *Dicroglossidae* (3 species), *Bufonidae* (4 species), *Ranidae* (5 species),*Rhacophoridae* (3 species), and *Megophrydae* (3 species) as well as 1 species of frog which has not yet been identified. The reptile class consists of 5 families namely; *Agamidae* (1 species), *Colubridae* (5 species), *Gekkonidae* (2 species), *Scincidae* (3 species), *Geoemydidae* (1 species). There are two (2) species which are endemic to Kalimantan namely: *Cyrtodactylus malayanus, Lepturophis bornensis.*

Based on the results of the analysis, there are 4 species of herpetofauna which are new records in the BKNP area, namely *Kurixalus appendiculatus*, *Lepturophis bornensis*, *Aplopeltura boa* and *Rhabdorphis chrysargos.* In addition, there are several species of herpetofauna that have not yet been identified to the species level, namely 2 species of lizard (*Sphenomorphus sp 1* and *Sphenomorphus sp 2*) and one unidentified species of frog and 2 other frog species for which the name of the species is not known, namely *Rhacophorus sp.* dan *Leptobrachella sp*. This indicates that the BKNP area is an area that is rich in species of herpetofauna and it is quite possible that there are many species that have still not yet been identified.

8.1.5 Fish

The observations at 23 stations identified a total of 22 species of fish, belonging to 5 families and 17 genera or about 20% of the fish species data that are found in BKNP, i.e. as many as 112 species. During this observation also was found a fish species "*Ikan Buntal Sabang*" which is a new species recording.

The frequency of the occurrence of the fish species in each river that was observed was varying and on the average 10 species was found with different compositions. The fish species that have the greatest frequency of occurrences, which was most often encountered, was *Rasbora volzii* and *Lobocheilus bo*. The largest distribution of species was found in the Santu river and Riak Tapang river (15 species), while the smallest in the Senentang river (4 species).

The Riak Tapang is the location with the distribution of the species and the largest number of individuals, while the largest species richness was found in the Santu river with an index of 3,008 and the smallest (1,059) was situated in the Senentang river. Based on the foregoing, it can be said that the rivers in the Sub DAS Embaloh has a low fish diversity judging by the diversity of the species.

8.1.6 Insects

Species of insects which were found in observation locations were identified with a total of 82 species belonging to 11 orders, 45 families, and 70 genera. The proportion of the number of these species is 48% in relation to existing data of insects in BKNP. Order *Lepidopteramerupakan*

is the order with the largest number of species found, which reached 32 species. Other orders with the fewest species were found, each with 1 species is: *Diptera* with the species housefly (*Musca domestica*); *Isoptera* with termite species (*Macrotermes gilvus*); *Mantodea* with European Mantis species (*Manthis religiosa*); and *Phasmatodea* with Chan's megastick species (*Phobaeticus chain*).

According to the global conservation priority, there are no observations of insects which belong to the priority scale. Based on the IUCN *Redlist*, insect species which are found can be divided into 2 categories, namely *Least Concern*/LC (3 species) and *Not Evaluated*/NE (59 species). But there are 9 other species which could not be identified because these are only known to the genus level. The Rajah Brooke's Birdwing species (*Trigonoptera brookiana*) found in these observations is included among nationally protected species and was included as one of the priority species for conservation at both the local/site and national level.

8.2 Recommendations

8.2.1 Flora

In addition to using the trail/strip/transect methods of observation, it is also necessary to make observations and recordings of the species along the lines of the observations/transects. Although increasing the observation time needs to be done to minimize the number of the flora species that was not identified during the identification of the species on the observation location.

To minimize the level of mistakes (human error), adequate support is required, especially regarding the means, infrastructure and human resources in the activity analysis of flora/vegetation, including the species identifier in the field.

Observations must also be carried out in other parts of the BKNP area, especially in the Eastern part that have somewhat different characteristics to determine species diversity, richness and evenness of the flora species more comprehensively.

8.2.2 Mammals and Primates

Must be carried out by increasing the intensity of the survey as in the inventory of wildlife, that is by increasing the number of locations of observations, so as the diversity, the abundance and the existence of the animal species in the locations could be identified with more accuracy.

Some locations in Sub DAS Embaloh which were not included in this observation, such as the Sebabai area should also be included as a location of observation because of the potential presence of as well as abundance of mammals on the site, which is quite abundant, and relatively easily encountered given its location has not yet been much visited by the general public.

In order to determine the existence and condition of the carnivorous species inside the BKNP area, namely Sun bear (*Helarctos malayanus*) and Clouded leopard *(Neofelis nebulosa*) the mounting of a *Camera Trap* will be necessary at places crossings of trails/tracks as it is difficult to encounter them directly.

8.2.3 Birds

Remembering that BKNP has been defined by Birdlife International as an *Important Bird Area*, therefore the bird observations need to be made periodically, especially for those species which are protected and it is important to map their habitats.

Tracks/trails for specific observations, particularly observation stations with relatively high species diversity, such as stations 3 and 23 need to be monitored further to their development as a *Bird Watching Area*.

In addition to make the observation stations permanent which have already been made, it

will also need to be created/added a number of new observation stations in other locations so that the scope of the observations can become more thorough.

8.2.4 Herpetofauna

To obtain data and information that is more detailed about the diversity of herpetofauna, a more intensive observation need to be done with more adequate research facilities and infrastructure.

Considering the observations at this time focused on aquatic habitat, it is necessary also to make observations of the terrestrial habitat, which usually takes form of tracks/foot-paths/ trails in old secondary forests or tracks/footpaths of mammals (deer, boar, deer) in primary forests.

It should also be observed that with longer periods of observation time and effort which is more robust to search for amphibians and reptiles in a wider observation area so that the data obtained can be better and more diverse.

Considering the discovery of new species, namely the frog and the snake, then further observations must be carried out, both towards the species in question and their habitat.

8.2.5 Fish

Considering the BKNP area is divided into 5 (five) Sub DAS, namely the Embaloh in the west, Sibau-Menjakan and Mendalam in the center, as well as the Kapuas Hulu/Koheng and Bungan in the eastern part, then it is also necessary to identify fish species at these locations to get a figure of the richness of the species which is more comprehensive.

Different habitat conditions, in accordance with the physical condition of the rivers concerning the width, clarity/turbidity, depth, muddiness, stonyness, conditions of currents and rapids, also need to be considered in the analysis of the diversity, abundance and evenness of the species in addition to the characteristics of their habitats.

It is necessary to increase the intensity of sampling in Sub DAS Embaloh so as the data and information that will be obtained will be more comprehensive, including further observations towards the newly discovered species.

8.2.6 Insects

Observation of insects was this time carried out only on 23 transect strips in and around the river currents that was at an altitude of 105 - 205 meter above sea level and was lowland rainforest so that further observations have to be carried out to the upstream area of the river.

The intensity of observation must be increased by increasing the number of locations of observation of trails/strips in an open area to determine the differences in diversity, richness and abundance in different habitats.

Observations also need to be done with respect to those species of insects that are active at night (*nocturnal*) to determine the diversity, richness and abundance of the species that live in the area of BKNP.

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Appendices

Appendix 1. **List of Flora Species in Sub DAS Embaloh BKNP Area**

No	Name of Species	Local Name	Family
1	*Actinodaphne borneensis Meisn.*	Medang	Lauraceae
2	*Adinandra dumosa Jack*	Legai	Pentaphylaceae
3	*Aglaia cumingiana Turcz*	Lantupak	Meliaceae
4	*Aglaia sp.*	Lantupak	Meliaceae
5	*Aglaonema brevispathum (Engl.) Engl.*	Tanaman hias	Araceae
6	*Agrostistachys longifolia Benth.*	Gelintum	Euphorbiaceae
7	*Alpinia sp.*	Tanaman obat	Zingiberaceae
8	*Alseodaphne borneensis Gamble*	Medang	Lauraceae
9	*Alseodaphne sp.*	Medang	Lauraceae
10	*Anisophyllea disticha (Jack) Baill.*	Kayu Ribu	Anisophyllaceae
11	*Antidesma leucopodum Miq.*	Engkuni, rambai tikus	Phyllanthaceae
12	*Antidesma sp.*	Kayu masam	Phyllanthaceae
13	*Aporosa benthamiana Hook.f.*	Mergantung, Kayu masam	Phyllanthaceae
14	*Aporosa granularis Airy Shaw*	Kayu masam	Phyllanthaceae
15	*Aporosa lunata (Miq.) Kurz*	Kayu masam	Phyllanthaceae
16	*Aporosa sp.*	Kayu masam	Phyllanthaceae
17	*Archidendron sp.*	Pau	Leguminosae
18	*Ardisia copelandii Mez*	Merjemah	Primulaceae
19	*Ardisia elliptica Thunb.*	Merjemah	Primulaceae
20	*Ardisia pyrsocoma B.C.Stone*	Merjemah	Primulaceae
21	*Artocarpus elasticus Reinw. ex Blume*	Terap	Moraceae
22	*Artocarpus odoratissimus Blanco.*	Pingan	Moraceae
23	*Baccaurea polyneura*	Jelentik	Euphorbiaceae
24	*Bauhinia sp.*	Kupu-kupu	Leguminosae
25	*Begonia sp.*	Riang (lb. Tamb.)	Begoniaceae
26	*Bauhinia crudiantha*	Kupdaup	Leguminosae
27	*Calamus sp.*	Rotan	Arecaceae
28	*Calophyllum banyengii P.F.Stevens*	Bintangor	Calophyllaceae
29	*Calophyllum dioscurii P.F.Stevens*	Bintangor	Calophyllaceae
30	*Calophyllum ferrugineum Ridl.*	Bintangor	Calophyllaceae
31	*Calophyllum lanigerum Miq.*	Bintangor	Calophyllaceae
32	*Calophyllum rigidum cf.Miq*	Bintangor	Calophyllaceae
33	*Calophyllum sp.1*	Bintangor	Calophyllaceae
34	*Calophyllum sp.2*	Bintangor	Calophyllaceae
35	*Calophyllum venulosum Zoll.*	Bintangor	Calophyllaceae
36	*Canarium sp.*	Kenari/dabai	Burseraceae
37	*Canthium sp.*	Rukam, temongang	Rubiaceae
38	*Caryota sp.*	Pinang moreng	Arecaceae
39	*Cayratia mollissima (Planch.) Gagnep.*	akar	Vitaceae
40	*Cephalomappa malloticarpa J.J.Sm*	Bantas	Euphorbiaceae
41	*Cinnamomum sp.1*	Kayu manis	Lauraceae
42	*Cinnamomum sp.2*	Kayu manis	Lauraceae
43	*Cinnamomum sp.3*	Kayu manis	Lauraceae
44	*Cinnamomum sp.4*	Kayu manis	Lauraceae
45	*Cinnamomum sp.5*	Kayu manis	Lauraceae
46	*Cleistanthus sp.1*	Kerankajan	Phyllanthaceae
47	*Cleistanthus sp.2*	Ambis burung, Kaliwaju gunung, Kerankajan.	Phyllanthaceae
48	*Clidemia hirta (L.) D.Don.*	Bahang, Kunceng batu, kemunting	Melastomataceae
49	*Coelogyne sp.*	Anggrek (Tanaman hias)	Orchidaceae

