

MALAYSIA REEFS AND ISLANDS CONSERVATION PROJECT 2003

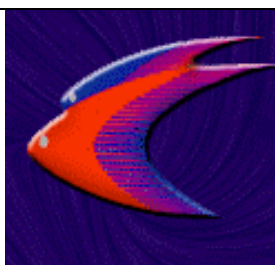
REPORT OF THE TERRESTRIAL PILOT PHASE

**A COLLABORATIVE PROJECT BETWEEN THE MARINE PARKS SECTION,
DEPARTMENT OF FISHERIES, GOVERNMENT OF MALAYSIA
AND CORAL CAY CONSERVATION.**



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EXECUTIVE SUMMARY

The terrestrial phase of the pilot project of the MRICP was finally completed in early July 2003. The successful six-week research period initially concentrated on the larger island, Perhentian Besar.

This report details the first ever inventory surveys that have been completed on the island group and have revealed a myriad of species, including the charismatic Colugo or 'Flying lemur' (*Cynocephalus variegatus*), the threatened Nicobar pigeon (*Caloenas nicobarica*) and new island records for several species which are thought to no longer exist (or have never been recorded) on the neighbouring and larger island of Redang, which has greater development pressures. These include the Short-nosed Fruit Bat (*Cynopterus brachyotis*) and the Lesser Sheath-tailed bat (*Emballonura monticola*) that were recorded by the MRICP but were last recorded on Redang in 1911.

The study undertook basic habitat mapping and revealed that Perhentian Besar is dominated by relatively undisturbed dipteropaceae forest, however, detailed vegetation inventories were not completed. The project did complete preliminary inventory surveys on major faunal groups, including: the volant and non-volant mammals, herptofauna, birds and butterflies. The initial results indicate the potential conservation importance of the Perhentian islands. However, there is much more field research to complete before conservation management recommendations can be proposed.

The presence of the pilot project also generated much interest amongst national research organisations such as the Forest Research Institute of Malaysia (FRIM), and amongst many NGOs, such as, Treat Every Environment Special (TrEES) and the Malaysian Nature Society. CCC plans to return to the Perhentians in March 2004 to extend its conservation research work in partnership with other stakeholder groups.

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1. INTRODUCTION

Malaysia has an extensive forest resource, with forestland cover approaching 60% of its landmass (FAO 2002). The forests are vital ecosystems of high productivity and diversity, which provides one of the main sources of income, survival and sustainable development of the Malay population.

The climate of Malaysia is typically humid and is characterised by year round high temperatures and seasonal heavy rain. As a result of these climatic conditions, the predominant natural vegetation is tropical rain forest, the main forest types being lowland and hill dipterocarp forest, peat swamp forest, freshwater swamp forest and mangrove. The forest types occurring in the three States, Peninsular Malaysia, Sarawak and Sabah have great similarities, both in structure and floristic composition (rainforestweb.org. 2001). In addition to these three states, Malaysia consists of a number of small islands off the mainland.

Malaysia is located north of the Equator within latitudes 1° to 7° north and longitudes 100° to 119° east. The total land area is approximately 32.9 million hectares with more than 19 million hectares of forest cover. Only a century ago Malaysia was sparsely populated and covered by vast areas of untouched tropical rainforest. The population now, however, stands at 23 million with over 80% inhabiting Peninsular Malaysia (FAO 2002).

Much of the virgin forests of Malaysia have been cleared to make way for agriculture, new forest plantations and industrial developments. Nevertheless the Malaysian region supports a diverse array of fauna and flora with over 12,000 plant species, 740 species of avifauna, 336 mammals and 620 species of herpetiles (Rainforestweb.org. 2001).

Although Malaysia is heading towards industrialisation, its economy is still rooted in the production and export of primary commodities - crude oil, palm oil, tin and rubber still provide over 50% of export earnings. Malaysia leads the world in the production of rubber and is one of the biggest producers of cocoa, palm oil, tropical hardwoods, pepper and tin, all of which are mostly exported in processed forms. Of the various natural resource sectors, forestry remains one of the most important, contributing significantly to socio-economic development of the country (FAO 2002).

As a result of this and despite the persistence of almost half of the Malaysian landmass being forested, deforestation rates have been over 2.4% annually since 1990. Forests are being encroached by destructive development plans including logging, oil palm plantations, pulpwood plantations, hydroelectric dams, mining activities, and resort development (rainforestweb.org 2001). Malaysia has some 1.75 million ha of plantations, with an annual establishment rate of almost 35000ha with rubber plantations accounting for almost 85%.

The vast majority of Malaysia's forests are classified as inland dipterocarp forests, which may be further categorised into lowland, hill, upland and montane types. The main

species are from the genera *Anisoptera*, *Dipterocarpus*, *Dryobalanops*, *Hopea*, *Shorea* and *Parashorea*. Malaysia also has small areas of fresh water swamp forest, mangroves and plantation forests (FAO 2002).

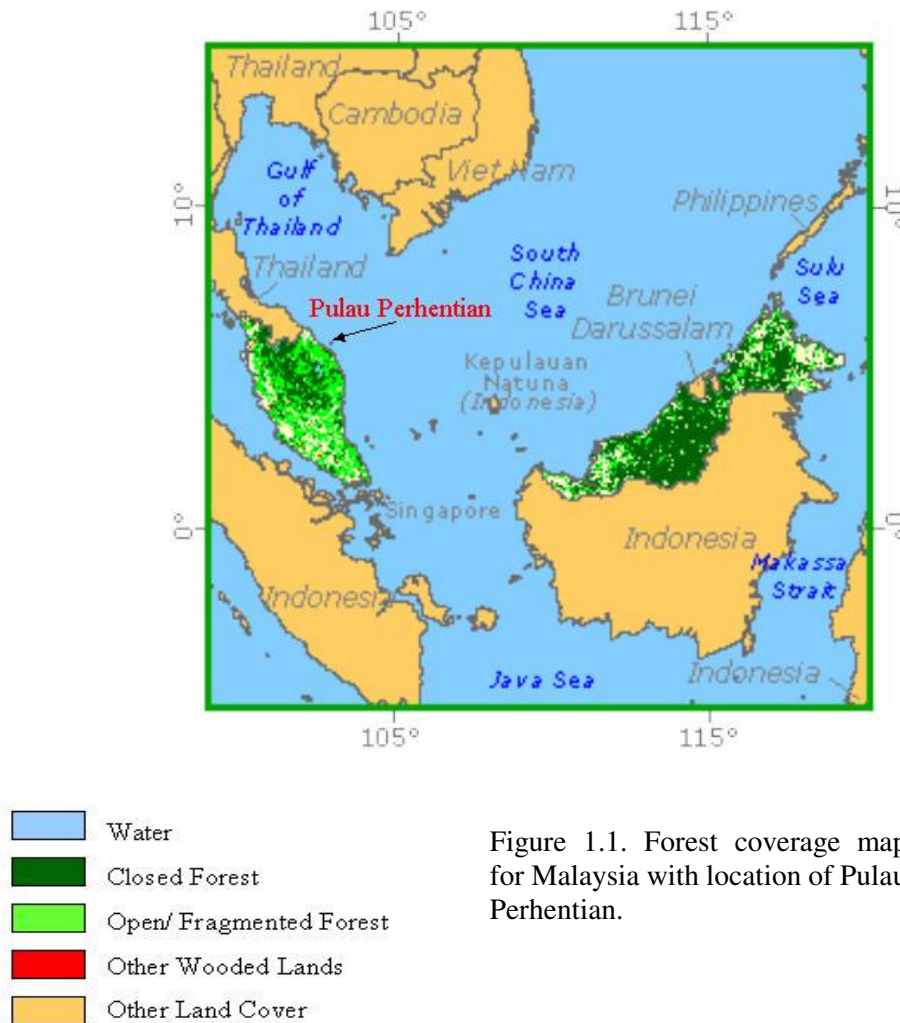


Figure 1.1. Forest coverage map for Malaysia with location of Pulau Perhentian.