No	Name of Species	Local Name	Family
50	*Castanopsis sp.*	Barangan	Fagaceae
51	*Dacryodes sp.*	Kedongdong/ kembayau	Burseraceae
52	*Dehaasia sp.*	Medang	Lauraceae
53	*Dendrobium grande Hook.f.*	Anggrek (Tanaman hias)	Orchidaceae
54	*Desmos cf.cochinchinensis*	Tanaman bawah	Annonaceae
55	*Dialium kunstleri Prain.*	Keranji	Leguminosae
56	*Dicranopteris linearis (Burm. f.) Underw.*	Resam	Gleicheniaceae
57	*Dillenia sp.*	Simpur	Dilleniaceae
58	*Diospyros ferruginescens Bakh.*	Kayu malam	Ebenaceae
59	*Diospyros sp.*	Kayu malam	Ebenaceae
60	*Diospyros sumatrana Miq.*	Kayu malam	Ebenaceae
61	*Dipterocarpus grandiflorus (Blanco) Blume*	Tekam, keruing	Dipterocarpaceae
62	*Dipterocarpus oblongifolius Blume*	Keruing	Dipterocarpaceae
63	*Dipterocarpus semivestitus Slooten*	Keruing padi	Dipterocarpaceae
64	*Dipterocarpus sp.1*	Tekam, keruing	Dipterocarpaceae
65	*Dipterocarpus sp.2*	Keruing	Dipterocarpaceae
66	*Dipterocarpus sp.3*	Keruing	Dipterocarpaceae
67	*Dryobalanops beccarii Dyer*	Keladan	Dipterocarpaceae
68	*Dryobalanops lanceolata Burck*	Kelansau	Dipterocarpaceae
69	*Dryobalanops oblongifolia Dyer*	Kelansau	Dipterocarpaceae
70	*Durio graveolens Becc*	Durian burung	Malvaceae
71	*Durio griffithii (Mast.) Bakh*	Durian hutan	Malvaceae
72	*Durio zibethinus Murray*	Durian	Malvaceae
73	*Elaeocarpus sp.1*	Surugam, Bengkinang	Elaeocarpaceae
74	*Elaeocarpus sp.2*	Surugam, Bengkinang	Elaeocarpaceae
75	*Elaeocarpus sp.3*	Surugam, Bengkinang	Elaeocarpaceae
76	*Endospermum sp.*	Melbau, melakong	Euphorbiaceae
77	*Eria sp.1*	Anggrek (Tanaman hias)	Orchidaceae
78	*Eria sp.2*	Anggrek (Tanaman hias)	Orchidaceae
79	*Eurycoma longifolia Jack*	Pasak bumi, tongkat ali, sengkayap (Tanaman obat)	Simaroubaceae
80	*Elateriospermum tapos*	Kelampai	Euphorbiaceae
81	*Fibraurea tinctoria*	Akar kuning	Menispermaceae
82	*Fagraea ceilanica Thunb.*	Tembesuk	Gentianaceae
83	*Fagraea fragrans Roxb.*	Tembesuk	Gentianaceae
84	*Ficus sp.*	Ficus	Moraceae
85	*Fordia splendidissima (Blume ex Miq.) Buijsen*	Tobah utan	Leguminosae
86	*Garcinia beccarii Pierre*	Manggis	Clusiaceae
87	*Garcinia borneensis Pierre*	Manggis	Clusiaceae
88	*Garcinia nitida Pierre*	Manggis	Clusiaceae
89	*Garcinia parvifolia (Miq.) Miq.*	Asam kandis	Clusiaceae
90	*Garcinia sp.1*	Manggis	Clusiaceae
91	*Garcinia sp.2*	Manggis	Clusiaceae
92	*Garcinia sp.3*	Manggis	Clusiaceae
93	*Gardenia sp.*	Kopi-kopi	Rubiaceae
94	*Gardenia sp.1*	Kopi-kopi	Rubiaceae
95	*Gironniera nervosa Planch.*	Lempung bulu	Cannabaceae
96	*Gironniera sp.1*	Lempung bulu	Cannabaceae
97	*Gironniera sp.2*	Lempung bulu	Cannabaceae
98	*Gironniera subaequalis Planch*	Lempung bulu	Cannabaceae

No	Name of Species	Local Name	Family
99	*Gluta sp.*	Rengas	Anacardiaceae
100	*Gluta wallichii (Hook.f.) Ding Hou.*	Rengas	Anacardiaceae
101	*Goniothalamus sp.1*	Empalis	Annonaceae
102	*Goniothalamus sp.2*	Empalis	Annonaceae
103	*Goniothalamus sp.3*	Empalis	Annonaceae
104	*Gonystylus sp.1*	Ramin	Thymelaeaceae
105	*Gonystylus sp.2*	Ramin	Thymelaeaceae
106	*Gonystylus sp.3*	Ramin	Thymelaeaceae
107	*Hopea dryobalanoides Miq.*	Merawan	Dipterocarpaceae
108	*Hopea sp.1*	Merawan	Dipterocarpaceae
109	*Hopea sp.2*	Merawan	Dipterocarpaceae
110	*Hopea sp.3*	Merawan	Dipterocarpaceae
111	*Hopea sp.4*	Merawan	Dipterocarpaceae
112	*Horsfieldia sp.*	Darah-darah, kumpang	Myristicaceae
113	*Knema conferta (King) Warb.*	Endera, darah-darah	Myristicaceae
114	*Knema glaucescens Jack*	Dara-dara	Myristicaceae
115	*Knema pulchra (Miq.) Warb.*	Darah-darah, dara-dara	Myristicaceae
116	*Koompassia excelsa (Becc.) Taub.*	Kempas	Leguminosae
117	*Koompassia malaccensis Benth.*	Kempas	Leguminosae
118	*Lasianthus borneensis Merr.*	Sjiloh	Rubiaceae
119	*Lasianthus griffithii Wight*	Merjantung	Rubiaceae
120	*Lasianthus sp.1*	Sjiloh	Rubiaceae
121	*Lasianthus sp.2*	Sjiloh	Rubiaceae
122	*Lepisanthes amoena (Hassk.) Leenh*	Kalansua	Sapindaceae
123	*Licuala spinosa Wurmb*	Gernih	Arecaceae
124	*Lithocarpus sp.1*	Empili	Fagaceae
125	*Lithocarpus sp.2*	Empili	Fagaceae
126	*Lithocarpus sp.3*	Empili	Fagaceae
127	*Lithocarpus sp.4*	Empili	Fagaceae
128	*Lithocarpus sundaicus (Blume) Rehd.*	Empili	Fagaceae
129	*Litsea rubiginosa (Blume) Boerl*	Medang	Lauraceae
130	*Litsea sp.1*	Medang	Lauraceae
131	*Litsea sp.2*	Medang	Lauraceae
132	*Lophopetalum multinervium Ridl.*	Bajan, Bantas, Perupok	Celastraceae
133	*Lophopetalum sp.*	Bajan, Bantas, Perupok	Celastraceae
134	*Lophopetalum sp.1*	Bajan, Bantas, Perupok	Celastraceae
135	*Lophopetalum sp.2*	Kumpang	Celastraceae
136	*Macaranga bancana (Miq.) Mull.Arg.*	Purang	Euphorbiaceae
137	*Macaranga beccariana Merr.*	Purang	Euphorbiaceae
138	*Macaranga pruinosa Mull.Arg*	Purang	Euphorbiaceae
139	*Macaranga sp. 1*	Purang	Euphorbiaceae
140	*Macaranga sp.2*	Purang	Euphorbiaceae
141	*Macaranga umbrosa S.J.Davies*	Purang	Euphorbiaceae
142	*Madhuca sp.1*	Nyatoh	Sapotaceae
143	*Madhuca sp.2*	Nyatoh	Sapotaceae
144	*Mangifera sp.*	Mangga	Anacardiaceae
145	*Melanochyla angustifolia Hook.f.*	Rengas	Anacardiaceae
146	*Melanochyla sp.*	Rengas	Anacardiaceae
147	*Melastoma malabathricum L.*	Kemunting	Melastomataceae
148	*Memecylon sp.1*	Nipis kulit	Melastomataceae
149	*Memecylon sp.2*	Nipis kulit	Melastomataceae
150	*Microcos fibrocarpa (Mast.) Burret*	Tanaman bawah	Malvaceae
151	*Microcos sp.*	Tanaman bawah	Malvaceae

No	Name of Species	Local Name	Family
152	*Microcos sp.1*	Tanaman bawah	Malvaceae
153	*Microcos sumatrana (Baker.f.) Burret*	Tanaman bawah	Malvaceae
154	*Myristica iners Blume*	Darah-darah	Myristicaceae
155	*Myristica sp.*	Dara-dara, darah-darah	Myristicaceae
156	*Myrmeconauclea sp.*	Dugal gawak, Panahan, Pitand.	Rubiaceae
157	*Neoscortechinia sp.*	Bantas	Euphorbiaceae
158	*Nephelium uncinatum Radlk. ex Leenh*	Rambutan hutan	Sapindaceae
159	*Ochanostachys amentacea Mast.*	Kayu bol	Olacaceae
160	*Palaquium sp.1*	Nyatoh	Sapotaceae
161	*Palaquium sp.2*	Nyatoh	Sapotaceae
162	*Palaquium sp.3*	Nyatoh	Sapotaceae
163	*Pandanus sp.*	Pandan-pandan	Pandanaceae
164	*Payena acuminata (Blume) Pierre*	Nyatoh	Sapotaceae
165	*Pentace triptera Mast*	Lukai	Malvaceae
166	*Pleiocarpidia sp.*	Sabah bubu	Rubiaceae
167	*Polyalthia cauliflora Hook.f. & Thomson*	Semukau, Dilasai	Annonaceae
168	*Polyalthia sp.1*	Dilasai	Annonaceae
169	*Polyalthia sp.2*	Dilasai	Annonaceae
170	*Polyalthia sumatrana (Miq.) Kurz*	Dilasai	Annonaceae
171	*Praravinia parviflora Bremek.*	Kopi-kopi	Rubiaceae
172	*Pternandra crassicalyx Maxwell.*	Puloh, pulo	Melastomataceae
173	*Pternandra rostrata (Cogn.) Nayar*	Puloh, pulo	Melastomataceae
174	*Pternandra sp.*	Puloh, pulo	Melastomataceae
175	*Rourea mimosoides (Vahl.) Planch.*	Akar reh (tanaman obat)	Connaraceae
176	*Salacia sp.*	Kerupu	Celastraceae
177	*Santiria laevigata Bl.*	Kayu boah	Burseraceae

No	Name of Species	Local Name	Family
178	*Santiria rubiginosa Bl.*	Inemanah	Burseraceae
179	*Schefflera petiolosa Harms*	Karot, kayu ala	Araliaceae
180	*Shorea leprosula Miq.*	Meranti	Dipterocarpaceae
181	*Shorea macrophylla (de Vriese) P.S.Ashton*	Tengkawang	Dipterocarpaceae
182	*Shorea macroptera Dyer*	Meranti	Dipterocarpaceae
183	*Shorea ovalis Blume*	Meranti	Dipterocarpaceae
184	*Shorea parvifolia Dyer*	Meranti	Dipterocarpaceae
185	*Shorea peltata Symington*	Meranti	Dipterocarpaceae
186	*Shorea pinanga Scheff*	Meranti	Dipterocarpaceae
187	*Shorea ochracea*	Raruk	Dipterocarpaceae
188	*Shorea sp.1*	Meranti	Dipterocarpaceae
189	*Shorea sp.2*	Meranti	Dipterocarpaceae
190	*Shorea sp.3*	Meranti	Dipterocarpaceae
191	*Shorea sp.4*	Meranti	Dipterocarpaceae
192	*Shorea sp.5*	Meranti	Dipterocarpaceae
193	*Shorea sp.6*	Meranti	Dipterocarpaceae
194	*Smilax blumei DC.*	Akar kemudang, merudang	Smilacaceae
195	*Smilax sp.*	Akar kemudang	Smilacaceae
196	*Spatholobus ferrugineus*	Kemedu	Leguminosae
197	*Spatholobus oblongifolius Merr.*	Kemedu	Leguminosae
198	*Stemonurus secundiflorus Blume*	Jerumut	Stemonuraceae
199	*Syzygium chloranthum (Duthie) Merrill & Perry*	Ubah	Myrtaceae
200	*Syzygium chrisrmannii Merrill & Perry*	Ubah	Myrtaceae
201	*Syzygium cleistocalyx P.S.Ashton*	Ubah	Myrtaceae
202	*Syzygium havilandii(Merrill) Merrill & Perry*	Ubah	Myrtaceae
203	*Syzygium jambos (Linn.) Ashton*	Ubah	Myrtaceae