Malaysia has designated more than three-quarters of its natural forests as Permanent Forest Estate (PFE) to be managed and for sustainable development. Malaysia has more than 50 national parks and reserves with small areas of representative forest types managed within the PFE as Virgin Jungle Reserves (FAO 2002).

Research on Malaysian tropical forests and their inherent fauna and flora has largely concentrated on the mainland areas, focusing on tropical tree distributions (Condit *et al.*, 1996), vegetation species diversity (Gimaret-Carpentier *et al.*, 1998) and the effects of habitat disturbance (Laidlaw 2001). Other studies areas have investigated specific

taxonomic groups, such as the Large flying fox, *Pteropus vampyrus* (Mohd-Azlan *et al.*, 2001), woodpecker abundance (Styring & Ickes 2001) and native wild pigs (*Sus scrofa*) (Ickes 2001).

The small islands that line the coast of Peninsular Malaysia are heavily forested and likely to have a very important ecological role (Cronk 2001). Such islands often provide havens for endemic, endangered and migratory species as previously found on similar forested islands in Southeast Asia (Turner *et al.*, 2002a). Pulau Redang, situated off the north east coast of peninsular Malaysia, has been noted to support a number of unique species, including half the mammalian species identified (Rahman & Ibrahim 1996). The Flying lizard (*Acanthosauria armata*) illustrates the importance of the offshore landmasses, as although rare on mainland Malaysia, this species thrives on the surrounding islands of peninsular Malaysia.

Despite this, virtually no research has been conducted on the numerous forested islands surrounding peninsular Malaysia. The main focus of the island research has centred on Langkawi off the west coast of peninsular Malaysia, investigating the herpetofauna (Bowles 1997), forest structure (Kohira *et al.*, 2001), land use and cover distribution (Baban & Yusof 2001), and forest recreation (Jussoff & Hassan 1996). Other studied areas include the Republic of Singapore located off the south coast of peninsular Malaysia. Here factors affecting specific species distributions on small tropical islands were investigated (Koh *et al.*, 2002). Little investigation into the east coast islands has been carried out, and that which has is limited to the flora and vegetation of Pulau Tioman (Latiff *et al.*, 1999) and the water resources of Pulau Perhentian (Yap & Kahoru 2001).

The Perhentian islands, located off the far northeast coast of peninsula Malaysia, are therefore an important area for ecological study. The two main islands, known as Pulau Perhentian Besar and P. Perhentian Kecil or more simply as big and small island are situated only 4 hours south of the Thai border and on the East Coast road toward Singapore. Both rise up out of the sea covered in a lush tropical rainforest and fringed by extensive coral reefs nearly 6,000 years old.

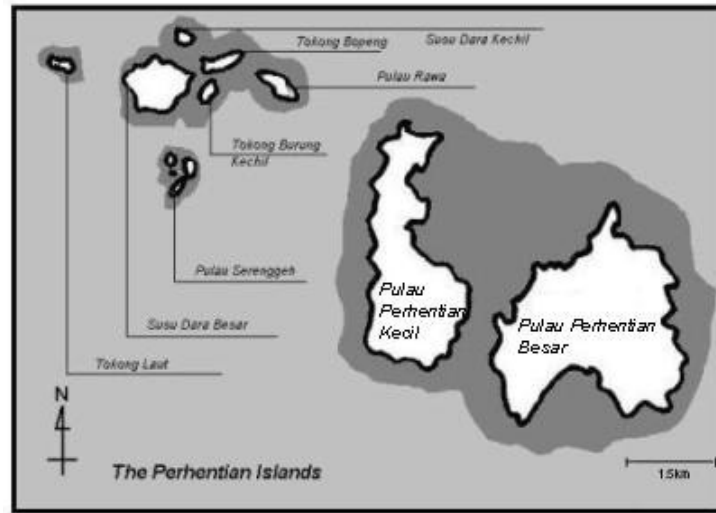


Figure 1.2. Schematic map of Perhentian Islands, Malaysia. (Approximate scale only).