No	Name of Species	Local Name	Family
204	*Syzygium multibracteolatum (Merrill) Merrill & Perry*	Ubah	Myrtaceae
205	*Syzygium nigricans (King) Merr. & L.M.Perry*	Ubah	Myrtaceae
206	*Syzygium palawanense (C.B.Rob.) Merr. & Perry.*	Ubah	Myrtaceae
207	*Syzygium racemosum (Blume) A.DC.*	Ubah	Myrtaceae
208	*Syzygium scortechinii (King) P.Chantaranothai & J.Parnell*	Ubah semut	Myrtaceae
209	*Syzygium sp.*	Jambu aek	Myrtaceae
	Syzygium tawahense (Korth.) Merr. & Perry	Ubah	Myrtaceae
210	*Syzygium velutinum A.P.Davis*	Ubah	Myrtaceae
211	*Timonius sp.*	Mulong udok	Rubiaceae
212	*Urophyllum arboreum (Reinw. ex Blume) Korth.*	Sabal bubu, meludok, kayu kropok	Rubiaceae
213	*Urophyllum sp.*	meludok	Rubiaceae
214	*Uvaria lamponga Scheff.*	Tanaman bawah	Annonaceae
215	*Uvaria sp.*	Tanaman bawah	Annonaceae
216	*Vatica micrantha Slooten*	Resak	Dipterocarpaceae
217	*Vatica oblongifolia Hook.f.*	Resak	Dipterocarpaceae
218	*Vatica sp.1*	Resak	Dipterocarpaceae
219	*Vatica sp.2*	Resak	Dipterocarpaceae
220	*Vatica sp.3*	Resak	Dipterocarpaceae
221	*Xantophylum sp.1*	Ruyak	Polygalaceae
222	*Xantophylum sp.2*	Ruyak	Polygalaceae
223	*Zingiber sp.*	Empuing, lea betong	Zingiberaceae
224	*Ziziphus havilandii Ridl.*	Akar kuku menaul (tanaman obat)	Rhamnaceae
225			Dipterocarpaceae
226			Melastomataceae
227			Rubiaceae

Appendix 2. **Plant Species as Source of Food (Food and Beverage)**

No	Name of Species	Local Name	Family
1	*Artocarpus elasticus Reinw. ex Blume*	Terap	Moraceae
2	*Artocarpus odoratissimus Blanco.*	Pingan	Moraceae
3	*Begonia sp.*	Riang (lb. Tamb)	Begoniaceae
4	*Calamus sp.*	Rotan	Arecaceae
5	*Canarium sp.*	Kenari/dabai	Burseraceae
6	*Caryota sp.*	pinang moreng	Arecaceae
7	*Cinnamomum sp.1*	Kayu manis	Lauraceae
8	*Cinnamomum sp.2*	Kayu manis	Lauraceae
9	*Cinnamomum sp.3*	Kayu manis	Lauraceae
10	*Cinnamomum sp.4*	Kayu manis	Lauraceae
11	*Cinnamomum sp.5*	Kayu manis	Lauraceae
12	*Dacryodes sp.*	Kedongdong/ kembayau	Burseraceae
13	*Dialium kunstleri Prain.*	Keranji	Leguminosae
14	*Durio graveolens Becc*	Durian burung	Malvaceae
15	*Durio griffithii (Mast.) Bakh*	Durian hutan	Malvaceae
16	*Durio zibethinus Murray*	Durian	Malvaceae
17	*Eurycoma longifolia Jack*	Pasak bumi, tongkat ali, sengkayap	Simaroubaceae
18	*Garcinia beccarii Pierre*	Manggis	Clusiaceae
19	*Garcinia borneensis Pierre*	Manggis	Clusiaceae
20	*Garcinia nitida Pierre*	Manggis	Clusiaceae
21	*Garcinia parvifolia (Miq.) Miq.*	Asam kandis	Clusiaceae
22	*Garcinia sp.1*	Manggis	Clusiaceae
23	*Garcinia sp.2*	Manggis	Clusiaceae
24	*Garcinia sp.3*	Manggis	Clusiaceae
25	*Licuala spinosa Wurmb*	Gernih	Arecaceae
26	*Lithocarpus sp.1*	Empili	Fagaceae
27	*Lithocarpus sp.2*	Empili	Fagaceae
28	*Lithocarpus sp.3*	Empili	Fagaceae
29	*Lithocarpus sp.4*	Empili	Fagaceae
30	*Lithocarpus sundaicus (Blume) Rehd.*	Empili	Fagaceae
31	*Mangifera sp.*	Mangga	Anacardiaceae
32	*Melastoma malabathricum L.*	Kemunting	Melastomataceae
33	*Nephelium uncinatum Radlk. ex Leenh*	Rambutan hutan	Sapindaceae
34	*Ziziphus havilandii Ridl.*	Akar kuku menaul (tanaman obat)	Rhamnaceae
35	*Baccaurea polyneura*	Jelentik	Euphorbiaceae
36	*Elateriospermum tapos*	Kelampai	Euphorbiaceae

Appendix 3. **Plant Species for Building Materials**

No	Name of Species	Local Name	Family
1	*Actinodaphne borneensis Meisn.*	Medang	Lauraceae
2	*Alseodaphne borneensis Gamble*	Medang	Lauraceae
3	*Alseodaphne sp.*	Medang	Lauraceae
4	*Calophyllum banyengii P.F.Stevens*	Bintangor	Calophyllaceae
5	*Calophyllum dioscurii P.F.Stevens*	Bintangor	Calophyllaceae
6	*Calophyllum ferrugineum Ridl.*	Bintangor	Calophyllaceae
7	*Calophyllum lanigerum Miq.*	Bintangor	Calophyllaceae
8	*Calophyllum rigidum cf.Miq*	Bintangor	Calophyllaceae
9	*Calophyllum sp.1*	Bintangor	Calophyllaceae
10	*Calophyllum sp.2*	Bintangor	Calophyllaceae
11	*Calophyllum venulosum Zoll.*	Bintangor	Calophyllaceae
12	*Dipterocarpus grandiflorus (Blanco) Blume*	Tekam, keruing	Dipterocarpaceae
13	*Dipterocarpus oblongifolius Blume*	Keruing	Dipterocarpaceae
14	*Dipterocarpus semivestitus Slooten*	Keruing padi	Dipterocarpaceae
15	*Dipterocarpus sp.1*	Tekam, keruing	Dipterocarpaceae
16	*Dipterocarpus sp.2*	Keruing	Dipterocarpaceae
17	*Dipterocarpus sp.3*	Keruing	Dipterocarpaceae
18	*Dryobalanops beccarii Dyer*	Keladan	Dipterocarpaceae
19	*Dryobalanops lanceolata Burck*	Kelansau	Dipterocarpaceae
20	*Dryobalanops oblongifolia Dyer*	Kelansau	Dipterocarpaceae
21	*Gluta sp.*	Rengas	Anacardiaceae
22	*Gluta wallichii (Hook.f.) Ding Hou.*	Rengas	Anacardiaceae
23	*Goniothalamus sp.1*	Semukau	Annonaceae
24	*Goniothalamus sp.2*	Empalis	Annonaceae
25	*Goniothalamus sp.3*	Empalis	Annonaceae
26	*Gonystylus sp.1*	Ramin	Thymelaeaceae
27	*Gonystylus sp.2*	Ramin	Thymelaeaceae
28	*Gonystylus sp.3*	Ramin	Thymelaeaceae
29	*Hopea dryobalanoides Miq.*	Merawan	Dipterocarpaceae
30	*Hopea sp.1*	Merawan	Dipterocarpaceae
31	*Hopea sp.2*	Merawan	Dipterocarpaceae
32	*Hopea sp.3*	Merawan	Dipterocarpaceae
33	*Hopea sp.4*	Merawan	Dipterocarpaceae
34	*Lepisanthes amoena (Hassk.) Leenh*	Kalansua	Sapindaceae
35	*Lithocarpus sp.1*	Empili	Fagaceae
36	*Lithocarpus sp.2*	Empili	Fagaceae
37	*Lithocarpus sp.3*	Empili	Fagaceae
38	*Lithocarpus sp.4*	Empili	Fagaceae
39	*Lithocarpus sundaicus (Blume) Rehd.*	Empili	Fagaceae
40	*Litsea rubiginosa (Blume) Boerl*	Medang	Lauraceae
41	*Litsea sp.1*	Medang	Lauraceae
42	*Litsea sp.2*	Medang	Lauraceae
43	*Madhuca sp.1*	Nyatoh	Sapotaceae
44	*Madhuca sp.2*	Nyatoh	Sapotaceae
45	*Melanochyla angustifolia Hook.f.*	Rengas	Anacardiaceae
46	*Melanochyla sp.*	Rengas	Anacardiaceae
47	*Palaquium sp.1*	Nyatoh	Sapotaceae
48	*Palaquium sp.2*	Nyatoh	Sapotaceae
49	*Palaquium sp.3*	Nyatoh	Sapotaceae
50	*Payena acuminata (Blume) Pierre*	Nyatoh	Sapotaceae
51	*Polyalthia cauliflora Hook.f. & Thomson*	Semukau, Dilasai	Annonaceae
52	*Polyalthia sp.1*	Dilasai	Annonaceae
53	*Polyalthia sp.2*	Dilasai	Annonaceae
54	*Polyalthia sumatrana (Miq.) Kurz*	Dilasai	Annonaceae
55	*Shorea leprosula Miq.*	Meranti	Dipterocarpaceae
56	*Shorea macrophylla (de Vriese) P.S.Ashton*	Tengkawang	Dipterocarpaceae
57	*Shorea macroptera Dyer*	Meranti	Dipterocarpaceae
58	*Shorea ovalis Blume*	Meranti	Dipterocarpaceae

No	Name of Species	Local Name	Family
59	*Shorea parvifolia Dyer*	Meranti	Dipterocarpaceae
60	*Shorea peltata Symington*	Meranti	Dipterocarpaceae
61	*Shorea pinanga Scheff*	Meranti	Dipterocarpaceae
62	*Shorea ochracea*	Raruk	Dipterocarpaceae
63	*Shorea sp.1*	Meranti	Dipterocarpaceae
64	*Shorea sp.2*	Meranti	Dipterocarpaceae
65	*Shorea sp.3*	Meranti	Dipterocarpaceae
66	*Shorea sp.4*	Meranti	Dipterocarpaceae
67	*Shorea sp.5*	Meranti	Dipterocarpaceae
68	*Shorea sp.6*	Meranti	Dipterocarpaceae
69	*Syzygium chloranthum (Duthie) Merrill & Perry*	Ubah	Myrtaceae
70	*Syzygium chrisrmannii Merrill & Perry*	Ubah	Myrtaceae
71	*Syzygium cleistocalyx P.S.Ashton*	Ubah	Myrtaceae
72	*Syzygium havilandii(Merrill) Merrill & Perry*	Ubah	Myrtaceae
73	*Syzygium jambos (Linn.) Ashton*	Ubah	Myrtaceae

No	Name of Species	Local Name	Family
74	*Syzygium multibracteolatum (Merrill) Merrill & Perry*	Ubah	Myrtaceae
75	*Syzygium nigricans (King) Merr. & L.M.Perry*	Ubah	Myrtaceae
76	*Syzygium palawanense (C.B.Rob.) Merr. & Perry.*	Ubah	Myrtaceae
77	*Syzygium racemosum (Blume) A.DC.*	Ubah	Myrtaceae
78	*Syzygium scortechinii (King) P.Chantaranothai & J.Parnell*	Ubah semut	Myrtaceae
79	*Syzygium sp.*	Jambu aek	Myrtaceae
80	*Syzygium tawahense (Korth.) Merr. & Perry*	Ubah	Myrtaceae
81	*Syzygium velutinum A.P.Davis*	Ubah	Myrtaceae
82	*Vatica micrantha Slooten*	Resak	Dipterocarpaceae
83	*Vatica oblongifolia Hook.f.*	Resak	Dipterocarpaceae
84	*Vatica sp.1*	Resak	Dipterocarpaceae
85	*Vatica sp.2*	Resak	Dipterocarpaceae
86	*Vatica sp.3*	Resak	Dipterocarpaceae

Appendix 4. **Plant Species as Source of Drugs/Medicine**

No	Name of Species	Local Name	Family
1	*Alpinia sp.*	Tanaman obat	Zingiberaceae
2	*Anisophyllea disticha (Jack) Baill.*	Kayu Ribu	Anisophyllaceae
3	*Aporosa benthamiana Hook.f.*	Mergantung, Kayu masam	Phyllanthaceae
4	*Clidemia hirta (L.) D.Don.*	Bahang, Kunceng batu, kemunting	Melastomataceae
5	*Durio griffithii (Mast.) Bakh*	Durian hutan	Malvaceae
6	*Elaeocarpus sp.1*	Surugam, Bengkinang	Elaeocarpaceae
7	*Elaeocarpus sp.2*	Surugam, Bengkinang	Elaeocarpaceae
8	*Elaeocarpus sp.3*	Surugam, Bengkinang	Elaeocarpaceae
9	*Eurycoma longifolia Jack*	Pasak bumi, tongkat ali,	Simaroubaceae
10	*Fibraurea tinctoria*	Akar kuning	Menispermaceae
11	*Garcinia nitida Pierre*	Manggis	Clusiaceae
12	*Garcinia parvifolia (Miq.) Miq.*	Asam kandis	Clusiaceae
13	*Garcinia sp.1*	Manggis	Clusiaceae
14	*Garcinia sp.2*	Manggis	Clusiaceae
15	*Garcinia sp.3*	Manggis	Clusiaceae
16	*Gardenia sp.*	Kopi-kopi	Rubiaceae
17	*Gardenia sp.1*	Kopi-kopi	Rubiaceae
18	*Licuala spinosa Wurmb*	Gernih	Arecaceae
19	*Praravinia parviflora Bremek.*	Kopi-kopi	Rubiaceae
20	*Rourea mimosoides (Vahl.) Planch.*	Akar reh (tanaman obat)	Connaraceae
21	*Shorea ochracea*	Raruk	Dipterocarpaceae
22	*Smilax sp.*	Akar kemudang	Smilacaceae
23	*Spatholobus ferrugineus*	Kemedu	Leguminosae
24	*Spatholobus oblongifolius Merr.*	Kemedu	Leguminosae
25	*Urophyllum sp.*	meludok	Rubiaceae
26	*Ziziphus havilandii Ridl.*	*Akar kuku menaul*	Rhamnaceae
27	*Bauhinia crudiantha*	*Kupdaup*	Leguminosae
28	*Cinnamomum sp.1*	Kayu manis	Lauraceae
29	*Cinnamomum sp.2*	Kayu manis	Lauraceae
30	*Cinnamomum sp.3*	Kayu manis	Lauraceae
31	*Cinnamomum sp.4*	Kayu manis	Lauraceae
32	*Cinnamomum sp.5*	Kayu manis	Lauraceae

Appendix 5. **List of Mammal That Was Found In Sub DAS Embaloh**

No	Local Name	Name of Species	Family	Protection Status			Occurrence in DAS Embaloh						Σ		Total	Inf
				IUCN	CITES	RI	T	SR	DR	SntngR	RTR	RWN	D	ID	Total	
1	Babi berjenggot	*Sus barbatus*	Suidae	NT			V	V	V	V	V	V	19	18	37	
2	Bajing Kerdil dataran Rendah	*Exilisciurus exilis*	Sciuridae	DD			V	V				V	9		9	
3	Bajing tanah ekor tegak	*Rheithrosciurus macrotis*	Sciuridae	V							1		1		1	
4	Bajing Terbang Raksasa	*Petaurista petaurista*	Petauristinae	LC					V				2		2	
5	Bajing Terbang Totol	*Petaurista elegans*	Petauristinae	LC								V	3		3	
6	Beruang Madu	*Helarctos malayanus*	Ursidae	VU		P				V		V		3	3	
7	Beruk	*Macaca nemestrina*	Cercopithecidae	V	II	P			V				5		5	
8	Kelasi / Lutung Merah	*Presbytis rubicunda*	Cercopithecidae	LC	II	P	V	V					15		15	
9	Landak Raya	*Hystrix brachyura*	Hystricidae	LC		P	V						2		2	
10	Macan Dahan	*Neofelis nebulosa*	Felidae	VU	I	P					V			1	1	
11	Monyet Kra	*Macaca fascicularis*	Cercopithecidae	LC				V					5		5	
12	Orangutan	*Pongo pygmaeus pygmaeus*	Hominidae	EN	I	P		V		V	V		4	1	5	
13	Owa Kelawat	*Hylobates muelleri*	Hylobatidae	EN	I	P	V	V	V	V	V	V	55	22	77	
14	Pelanduk Napu	*Tragulus napu*	Tragulidae	LC		P					V		1		1	
15	Rusa sambar	*Cervus unicolor*	Cervidae	LC				V					1		1	
16	Tikus Duri Coklat	*Maxomys rajah*	Muridae	V								1	1		1	
17	Tringgiling Peusing	*Manis javanica*	Manidae	EN	II		V	V						3	3	
Total Encountered													**123**	**48**	**171**	

Explanation:
ID = Indirect (scratches, feaces, voices, footsteps, etc.); D = Direct (Analysts direct contact with animals); I = Interview; RI = Republic of Indonesia; I = Appendix I; II = Appendix II; III = Appendix III;
E = Endangered; V = Vulnerable; SP = Species Protection; T = Tekelan; SR = Santo River; DR = Dajo River; SntngR = Senentang River; RTR = Riak Tapang River; RWN = River Without A Name

Appendix 6. **Mammal in Sub DAS Embaloh Based on Interview With the Communities**

No	Local Name	Scientific Name	Family	Protection Status			Inf
				IUCN	CITES	RI	
1	Angkis Ekor Panjang	*Trichys fasciculata*		LC			w
2	Babi ternak	*Sus scrofa*	Suidae				w
3	Bajing Ekor Kuda	*Sundasciurus hippurus*		NT			w
4	Bajing kerdil telinga hitam	*Nannosciurus melanotis*	Sciuridae				w
5	Bajing Kinabalu	*Callosciurus baluensis*		LC			w
6	Bajing Tanah Bergaris Empat	*Lariscus hosei*		NT			w
7	Bajing Tanah Bergaris Tiga	*Lariscus insignis*		LC			w
8	Bajing Terbang Coklat Merah	*Aeromys thomasi*		DD			w
9	Bajing terbang pipi jingga	*Petinomys vordermanni*	Sciuridae				w
10	Bajing tiga warna	*Callosciurus prevostii*	Sciuridae				w
11	Bangkalit Besar	*Hesperoptenus tomesi*		LC			w
12	Berang-Berang	*Lutrogale perspicillata*		VU			w
13	Codot Pisang Coklat	*Macroglossus minimus*		LC			w
14	Garangan Kalimantan	*Herpestes hosei*					w
15	Jelarang Bilalang	*Ratufa affinis*		VU			w
16	Kalong Besar	*Pteropus vampyrus*		LC			w
17	Kelelawar Buluh Besar	*Tylonycteris robustula*		NT			w
18	Kelelawar Pekarangan	*Scotophilus kuhlii*		LC			w
19	Kijang Muncak	*Muntiacus muntjac*		LC			w
20	Krabuku Ingkat	*Tarsius bancanus*		VU			w
21	Kucing Merah	*Felis badia*					w
22	Kukang Bukang	*Nycticebus coucang*		VU			w
23	Linsang Linsang	*Prionodon linsang*		LC			w
24	Musang Akar	*Arctogalidia trivirgata*		LC			w
25	Musang Belang	*Diplogale derbyanus*					w
26	Musang Galing	*Paguma larvata*		LC			w
27	Musang Luwak	*Paradoxurus hermaphroditus*		VU			w
28	Nyingnying Perut Kelabu	*Chiropodomys muroides*		DD			w
29	Pelanduk Kancil	*Tragulus javanicus*		DD			w
30	Rindil Bulan (Cucurut)	*Echinosorex gymnurus*		LC			w
31	Tikus Besar Gunung	*Sundamys infraluteus*		LC			w
32	Tupai Tanah	*Tupaia tana*		LC			w

Appendix 7. **Mammal Species Found in Each Observation Location**

Observation location	Local Name	Scientific Name	Total
Tekelan	Owa Kelawat	*Hylobates muelleri*	26
	Babi berjenggot	*Sus barbatus*	9
	Bajing Kerdil dataran Rendah	*Exilisciurus exilis*	1
	Kelasi / Lutung Merah	*Presbytis rubicunda*	2
	Landak Raya	*Hystrix brachyura*	2
	Tringgiling Peusing	*Manis javanica*	2
Sungai Santo	Babi berjenggot	*Sus barbatus*	5
	Kelasi / Lutung Merah	*Presbytis rubicunda*	13
	Monyet Kra	*Macaca fascicularis*	5
	Orangutan	*Pongo pygmaeus pygmaeus*	1
	Owa Kelawat	*Hylobates muelleri*	9
	Tringgiling Peusing	*Manis javanica*	1
	Rusa sambar	*Cervus unicolor*	1
Sungai Dajo	Babi berjenggot	*Sus barbatus*	10
	Bajing Kerdil dataran Rendah	*Exilisciurus exilis*	3
	Bajing Terbang Raksasa	*Petaurista petaurista*	2
	Beruk	*Macaca nemestrina*	5
	Owa Kelawat	*Hylobates muelleri*	13
Sungai Senentang	Babi berjenggot	*Sus barbatus*	3
	Bajing Kerdil dataran Rendah	*Exilisciurus exilis*	1
	Beruang Madu	*Helarctos malayanus*	1
	Orangutan	*Pongo pygmaeus pygmaeus*	1
	Owa Kelawat	*Hylobates muelleri*	8
Sungai Riak Tapang	Babi berjenggot	*Sus barbatus*	3
	Bajing tanah ekor tegak	*Rheithrosciurus macrotis*	1
	Macan Dahan	*Neofelis nebulosa*	1
	Orangutan	*Pongo pygmaeus pygmaeus*	3
	Owa Kelawat	*Hylobates muelleri*	7
	Pelanduk Napu	*Tragulus napu*	1
	Tikus Duri Coklat	*Maxomys rajah*	1
Sungai Tanpa Nama	Babi berjenggot	*Sus barbatus*	7
	Bajing Kerdil dataran Rendah	*Exilisciurus exilis*	4
	Bajing Terbang Totol	*Petaurista elegans*	3
	Beruang Madu	*Helarctos malayanus*	2
	Owa Kelawat	*Hylobates muelleri*	14

Appendix 8. **Encountered Bird Species**

No	Name of the Bird	Scientific Name	English Name	Observation Station																						
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Phalacrocoracidae (1)																										
1	Pecuk-ular asia	*Anhinga melanogaster*	Oriental Darter																							x
Accipitridae (2)																										
2	Elang bondol	*Haliastur indus*	Brahminy Kite																							x
3	Elang-ikan kepala-kelabu	*Ichthyophaga ichthyaetus*	Grey-headed Fish-eagle					x																		x
Phasianidae (3)																										
4	Kuau raja*	*Argusianus argus*	Great Argus	x	x																				x	
Scolopacidae (4)																										
5	Trinil pantai	*Actitis hypoleucos*	Common Sandpiper																							x
Columbidae (5)																										
6	Punai kecil	*Treron olax*	Little Green Pigeon			x				x	x															x
Cuculidae (6)																										
7	Kangkok kumis	*Cuculus vagans*	Moustached Hawk-Cuckoo							x																
8	Kedasi hitam	*Surniculus lugubris*	Drongo Cuckoo														x									
9	Kadalan beruang	*Phaenicophaeus diardi*	Black-bellied Malkoha																	x						
10	Bubut besar	*Centropus sinensis*	Greater Coucal							x																x
Apodidae (7)																										
11	Walet sarang-putih	*Collocalia fuciphaga*	Edible-nest Swiftlet																							x
12	Walet sapi	*Collocalia esculenta*	Glossy Swiftlet																							x
Hemiprocnidae (8)																										
13	Tepekong rangkang	*Hemiprocne comata*	Whiskered Tree-swift																		x					
Trogonidae (9)																										