The Perhentians are protected by a series of marine protected areas, and are one of twelve island groups off Peninsular Malaysia that have been gazetted as Fisheries Protected Areas under the Fisheries act 1985 (Aikanathan & Hung 1994). Such designations do not cover the terrestrial resources of the island, and thus with most of the island groups, including the Perhentians, the ecological and economical importance of the forests have not yet been evaluated.

2. THE MALAYSIA REEFS AND ISLANDS CONSERVATION PROJECT

2.1. Project Background

Coral Cay Conservation (CCC) is a not-for-profit organisation that provides resources for the protection and sustainable use of tropical ecosystems. CCC works closely with local communities and organisations and is funded primarily by volunteers who pay to participate in the research programme as resource surveyors.

Following meetings between Marine Park Section personnel in Malaysia and Peter Raines, CCC Managing Director in May 2002, a collaborative project was planned to be undertaken on the Perhentian Islands between March and June 2003. This would initially be a 3 month pilot phase project with a view to long-term implementation of the Malaysia Reefs and Islands Conservation Project (MRICP). Full details of the project development stages and rationale for the MRICP are given by Raines (2002).

A preliminary literature review (see *Introduction*) reveals that virtually no baseline ecological survey work has been completed on the Perhentians. Thus, whilst the islands are inhabited and support a growing tourist industry, the impacts on the islands natural resources via consumptive and non-consumptive uses is unclear. Surveys by CCC will provide the data and outputs necessary to provide management recommendations and habitat maps to help the long-term conservation and sustainable management of this area.

Aims of the pilot project:

- (i) Provide a baseline of terrestrial information on the fauna and flora of the Perhentian islands (Besar island).
- (ii) Provide outputs that will include, but are not limited to, a terrestrial habitat data and spatially referenced species inventories for Besar Island.
- (iii) Develop a strategy for longer-term monitoring of key habitats and species in order to underpin conservation and sustainable management.

2.2. Report Outline

This report attempts to provide an initial characterisation of the biodiversity of Pulau Perhentian Besar. The ecological survey work has concentrated in specific forest habitat types during the six-week pilot project phase (14th May to 25th June 2003) in order to develop reliable species inventory and distribution information for major faunal and floral groups.

The main section of the report focuses primarily on faunal assessments but with some vegetation characterisation provided. Empirical inventory data on seven different faunal groups (birds, volant mammals, amphibians, reptiles, invertebrates and non-volant

mammals) are presented. Vegetation assessments from different locations with Besar Island are also detailed.

In the final sections, ongoing collaboration and community work is documented. Finally, the findings of this research are related to existing knowledge, and future research and conservation recommendations are proposed.

3. VOLUNTEER TRAINING

The vast majority of survey work completed by CCC is undertaken by volunteers, thus efficient and effective training is a vital component of any volunteer programme in order to allow participants to quickly gain the required identification and survey skills that allow them to collect accurate and useful data. CCC uses an intensive one-week training programme (*The CCC Skills Development Programme*) that has been constantly refined since the late 1990s. The programme is designed to provide volunteers, who may have no biological knowledge, with the skills necessary to collect useful and reliable data. The primary aim of the lectures and practical tasks during this one-week programme is to train volunteers to use specialised field equipment and give them the ability to discern the specific identification characteristics and relevant biological attributes of the species that they will encounter during their terrestrial surveys.

The training programme is co-ordinated by the Project Scientist (PS) and Science Officer (SO) and involves lectures, seminars, practical field based learning and evening audio-visual presentations. Volunteers are also encouraged to practise survey techniques and utilise identification guides to ensure a thorough understanding of the information provided in the lectures. An important component of the training schedule is a series of testing procedures to ensure that each volunteer has reached a minimum acceptable standard.

3.1. Skills Development Programme

An outline of the proposed Skills Development Programme (SDP) that will be delivered by CCC staff as part of the terrestrial phase of the MRICP pilot project is given below (Table 3.1). The PS and SO will be primarily responsible for the delivery of the SDP.