No	Name of the Bird	Scientific Name	English Name	Observation Station																					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
14	Luntur putri	*Harpactes duvaucelii*	Scarlet-rumped Trogon	x															x						x	
Alcedinidae (10)																										
15	Raja-udang meninting	*Alcedo meninting*	Blue-eared Kingfisher																							x
16	Raja-udang kalung-biru	*Alcedo euryzona*	Blue-banded Kingfisher										x													x
17	Pekaka emas	*Pelargopsis capensis*	Stork-billed Kingfisher																							x
18	Cekakak-hutan melayu	*Actenoides concretus*	Rufous-collared Kingfisher	x																						
Bucerotidae (11)																										
19	Enggang jambul	*Aceros comatus*	White-crowned Hornbill																							x
20	Kangkareng hitam	*Anthracoceros malayanus*	Black Hornbill														x									
21	Rangkong badak	*Buceros rhinoceros*	Rhinoceros Hornbill																						x	
22	Rangkong gading	*Buceros vigil*	Helmeted Hornbill						x																	
Picidae (12)																										
23	Pelatuk besi	*Dinopium javanense*	Common Goldenback													x										
24	Caladi badok	*Meiglyptes tukki*	Buff-necked Woodpecker							x																
Eurylaimidae (13)																										
25	Sempur-hujan sungai	*Cymbirhynchus macrorhynchos*	Black-and-red Broadbill																							x
26	Sempur-hujan darat	*Eurylaimus ochromalus*	Black-and-yellow Broadbill			x			x							x										
Chloropseidae (14)																										

No	Name of the Bird	Scientific Name	English Name	Observation Station																					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
27	Cica-daun kecil	*Chloropsis cyanopogon*	Lesser Green Leafbird	x	x	x	x									x										
Pycnonotidae (15)																										
28	Cucak sakit-tubuh	*Pycnonotus melanoleucos*	Black-and-white Bulbul		x	x	x		x	x	x				x	x						x			x	
29	Cucak kuricang	*Pycnonotus atriceps*	Black-headed Bulbul			x																				
30	Cucak kelabu	*Pycnonotus cyaniventris*	Grey-bellied Bulbul													x										
31	Cucak rumbai-tungging	*Pycnonotus eutilotus*	Puff-backed Bulbul			x																				
32	Merbah belukar	*Pycnonotus plumosus*	Olive-winged Bulbul			x																				
33	Merbah kacamata	*Pycnonotus erythropthalmos*	Spectacled Bulbul			x	x																			
34	Empuloh janggut	*Alophoixus bres*	Grey-cheeked Bulbul										x													
Dicruridae (16)																										
35	Srigunting batu	*Dicrurus paradiseus*	Greater Racquet-tailed Drongo															x								
Timaliidae (17)																										
36	Tepus tunggir-merah	*Stachyris maculata*	Chestnut-rumped Babbler																x							
Turdidae (18)																										
37	Kucica hutan	*Copsychus malabaricus*	White-rumped Shama			x						x								x						
38	Meninting cegar	*Enicurus ruficapillus*	Chestnut-naped Forktail					x																		
Sylviidae (19)																										
39	Cinenen belukar	*Orthotomus atrogularis*	Dark-necked Tailorbird								x															

No	Name of the Bird	Scientific Name	English Name	Observation Station																						
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Muscicapidae (20)																										
40	Sikatan-rimba dada-kelabu	*Rhinomyias umbratilis*	Grey-chested Rhinomyias																					x		
41	Sikatan cacing	*Cyornis banyumas*	Hill Blue Flycatcher																						x	
42	Sikatan kalimantan	*Cyornis superbus*	Bornean Blue Flycatcher				x																			
Monarchidae (21)																										
43	Seriwang asia	*Terpsiphone paradisi*	Asian Paradise-flycatcher	x	x			x																		x
Nectariniidae (22)																										
44	Burung-madu polos	*Anthreptes simplex*	Plain Sunbird				x																			
45	Burung-madu belukar	*Anthreptes singalensis*	Ruby-cheeked Sunbird							x																
46	Burung-madu rimba	*Hypogramma hypogrammicum*	Purple-naped Sunbird			x																				
47	Pijantung kecil	*Arachnothera longirostra*	Little Spiderhunter			x																				
48	Pijantung besar	*Arachnothera robusta*	Long-billed Spiderhunter			x																				
49	Pijantung tasmak	*Arachnothera flavigaster*	Spectacled Spiderhunter				x																			
Dicaeidae (23)																										
50	Pentis pelangi	*Prionochilus percussus*	Crimson-breasted Flowerpecker				x														x					
51	Pentis kalimantan	*Prionochilus xanthopygius*	Yellow-rumped Flowerpecker																	x						
52	Pentis kumbang	*Prionochilus thoracicus*	Scarlet-breasted Flowerpecker																	x						

Explanation:

* There was no direct observation (voice)

Observation station no.23 is an observation station located along the River Embaloh, starting from the mouth of the River Peyang to the boundary of the Betung Kerihun National Park

Appendix 9. **Conservation Status of Birds Species in BKNP**

	Scientific Name	Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
Anhingidae						
1	*Anhinga melanogaster*	x	-	x	P / NT	Photo is not available
Ardeidae						
2	*Butorides striatus*	x	-	-	-	
3	*Egretta alba*	x	-	-	-	
4	*Egretta garzeta*	x	-	-	-	
Accipitridae						
5	*Pernis ptylorhynchus*	x	-	-	-	
6	*Haliaeetus leucogaster*	x	-	-	-	
7	*Aviceda jerdoni*	x	-	-	-	
8	*Accipiter gularis*	x	-	-	-	
9	*Accipiter nisus*	x	-	-	-	
10	*Accipiter trivirgatus*	x	-	-	-	
11	*Accipiter virgatus*	x	-	-	-	
12	*Haliastur indus*	x	-	x	P / LC	Photo is not available
13	*Hieraaetus kienerii*	x	-	-	-	
14	*Ichtyophaga humilis*	x	-	-	-	
15	*Ichtyophaga ichtyaetus*	x	-	x	P / NT	Photo is not available
16	*Ictinaetus malayensis*	x	-	-	-	
17	*Milvus migran*	x	-	-	-	
18	*Spizaetus cirrhatus*	x	-	-	-	
19	*Spilornis cheela*	x	-	-	-	
20	*Spizaetus alboniger*	x	-	-	-	
21	*Spizaetus nanus*	x	-	-	-	
Phasianidae						
22	*Argusianus argus*	x	-	x	P / NT	Photo available
23	*Lophura bulweri*	x	-	-	-	
24	*Lophura ignita*	x	-	-	-	
25	*Rollulus rouloul*	x	-	-	-	
Rallidae						
26	*Amaurornis phoenicura*	x	-	-	-	
Scolopacidae						
27	*Tringa hypoleucos*	x	-	x	NP / LC	Photo is not available

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
Phalaropidae						
28	*Phalaropus lobatus*	x	-	-	-	
Columbidae			-	-	-	
29	*Chalcopaps indica*	x	-	-	-	
30	*Ducula badia*	x	-	-	-	
31	*Ducula bicolor*	x	-	-	-	
32	*Ducula aenea*	x	-	-	-	
33	*Macropygia emiliana*	x	-	-	-	
34	*Macropygia ruficeps*	x	-	-	-	
35	*Ptilinopus melanospila*	x	-	-	-	
36	*Treron vernans*	x	-	-	-	
37	*Treron olax*	-	-	x	NP / LC	New Recording in BKNP; Photo is not available
Psittacidae						
38	*Loriculus galgulus*	x	-	-	-	
39	*Psitacula longicauda*	x	-	-	-	
Cuculidae						
40	*Centropus sinensis*	x	-	x	NP / LC	Photo is not available
41	*Cuculus canorus*	x	-	-	-	
42	*Cuculus fugax*	x	-	-	-	
43	*Cuculus merulinus*	x	-	-	-	
44	*Cuculus micropterus*	x	-	-	-	
45	*Cuculus saturatus*	x	-	-	-	
46	*Cuculus sepulchralis*	x	-	-	-	
47	*Cuculus sparverioides*	-	-	x	NP/LC	New Recording in BKNP; Photo is not available
48	*Eudynamis scolopaceae*	x	-	-	-	
49	*Phaenicophaeus curvirostris*	x	-	-	-	
50	*Phaenicophaeus javanicus*	x	-	-	-	
51	*Phaenicophaeus sumatranus*	x	-	-	-	
52	*Phaenicophaeus chlorophaeus*	x	-	-	-	

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
53	*Phaenicophaeus diardii*	x	-	x	NP/NT	Photo is available
54	*Surniculus lugubris*	x	-	x	NP/LC	Photo is available
Strigidae						
55	*Ketupa ketupu*	x	-	-	-	
56	*Otus spilocephalus*	x	-	-	-	
Caprimulgidae						
57	*Eurostopodus temminckii*	x	-	-	-	
Apodidae						
58	*Apus affinis*	x	-	-	-	
59	*Apus pacificus*	x	-	-	-	
60	*Collocalia esculenta*	x	-	x	NP/LC	Photo is not available
61	*Collocalia fuciphaga*	x	-	x	NP/LC	Photo is not available
62	*Collocalia maxima*	x	-	-	-	
63	*Hydrochous gigas*	x	-	-	-	
64	*Rhapidura leucopygialis*	x	-	-	-	
Hemiprocnidae						
65	*Hemiprocne longipennis*	x	-	-	-	
66	*Hemiprocne comata*	x	-	x	NP/LC	Photo is available
Trogonidae						
67	*Harpactes diardii*	x	-	-	-	
68	*Harpactes duvaucelli*	x	-	x	NP/NT	Photo is available
69	*Harpactes orrhophaeus*	x	-	-	-	
70	*Harpactes kasumba*	x	-	-	-	
71	*Harpactes whiteheadi*	x	-	-	-	
Alcedinidae						
72	*Actenoides concretus*	x	-	x	P/LC	Photos not available
73	*Alcedo atthis*	x	-	-	-	
74	*Alcedo euryzona*	x	-	x	P/VU	Photo is available
75	*Alcedo meninting*	x	-	x	P/LC	Phot is not available
76	*Ceyx erithacus*	x	-	-	-	
77	*Ceyx rufidorsa*	x	-	-	-	
78	*Halcyon coromanda*	x	-	-	-	
79	*Halcyon pileata*	x	-	-	-	
80	*Lacedo pulchella*	x	-	-	-	

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
81	*Pelargopsis capensis*	x	-	x	P/LC	Photo is not available
Meropidae						
82	*Nyctyornis amictus*	x	-	-	-	
Coraciidae						
83	*Eurystomus orientalis*	x	-	-	-	
Upupidae						
84	*Upupa epops*	x	-	-	-	
Bucerotidae						
85	*Aceros comatus*	x	-	x	P/NT	Photo is not available
86	*Aceros corrugatus*	x	-	-	-	
87	*Aceros undulatus*	x	-	-	-	
88	*Anorrhinus galeritus*	x	-	-	-	
89	*Anthracoceros albirostris*	x	-	-	-	
90	*Anthracoceros malayanus*	x	-	x	P/NT	Photo is not available
91	*Buceros rhinoceros*	x	-	x	P/NT	Photo is not available
92	*Buceros vigil*	x	-	x	P/NT	Photo is not available
Capitonidae						
93	*Calorhampus fuliginosus*	x	-	-	-	
94	*Megalaima chrysopogon*	x	-	-	-	
95	*Megalaima australis*	x	-	-	-	
96	*Megalaima eximia*	x	-	-	-	
97	*Megalaima henricii*	x	-	-	-	
98	*Megalaima mystacophanos*	x	-	-	-	
99	*Megalaima pulcherrima*	x	-	-	-	
100	*Megalaima monticola*	x	-	-	-	
101	*Megalaima raflesii*	x	-	-	-	
Picidae						
102	*Blythipicus rubiginosus*	x	-	-	-	
103	*Celeus brachyurus*	x	-	-	-	
104	*Dendrocopus canicapillus*	x	-	-	-	
105	*Dinopium javanense*	x	-	x	NP/LC	Photo is not available
106	*Dinopium raflesii*	x	-	-	-	
107	*Hemicircus concretus*	x	-	-	-	

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
108	*Meigliptes tristis*	x	-	-	-	
109	*Meigliptes tukki*	x	-	x	NP/NT	Photo is available
110	*Mulleripicus pulverulentus*	x	-	-	-	
111	*Picoides moluccensis*	x	-	-	-	
112	*Picus miniaceus*	x	-	-	-	
113	*Picus puniceus*	x	-	-	-	
114	*Reinwardtipicus validus*	x	-	-	-	
115	*Sasia abnormis*	x	-	-	-	
Eurylaimidae						
116	*Calyptomena hosei*	x	-	-	-	
117	*Calyptomena viridis*	x	-	-	-	
118	*Calyptomena whiteheadi*	x	-	-	-	
119	*Corydon sumatranus*	x	-	-	-	
120	*Cymbirhynchus macrorhynchos*	x	-	x	NP/LC	Photo is not available
121	*Eurylaimus javanicus*	x	-	-	-	
122	*Eurylaimus ochromalus*	x	-	x	P/NT	Photo is available
Pittidae						
123	*Pitta baudii*	x	-	-	-	
124	*Pitta granatina*	x	-	-	-	
125	*Pitta guajana*	x	-	-	-	
126	*Pitta nympha*	x	-	-	-	
Hirundinidae						
127	*Hirundo rustica*	x	-	-	-	
128	*Hirundo striolata*	x	-	-	-	
129	*Hirundo tahitica*	x	-	-	-	
Campephagidae						
130	*Coracina fimbriata*	x	-	-	-	
131	*Coracina larvata*	x	-	-	-	
132	*Hemipus hirundinaceus*	x	-	-	-	
133	*Hemipus picatus*	x	-	-	-	
134	*Lalage nigra*	x	-	-	-	
135	*Tephrodornis gularis*	x	-	-	-	

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
136	*Pericrocotus flammeus*	x	-	-	-	
Chloropseidae						
137	*Aeghitina tiphia*	x	-	-	-	
138	*Aeghitina viridissima*	x	-	-	-	
139	*Chloropsis cochinchinensis*	x	-	-	-	
140	*Chloropsis cyanopogon*	x	-	x	NP/LC	Photo is available
141	*Chloropsis sonneratii*	x	-	-	-	
Pycnonotidae						
142	*Alophoixus bres*	x	-	x	NP/LC	Photo is available
143	*Alophoixus ochraceus*	x	-	-	-	
144	*Alophoixus phaeocephalus*	x	-	-	-	
145	*Criniger finschii*	x	-	-	-	
146	*Hypsipetes flavala*	x	-	-	-	
147	*Iole olivaceae*	x	-	-	-	
148	*Ixos malaccensis*	x	-	-	-	
149	*Pycnonotus atriceps*	x	-	x	NP/LC	Photo is available
150	*Pycnonotus brunneus*	x	-	-	-	
151	*Pycnonotus cyaniventris*	x	-	x	NP/NT	Photo is available
152	*Pycnonotus erythrophthalmos*	x	-	x	NP/LC	Photo is available
153	*Pycnonotus eutilotus*	x	-	x	NP/NT	Photo is available
154	*Pycnonotus flavescens*	x	-	-	-	
155	*Pycnonotus goiavier*	x	-	-	-	
156	*Pycnonotus melanicterus*	x	-	-	-	
157	*Pycnonotus nieuwenhuisi*	x	-	-	-	
158	*Pycnonotus plumosus*	x	-	x	NP/LC	Photo is available
159	*Pycnonotus simplex*	x	-	-	-	
160	*Pycnonotus squamatus*	x	-	-	-	
161	*Pycnonotus zeylanicus*	x	-	-	-	
162	*Pycnonotus melanoleucos*	x	-	x	NP/NT	Photo is available
163	*Setornis criniger*	x	-	-	-	
164	*Tricholestes criniger*	x	-	-	-	

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
Dicruridae						
165	*Dicrurus aeneus*	x	-	-	-	
166	*Dicrurus annectans*	x	-	-	-	
167	*Dicrurus leucophaeus*	x	-	-	-	
168	*Dicrurus macrocercus*	x	-	-	-	
169	*Dicrurus paradiseus*	x	-	x	NP/LC	Photo is not available
170	*Dicrurus hottentotus*	x	-	-	-	
Oriolidae						
171	*Oriolus xanthonotus*	x	-	-	-	
172	*Oriolus xanthornus*	x	-	-	-	
173	*Oriolus chinensis*	x	-	-	-	
174	*Irena puella*	x	-	-	-	
Corvidae						
175	*Corvus enca*	x	-	-	-	
176	*Corvus macrorhynchos*	x	-	-	-	
177	*Dendrocitta cinerascens*	x	-	-	-	
178	*Platylophus galericulatus*	x	-	-	-	
179	*Platysmurus leucopterus*	x	-	-	-	
180	*Pityriasis gymnocephala*	x	-	-	-	
Sittidae						
181	*Sitta frontalis*	x	-	-	-	
Timaliidae						
182	*Alcippe bruneicauda*	x	-	-	-	
183	*Garulax paliatus*	x	-	-	-	
184	*Kenopia striata*	x	-	-	-	
185	*Macronous gularis*	x	-	-	-	
186	*Macronous ptilosus*	x	-	-	-	
187	*Malacocincla abbotii*	x	-	-	-	
188	*Malacocincla malaccensis*	x	-	-	-	
189	*Malacocincla perspicillata*	x	-	-	-	
190	*Malacocincla sepiarium*	x	-	-	-	
191	*Malacopteron affine*	x	-	-	-	

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
192	*Malacopteron albogularae*	x	-	-	-	
193	*Malacopteron cinereum*	x	-	-	-	
194	*Malacopteron magnirostre*	x	-	-	-	
195	*Malacopteron magnum*	x	-	-	-	
196	*Napothera atrigularis*	x	-	-	-	
197	*Napothera crassa*	x	-	-	-	
198	*Napothera epilepidota*	x	-	-	-	
199	*Pellorneum capistratum*	x	-	-	-	
200	*Pellorneum pyrrogenys*	x	-	-	-	
201	*Pomatorhinus montanus*	x	-	-	-	
202	*Pteruthius flaviscapis*	x	-	-	-	
203	*Ptilocichla leucogrammica*	x	-	-	-	
204	*Stachyris erythropthera*	x	-	-	-	
205	*Stachyris leucotis*	x	-	-	-	
206	*Stachyris maculata*	x	-	x	NP/NT	Photo is available
207	*Stachyris nigriceps*	x	-	-	-	
208	*Stachyris nigricollis*	x	-	-	-	
209	*Stachyris poliocephala*	x	-	-	-	
210	*Stachyris rufifrons*	x	-	-	-	
211	*Trichastoma bicolor*	x	-	-	-	
212	*Trichastoma rostratum*	x	-	-	-	
213	*Yuhina everetti*	x	-	-	-	
214	*Yuhina zantholeuca*	x	-	-	-	
Turdidae						
215	*Brachypteryx montana*	x	-	-	-	
216	*Copsychus malabaricus*	x	-	x	NP/LC	Photo is available
217	*Copsychus saularis*	x	-	-	-	
218	*Copsychus stricklandi*	x	-	-	-	
219	*Enicurus leschenaulti*	x	-	-	-	
220	*Enicurus ruficapillus*	x	-	x	NP/NT	Photo is not available
221	*Erithacus cyane*	x	-	-	-	
222	*Luscinia calliope*	x	-	-	-	

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
223	*Oenanthe oenanthe*	x	-	-	-	
224	*Trichixos pyrrhopygus*	x	-	-	-	
225	*Zoothera interpres*	x	-	-	-	
Sylviidae						
226	*Cetia vulcania*	x	-	-	-	
227	*Locustela lanceolata*	x	-	-	-	
228	*Locustela certhiola*	x	-	-	-	
229	*Orthotomus atrogularis*	x	-	x	NP/LC	Photo is available
230	*Orthotomus cuculatus*	x	-	-	-	
231	*Orthotomus sericeus*	x	-	-	-	
232	*Phylloscopus borealis*	x	-	-	-	
233	*Seicercus montis*	x	-	-	-	
234	*Prinia flaviventris*	x	-	-	-	
235	*Urosphena whiteheadi*	x	-	-	-	
Muscicapidae						
236	*Culicicapa ceylonensis*	x	-	-	-	
237	*Cyornis banyumas*	x	-	x	NP/LC	Photo is available
238	*Cyornis caerulatus*	x	-	-	-	
239	*Cyornis rufigastra*	x	-	-	-	
240	*Cyornis superbus*	x	-	x	NP/LC	Photo is available
241	*Cyornis turcosus*	x	-	-	-	
242	*Cyornis unicolor*	x	-	-	-	
243	*Eumyas indigo*	x	-	-	-	
244	*Eumyas thalasina*	x	-	-	-	
245	*Ficedula dumetoria*	x	-	-	-	
246	*Ficedula hyperythra*	x	-	-	-	
247	*Ficedula mugimaki*	x	-	-	-	
248	*Ficedula narcissina*	x	-	-	-	
249	*Ficedula parva*	x	-	-	-	
250	*Ficedula westermanni*	x	-	-	-	
251	*Hypothimis azurea*	x	-	-	-	
252	*Muscicapa dauurica*	x	-	-	-	
253	*Muscicapa ferruginea*	x	-	-	-	
254	*Muscicapa griseisticta*	x	-	-	-	

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
255	*Muscicapa sibirica*	x	-	-	-	
256	*Muscicapella hodgsoni*	x	-	-	-	
257	*Philentoma pyrrhopterum*	x	-	-	-	
258	*Philentoma velatum*	x	-	-	-	
259	*Rhinomyias brunneata*	x	-	-	-	
260	*Rhinomyias gularis*	x	-	-	-	
261	*Rhinomyias olivaceae*	x	-	-	-	
262	*Rhinomyias ruficauda*	x	-	-	-	
263	*Rhinomyias umbratilis*	x	-	x	NP/NT	Photo is available
264	*Rhipidura javanica*	x	-	-	-	
265	*Rhipidura perlata*	x	-	-	-	
266	*Terpsiphone paradisi*	x	-	x	NP/LC	Photo is not available; According to (MacKinnon 1994) and (Sibbly& Monroe 1990), this species belongs to family Monarchidae
Motacillidae						
267	*Motacilla cinerea*	x	-	-	-	
268	*Motacilla flava*	x	-	-	-	
Artamidae			-	-	-	
269	*Artamus leucorhynchos*	x	-	-	-	
Sturnidae						
270	*Gracula religiosa*	x	-	-	-	
Nectarinidae						
271	*Aethopyga siparaja*	x	-	-	-	
272	*Anthreptes malacensis*	x	-	-	-	
273	*Anthreptes simplex*	x	-	x	P/LC	Photo is available
274	*Anthreptes singalensis*	x	-	x	P/LC	Photo is available
275	*Arachnothera affinis*	x	-	-	-	
276	*Arachnothera chrysogenys*	x	-	-	-	
277	*Arachnothera crassirostris*	x	-	-	-	
278	*Arachnothera everetti*	x	-	-	-	
279	*Arachnothera flavigaster*	x	-	x	P/LC	Photo is available

Scientific Name		Data ITTO-TNBK 1998		Data ITTO-TNBK 2014		Information
		Listed	Consertvation Status	Listed	Consertvation Status	
280	*Arachnothera juliae*	x	-	-	-	
281	*Arachnothera longirostra*	x	-	x	P/LC	Photo is available
282	*Arachnothera robusta*	x	-	x	P/LC	Photo is available
283	*Hypogramma hypogrammicum*	x	-	x	P/LC	Photo is available
284	*Nectarinia calcostetha*	x	-	-	-	
285	*Nectarinia jugularis*	x	-	-	-	
286	*Nectarinia sperata*	x	-	-	-	
Dicaeidae						
287	*Dicaeum chrysorheum*	x	-	-	-	
288	*Dicaeum concolor*	x	-	-	-	
289	*Dicaeum cruentatum*	x	-	-	-	
290	*Dicaeum everetti*	x	-	-	-	
291	*Dicaeum monticolum*	x	-	-	-	
292	*Dicaeum trigonostigma*	x	-	-	-	
293	*Dicaeum trochileum*	x	-	-	-	
294	*Prionochilus maculatus*	x	-	-	-	
295	*Prionochilus percusus*	x	-	x	NP/LC	Photo is available
296	*Prionochilus thoracicus*	x	-	x	NP/NT	Photo is available
297	*Prionochilus xanthopygius*	x	-	x	NP/LC	Photo is available
Zosteropidae						
298	*Oculocincta squamifrons*	x	-	-	-	
299	*Zosterops everetti*	x	-	-	-	
300	*Chlorocharis emiliae*	x	-	-	-	
Ploceidae						
301	*Lonchura fuscans*	x	-	-	-	
302	*Passer montanus*	x	-	-	-	

Explanation: (NP) Not Protected; (P) Protected; (LC) Least Concern; (NT) Near Threatened; (VU) Vulnerable