Table 3.1. Summary timetable of the terrestrial SDP for MRICP pilot project.

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
AM	Background lectures: Malaysian environment Forest ecology	Habitat mapping & vegetation assessment: theory & approaches	Avian ecology & survey techniques theory	Mammal ecology & survey techniques theory	Herpetile ecology & survey techniques theory	Invertebrate ecology & survey techniques theory	Knowledge validation and testing (theory & practical).
PM	Introduction to survey techniques & protocols	Habitat mapping practical: Phase 1 surveys	Avian surveys practical: Mist nets & Mackinnon lists	Mammal surveys practical: Mist nets & Sherman traps	Herpetile surveys practical: Drift net & VES	Invertebrate surveys practical: VET & feeding traps	Prepare for surveys
EVE	Review	Review	Review	Review	Review	Revision	

Teaching and training materials will be adapted from those currently used on the Negros Rainforest Conservation Project (Turner *et al.*, 2002b) and those used as part of the Danjungan Island Biodiversity Survey (Turner *et al.*, 2002a). On satisfactory completion of the SDP the PS and SO manage the daily survey programme aided by locally recruited field guides.

4. STUDY AREA – PULAU PERHENTIAN BESAR

4.1. Study Area Description

The Perhentian Island Archipelago is located between 102 43'30"E to 102 45'30"E and 5 54'N to 5 54'30"N, approximately 21 km off Kuala Besut, Terengganu (Peninsular Malaysia). The archipelago consists of 11 small islands with the largest P. Kecil (approximately 524ha) and P. Besar (approximately 867ha), being the main areas of interest for the terrestrial research project. Additional islands take a westerly bearing off Kecil and consist of Susu Dara Besar, Susu Dara Kecil, Rawa and Takong Laut, as well as additional smaller islands (See Figure 1.2). All of these are uninhabited. All these islands and their surrounding waters have been recently established as Marine Parks.

Although tourism started in the 1960s, prior to the early 1980s, the main economic activities on the islands were fishing (local methods include hand line fishing and fish traps, whereas additional fishing pressures of purse seine and trawlers have been used by non locals) and small scale agriculture. Tourism really started to make an impact after 'Visit Terengganu Year 1992' and the development of the Perhentian Island Resort, the sole international class hotel, was built. Since this more and more developments have sprung up on both Kecil and Besar. The main economic activity of the islands now consists of tourism, with both local people and mainlanders being heavily involved.

The Perhentians do however have limited areas for development due to the lack of flat lands available. Most of the islands are hilly and still covered by forest and development has been restricted to small coastal strips. Excessive water demand from chalet resorts is an additional a problem. Most chalets bore their own water holes, and water is supplied by pumping ground water. Ground water is dependent on rainfall and there have been shortages in the past (1998 proved to be a problem year), however, even the installation of the water treatment plant at Telok Dalam has not solved all the problems.

Most of the fresh water streams run dry during the demanding summer months and only a few remain flowing. One of these, reaching Telok Dalam, is an important source of fresh water for fisherman using the islands as a rest stop or protection from storms.

4.2. Geology and Edaphic features of the Perhentian Islands

The Perhentian Island chain consists of continental islands that belong structurally to and represent a submerged part of the mainland. These islands survived the rise in sea level around 20,000 years ago when the sea level rose 120 metres. Thus the islands, originally connected by land bridges, have been isolated for 15 – 20,000 years.

The Perhentians are granite islands, which are characterized by hilly slopes joining the sea and granite tors protruding out forming cliffs and outcrops. Fringing coral reefs surrounds these islands.

The granite bedrock of the islands only permits the development of thin and rocky soil, however, in more sheltered valley areas, deeper soils have been allowed to form.