Appendix 10. **List of herpetofauna and their conservation status**

No	Species Name	Family	Total	Population Status
1	*Ahaetulla prasina*	Dicroglossidae	1	LC
2	*Amphiesma flavifrons*	Colubridae	8	LC
3	*Ansonia longidigita*	Bufonidae	7	NT
4	*Ansonia spinulifer*	Bufonidae	1	LC
5	*Aplopeltura boa*	Colubridae	2	LC
6	*Cyrtodactylus consobrinus*	Gekkonidae	1	LC
7	*Cyrtodactylus malayanus*	Gekkonidae	3	LC
8	*Gonocephalus grandis*	Agamidae	7	LC
9	*Hylarana hosii*	Ranidae	28	LC
10	*Hylarana picturata*	Ranidae	4	LC
11	*Hylarana raniceps*	Ranidae	44	LC
12	*Ingerophrynus divergens*	Bufonidae	2	-
13	*katak unidentified*	-	1	LC
14	*Kurixalus appendiculatus*	Rhacophoridae	1	LC
15	*Lebtobrachella mjobergi*	Megophrydae	8	-
16	*Lebtobrachella sp*	Colubridae	1	LC
17	*Lepturophis bornensis*	Dicroglossidae	2	NT
18	*Limnonectes ibanorum*	Dicroglossidae	31	LC
19	*Limnonectes kuhlii*	Dicroglossidae	20	LC
20	*Limnonectes leporinus*	Dicroglossidae	22	LC
21	*Megophrys nasuta*	Megophrydae	1	VU
22	*Notochelys platynota*	Geoemydidae	2	LC
23	*Nyctixalus pictus*	Rhacophoridae	1	LC
24	*Odorrana hosii*	Ranidae	1	LC
25	*Pedostibes hosii*	Bufonidae	2	LC
26	*Phrynoidis aspera*	Bufonidae	73	LC
27	*Rhabdophis chrysargos*	Colubridae	1	NT
28	*Rhacophorus gauni*	Rhacophoridae	1	-
29	*Rhacophorus sp*	Rhacophoridae	1	-
30	*Sphenomorphus sp 1*	Scincidae	4	-
31	*Sphenomorphus sp 2*	Scincidae	1	-
32	*Staurois guttatus*	Ranidae	64	LC
33	*Staurois latopalmatus*	Ranidae	45	LC
34	*Tropidophorus beccari*	Scincidae	43	LC

Appendix 11. **Fish Species**

Bangah (*Puntius binotatus*)

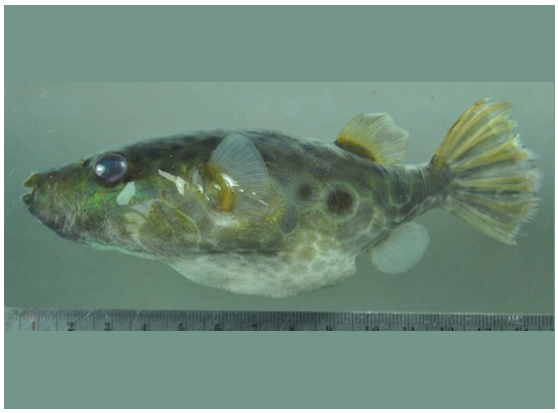
Boeng/Boin (*Anematichthys armatus*)

Bantak Surik (*Osteochilus waandersii*)

Bingkus (*Gyrinocheilus pustulosus*)

Bantak (*Osteochilus microcephalus*)

Buntal Sabang (*Monotrete* sp.)



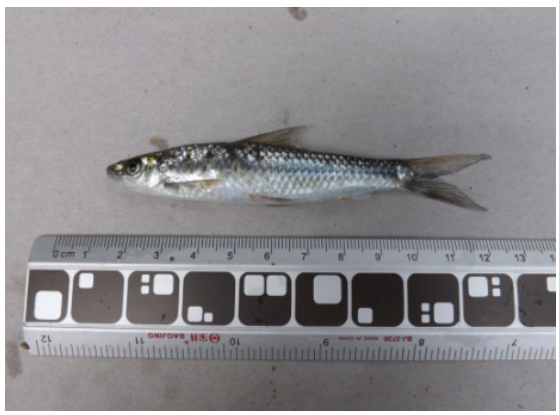
Buntal (*Monotrete leiurus*)

Entebuluh (*Oxygaster anomalura*)

Empurau (*Tor tambroides*)

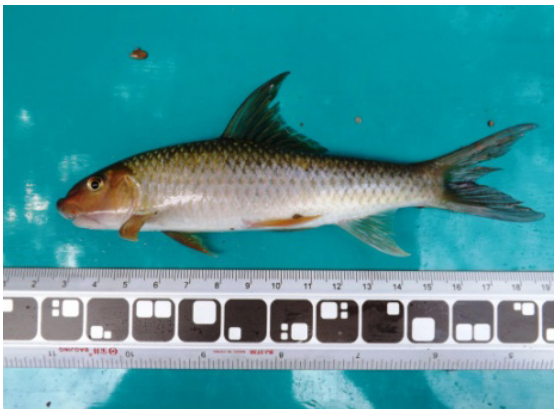
Ikan Pasir (*Acantopsis dialuzona*)

Engkarik (*Labiobarbus fasciatus*)

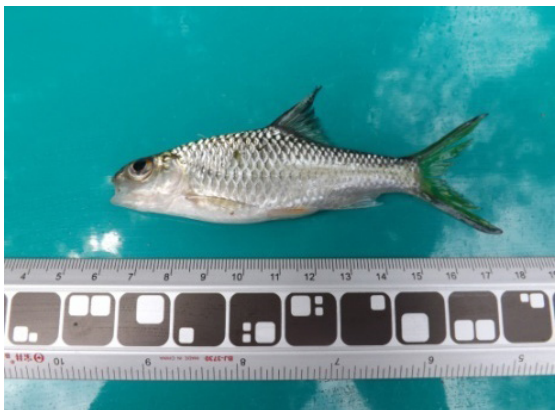


Kemujok (*Paracrossochilus acerus*)

Kenyuar (*Luciosoma setigerum*)



Kulong (*Lobocheilus bo*)



Kepiat (*Barbonymus collingwoodii*)

Kulong Nga' (Lobocheilus hispidus)

Kujam (*Labiobarbus lepthocheilus*)

Langkung (*Hampala bimaculata*)

Pansik/Engkadik (*Syncrossus hymenophysa*)

Seluang (*Rasbora volzii*)

Semah (*Tor tambra*)

Tilan (*Macrognathus aculeatus*)

Appendix 12. **The Composition of Fish Species**

Family	Genus	Species Name	Local Name	Total
Cobitidae	Acantopsis	*Acantopsis dialuzona*	Ikan Pasir	1
	Syncrossus	*Syncrossus hymenophysa*	Pansik/Engkadik	1
Cyprinidae	Anematichthys	*Anematichthys armatus*	Boeng/Boin	1
	Barbonymus	*Barbonymus collingwoodii*	Kepiat	90
	Hampala	*Hampala bimaculata*	Langkung	17
	Labiobarbus	*Labiobarbus fasciatus*	Engkarik	1
		Labiobarbus leptocheilus	Kujam	3
	Lobocheilus	*Lobocheilus bo*	Kulong	142
		Lobocheilus hispidus	Kulong Nga'	27
	Luciosoma	*Luciosoma setigerum*	Kenyuar	117
	Osteochilus	*Osteochilus microcephalus*	Bantak	56
		Osteochilus waandersii	Bantak Surik	30
	Oxygaster	*Oxygaster anomalura*	Entebuluh	4
	Paracrossochilus	*Paracrossochilus acerus*	Kemujok	35
	Puntius	*Puntius binotatus*	Bangah	5
	Rasbora	*Rasbora volzii*	Seluang	131
	Tor	*Tor tambra*	Semah	18
		Tor tambroides	Empurau	7
Gyrinocheilidae	Gyrinocheilus	*Gyrinocheilus pustulosus*	Bingkus	14
Mastacembelidae	Macrognathus	*Macrognathus aculeatus*	Tilan	1
Tetraodontidae	Monotrete	*Monotrete leiurus*	Buntal	1
		Monotrete sp.	Buntal Sabang	1

Appendix 13. **Fish spread in the Observation Location**

No	Species	River								
		Mentawak	Peyang	Santu	Sabung	Rambing	Dajo	Gong	Senentang	Riak Tapang
1	*Acantopsis dialuzona*									X
2	*Anematichthys armatus*									X
3	*Barbonymus collingwoodii*	X	X	X	X		X	X		X
4	*Gyrinocheilus pustulosus*	X	X	X	X					X
5	*Hampala bimaculata*	X	X	X	X	X		X		X
6	*Labiobarbus fasciatus*		X							
7	*Labiobarbus leptocheilus*							X		
8	*Lobocheilus bo*	X	X	X	X	X	X	X	X	X
9	*Lobocheilus hispidus*	X	X	X	X		X	X		X
10	*Luciosoma setigerum*	X		X	X	X		X	X	X
11	*Macrognathus aculeatus*			X						
12	*Monotrete leiurus*		X							
13	*Monotrete sp.*			X						
14	*Osteochilus microcephalus*	X	X	X	X	X	X	X		X
15	*Osteochilus waandersii*	X	X	X	X	X		X		X
16	*Oxygaster anomalura*		X							X
17	*Paracrossochilus acerus*	X	X	X	X	X	X	X		X
18	*Puntius binotatus*									X
19	*Rasbora volzii*	X	X	X	X	X	X	X	X	X
20	*Syncrossus hymenophysa*			X						
21	*Tor tambra*	X		X	X	X		X	X	
22	*Tor tambroides*	X		X						X

Explanation:
x = found

Appendix 14. **Physical and Chemical Conditions in the Location of the Observation**

River	Station	Point Coordinates		Water Temperature	Velocity	PH	DO
		BT	LU	(°C)	(m/det)		(mg/L)
Mentawak	TS 01	112,623	1,426	24,0	0,15	6,5	6,0
	TS 02	112,622	1,427	24,0	0,10	6,5	6,0
	TS 03	112,622	1,428	23,0	0,25	7,0	6,0
Peyang	TS 04	112,625	1,427	25,0	0,20	7,0	6,0
	TS 05	112,625	1,427	25,0	0,20	7,0	6,0
Santu	TS 06	112,488	1,415	24,0	0,15	7,0	5,5
	TS 07	112,488	1,416	23,0	0,10	7,0	6,0
	TS 08	112,488	1,417	24,0	0,10	7,0	6,0
Sabung	TS 09	112,476	1,404	21,0	0,20	7,0	6,0
	TS 10	112,474	1,403	20,0	0,10	7,0	6,0
Rambing	TS 11	112,555	1,403	21,0	0,20	7,0	5,0
	TS 12	112,555	1,401	21,0	0,10	7,0	6,0
	TS 13	112,557	1,405	24,0	0,30	7,0	5,0
	TS 14	112,555	1,406	23,0	0,20	7,0	5,0
Dajo	TS 15	112,538	1,395	25,0	0,25	7,0	6,0
Gong	TS 16	112,512	1,390	24,0	0,15	7,0	6,0
	TS 17	112,514	1,389	24,0	0,15	7,0	6,0
	TS 18	112,505	1,389	25,0	0,30	7,0	6,0
	TS 19	112,506	1,387	24,0	0,40	7,0	6,0
Senentang	TS 20	112,499	1,389	25,0	0,60	7,5	6,0
Riak Tapang	TS 21	112,475	1,386	24,0	0,15	6,5	6,0
	TS 22	112,476	1,384	22,0	0,15	7,0	6,0
	TS 23	112,477	1,385	23,0	0,20	7,0	6,0

Appendix 15. **Number of Fish in the Location of Observation**

No	Species Name	River / Station																							Total
		Mentawak			Peyang		Santu			Sabung		Rambing				Dajo	Gong				Senentang	Riak Tapang			
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1	*Acantopsis dialuzona*																					1			1
2	*Anematichthys armatus*																					1			1
3	*Barbonymus collingwoodii*	4	8	9	2	7	3		5	1						4			1			32	11	3	90
4	*Gyrinocheilus pustulosus*			2		1		1	1		3												6		14
5	*Hampala bimaculata*		1		1		2		1		2	4	2						1			1	2		17
6	*Labiobarbus fasciatus*					1																			1
7	*Labiobarbus leptocheilus*																1	2							3
8	*Lobocheilus bo*	1	8	7		7	5	3	16	5	19	6	4			4	5	4		1	7	9	28	3	142
9	*Lobocheilus hispidus*	1	1	4		2	2		1	1						2	2	1				3	7		27
10	*Luciosoma setigerum*	2	11	4			3	5	24	13	4	3	11	5	4		4	8	1		7	1	1	6	117
11	*Macrognathus aculeatus*						1																		1
12	*Monotrete leiurus*					1																			1
13	*Monotrete sp.*								1																1
14	*Osteochilus microcephalus*	1	4	12		1	3	1	3	1	4	1				2	1	1				7	8	6	56
15	*Osteochilus waandersii*			1	1	3	3		5	1	2			1			1					4	2	6	30
16	*Oxygaster anomalura*				1																			3	4
17	*Paracrossochilus acerus*		3			1	1	1	1	2	1	4	2	1	1	2		1	1	1		1	4	7	35
18	*Puntius binotatus*																					1		4	5
19	*Rasbora volzii*			6	13	4	4		1	2	4	3	5	8	24	1	6	16	6	4	1	12	7	4	131
20	*Syncrossus hymenophysa*						1																		1
21	*Tor tambra*		1	1				2	1	2	1		1	3	1			1	2		2				18
22	*Tor tambroides*			2				2	2															1	7
	Jumlah	**9**	**37**	**48**	**18**	**28**	**28**	**15**	**62**	**28**	**40**	**21**	**25**	**18**	**30**	**15**	**20**	**34**	**12**	**6**	**17**	**73**	**76**	**43**	**703**

Appendix 16. **Conservation Status of Fish based on the IUCN red- list**

Family	Genus	Species Name	Local Name	Redlist
Cobitidae	Acantopsis	*Acantopsis dialuzona*	Ikan Pasir	LC
	Syncrossus	*Syncrossus hymenophysa*	Pansik/Engkadik	NE
Cyprinidae	Anematichthys	*Anematichthys armatus*	Boeng/Boin	NE
	Barbonymus	*Barbonymus collingwoodii*	Kepiat	NE
	Hampala	*Hampala bimaculata*	Langkung	NE
	Labiobarbus	*Labiobarbus fasciatus*	Engkarik	NE
		Labiobarbus leptocheilus	Kujam	NE
	Lobocheilus	*Lobocheilus bo*	Kulong	NE
		Lobocheilus hispidus	Kulong Nga'	NE
	Luciosoma	*Luciosoma setigerum*	Kenyuar	DD
	Osteochilus	*Osteochilus microcephalus*	Bantak	LC
		Osteochilus waandersii	Bantak Surik	LC
	Oxygaster	*Oxygaster anomalura*	Entebuluh	LC
	Paracrossochilus	*Paracrossochilus acerus*	Kemujok	NE
	Puntius	*Puntius binotatus*	Bangah	LC
	Rasbora	*Rasbora volzii*	Seluang	NE
	Tor	*Tor tambra*	Semah	DD
		Tor tambroides	Empurau	DD
Gyrinocheilidae	Gyrinocheilus	*Gyrinocheilus pustulosus*	Bingkus	NE
Mastacembelidae	Macrognathus	*Macrognathus aculeatus*	Tilan	NE
Tetraodontidae	Monotrete	*Monotrete leiurus*	Buntal	LC
		Monotrete sp.	Buntal Sabang	-

Note: LC : Least Concern, DD : Data Deficient, NE : Not Evaluated, (-) : unidentified

Appendix 17. **Composition of Insect**

Ordo	Family	Genus	Species
Blattodea	Blattellidae	Blattella	*Blattella asahinai*
			Blattella germanica
		Celeriblattina	*Celeriblattina major*
Coleoptera	Buprestidae	Melanophila	*Melanophila sp.*
	Chrysomelidae	Aulacophora	*Aulacophora foveicollis*
	Coccinellidae	Hippodamia	*Hippodamia sp1.*
			Hippodamia sp2.
			Hippodamia sp3.
			Hippodamia sp4.
	Curculionidae	Curculio	*Curculio sp.*
	Geotrupidae	Geotrupes	*Geotrupes vernalis*
	Melandryidae	Conopalpus	*Conopalpus sp.*
	Mordellidae	Mordella	*Mordella aculeata*
	Nitidulidae	Carpophilus	*Carpophilus sp.*
		Haptoncus	*Haptoncus luteolus*
	Scarabaeidae	Heliocopris	*Heliocopris dominus*
	Scraptiidae	Anaspis	*Anaspis sp1.*
			Anaspis sp2.
			Anaspis sp3.
Diptera	Muscidae	Musca	*Musca domestica*
Hemiptera	Alydidae	Leptocorisa	*Leptocorisa sp.*
		Riptortus	*Riptortus linearis*
	Cicadellidae	Bothrogonia	*Bothrogonia sp.*
	Cicadidae	Cicadas	*Cicadas sp.*
	Derbidae	Proutista	*Proutista moesta*
	Lygaeidae	Spilostethus	*Spilostethus hospes*
	Pyrrhocoridae	Dysdercus	*Dysdercus cingulatus*
	Scutelleridae	Eucorysses	*Eucorysses grandis*
Hymenoptera	Apidae	Apis	*Apis cerana*
			Apis sp.
	Calliphoridae	Calliphora	*Calliphora vicina*
		Chrysomya	*Chrysomya bezziana*
	Chalcididae	Xanthopimpla	*Xanthopimpla gampsura*
	Dolichopodidae	Chrysosoma	*Chrysosoma leucopogon*

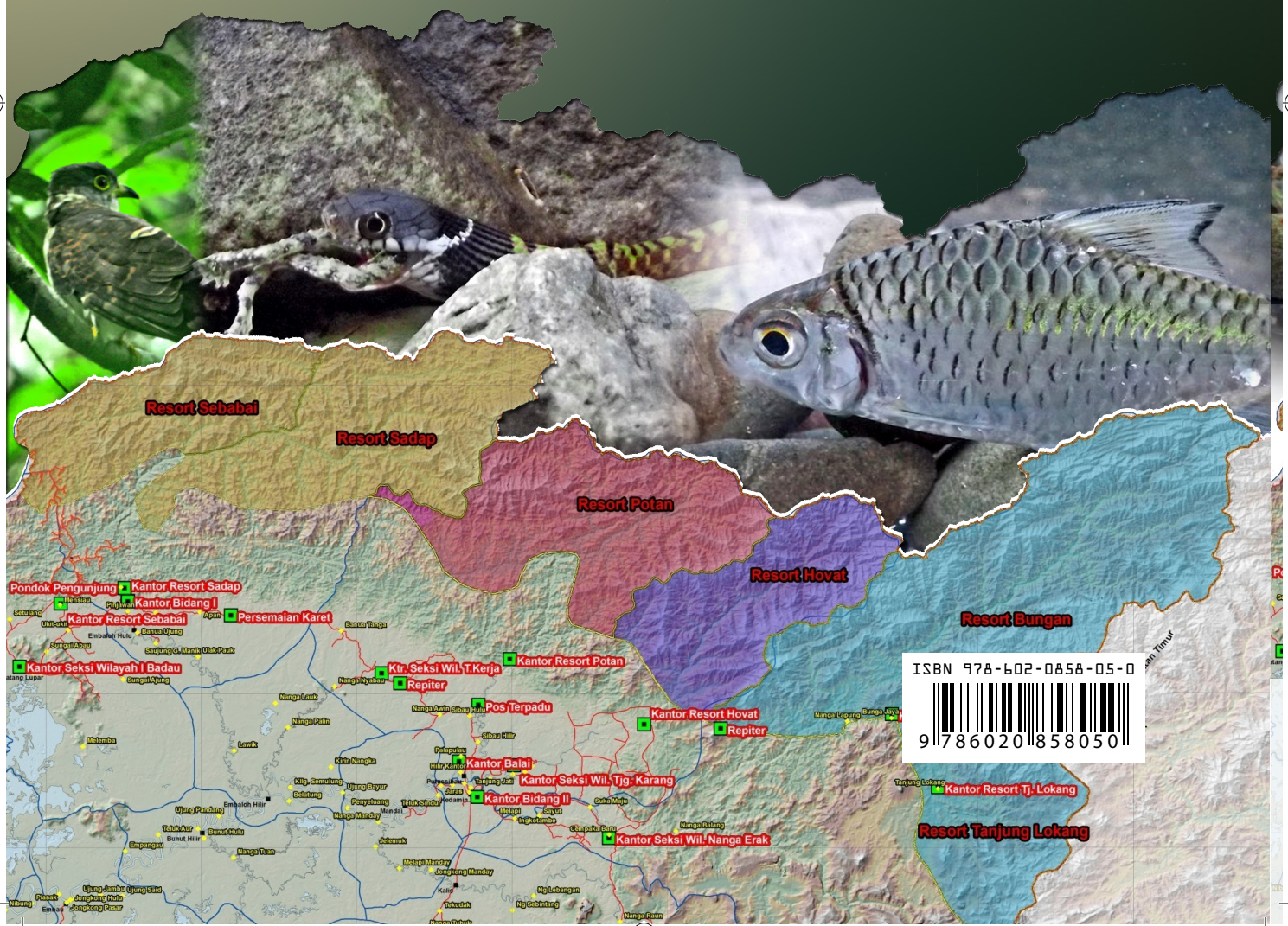
Ordo	Family	Genus	Species
	Formicidae	Camponotus	*Camponotus gigas*
		Echinopla	*Echinopla lineata*
	Stratiomyidae	Hermetia	*Hermetia illucens*
	Syrphidae	Syrphus	*Syrphus ribesii*
	Vesvidae	Polistes	*Polistes tenebricosus*
Lepidoptera	Arctiidae	Amata	*Amata sp1.*
			Amata sp2.
			Amata sp3.
	Delphacidae	Copicerus	*Copicerus irroratus*
	Hesperiidae	Koruthaialos	*Koruthaialos rubecula*
	Lycaenidae	Catochrysops	*Catochrysops strabo*
		Chilades	*Chilades parrhasius*
		Nacaduba	*Nacaduba hermus*
	Noctuidae	Argyrogramma	*Argyrogramma signata*
		Crioa	*Crioa aroa*
		Mythimna	*Mythimna convecta*
		Tryporyza	*Tryporyza interculas*
	Nymphalidae	Elymnias	*Elymnias panthera*
		Faunis	*Faunis gracilis*
		Ixias	*Ixias marianne*
		Potanthus	*Potanthus omaha*
		Ragadia	*Ragadia makuta*
		Rohana	*Rohana parisatis*
		Scopula	*Scopula perlata*
		Tanaecia	*Tanaecia palguna*
		Ypthima	*Ypthima philomela*
			Ypthima sp.
	Pappilonidae	Graphium	*Graphium antiphates*
			Graphium doson
		Papilio	*Papilio demoleus*
		Trogonoptera	*Trogonoptera brookiana*
	Pieridae	Catopsilia	*Catopsilia pomona*
		Colotis	*Colotis fausta*
		Eurema	*Eurema hecabe*

Ordo	Family	Genus	Species
			Eurema simulatrix
		Prioneris	*Prioneris philonome*
	Zygaenidae	Procridinae	*Procridinae sp.*
Isoptera	Termitidae	Macrotermes	*Macrotermes gilvus*
Mantodea	Mantidae	Manthis	*Manthis religiosa*
Odonata	Aeshnidae	Anax	*Anax guttatus*
	Coenagrionidae	Onychargia	*Onychargia atrocyana*

Ordo	Family	Genus	Species
	Euphaeidae	Dysphaea	*Dysphaea dimidiata*
	Protoneuridae	Prodasineura	*Prodasineura interrupta*
Orthoptera	Acrididae	Oxya	*Oxya chinensis*
		Phlaeoba	*Phlaeoba fumosa*
		Valanga	*Valanga nigricornis*
	Gryllotalpidae	Gryllotalpa	*Gryllotalpa orientalis*
Phasmatodea	Phasmatidae	Phobaeticus	*Phobaeticus chani*

Biodiversity Survey

In the Sub Watershed Embaloh, Betung Kerihun National Park



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