4.3. Perhentian Besar

i) *Topography*

Perhentian Besar is the largest of the islands within this archipelago. The island itself consists of many ridges with the highest peak reaching 321 metres above sea level, separated by low-lying valleys (See Figure 4.1). The main ridges run through the centre of the island and branch outwards to the northern tip (running north east) and down to the south tip (running south east) of the islands east facing side. The northeast and the east coast comprises of predominantly rocky outcrops that are steep slopes. Lower ridges and less steep sided topography reflect the west coast of the island.

The main beach areas are found on the west coast of the island, the sheltered bays of the south (Telok Dalam and south of Tanjung Tukas Lout), the north (Bsair Tiga Ruang and Telok Pauh) and west coast (stretching from Tanjung Genting to Tanjung Keke). These areas have been subjected to tourist development, heavily increasing over the last 10 years (see Figure 4.2). This has result in the loss of the natural beach fronted vegetation and been replaced with more ‘typical’ beachfront scenes of coconut palms and papaya trees. The north beach of Pasir Tiga Ruang is protected for the conservation of turtles and no development has occurred here. Here the vegetation is typical of coastal beach (strand) forest, consisting mainly of *Hibiscus* and *Pandas* species. The east coast is generally lacking in any beaches except for one, Tanjung Pasir Pinang Saribu, which is sheltered from the monsoon.

ii) *Vegetation Description*

Most of the island of Besar is virgin forest comprising of mainly Dipterocarp forest, both *Dipterocarpus* species and *Shorea* species. The main path across the island dissects at one of the narrowest points from the north at Perhentian Island Resort to the south of Flora Bay (Telok Dalam). The major part of the island (north-east side or east of the path) remains quite isolated with few, if any, paths through. However, there have been reports of seasonal hunting pressure with targeted species including birds, small mammals (e.g. squirrels) and lizards. This occurs in the monsoon times when fishermen take shelter from the storms in the area of Flora Bay. The west side is more developed, but with few resorts encroaching significantly in to the forest. On several coastal sites such as Telok Dalam and Pasir Jong, *Casuarina equisetifolia* (Casuarinaceae family) are found. It is believed that these have been deliberately planted for ornamental reasons.

The island is however heavily influenced by the monsoon that comes in on a northeasterly path. This is highlighted by the fact that the east side has no beach lines and the vegetation has patches of low scrub area in some of the more exposed places.

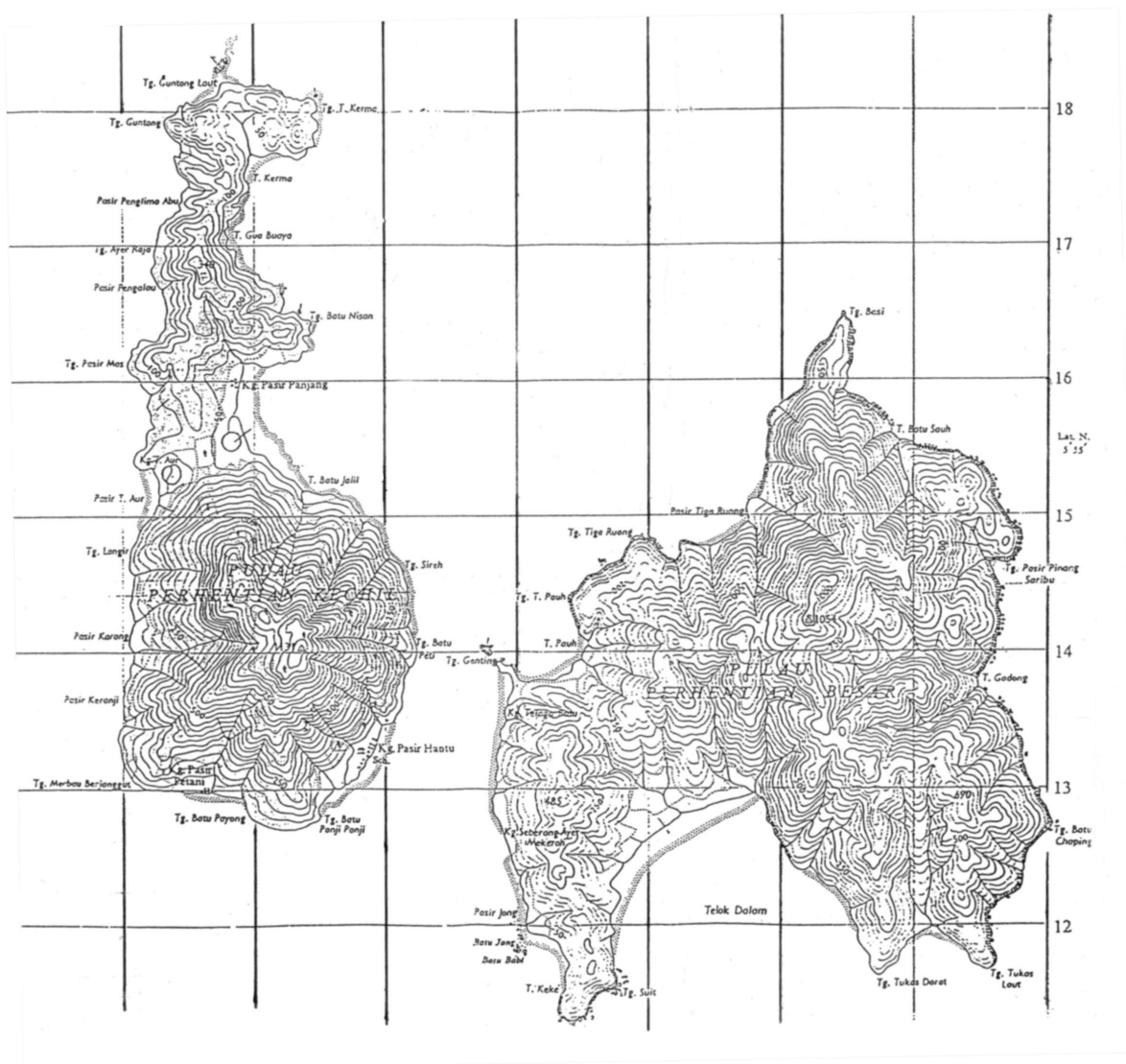


Figure 4.1. Topography of Pulau Perhentian Besar and Kecil.



Figure 4.2. Outline schematic map of Pulau Perhentians with place names and survey location

ii) *Vegetation Description (continued)*

There is only one major area on Besar that has been altered dramatically. Telok Dalam was once an area for agriculture (padi fields) and has been left in a state of course grassland and shrub area on the rainforest edge. Other resort areas have changed the natural vegetation by planting a variety of species. Most of these species include papaya and coconut.

Six main survey sites were established in different locations across the island. The vegetation description for each is as follows (all sites have been plotted in Figure 4.2):

1) Perhentian Island Jungle Trail

This site is located at north side of the island, above Telok Pauh. The steep sided path leads up to a ridge that overlooks the north of the island. This area has thin soil and large granite outcrops, with some rocks forming caves and caverns.

The dominant species at this site include; *Shorea* species (Dipterocarpaceae family), *Dipterocarpus* species (Dipterocarpaceae family), *Sindora* species (Leguminosae family) with these such individuals reaching heights of 50m or more. Abundant species within this area includes: *Ficus* species (Moraceae family). Fish Tail Palms (*Palmae* family), *Musa* species (Musaceae family), *Pandanus* species (Pandanaeae family), Tongkat Ali (*Eurycoma longifolia*, Simarubaceae family), rattans including *Calamus* species and *Daemonorps species* (Palmae family).

The understorey consists of a variety of Ginger (Costaceae and Zingiberaceae family) as well as many ferns, lianas, vines and epiphytes being present. Epiphytic orchids (Orchidaceae Family) were found on rocky outcrops and some trees and although locally abundant in some areas were generally seen occasionally throughout the general area. Bird's Nest Fern (*Asplenium nidus*, Aspleniaceae family) was also present although considered a rare sight at this location.

2) East Side

This site was based on the east side of the island and thus heavily influenced by the northeast monsoon. Situated on a ridge above Tukas Laut with steep rocky slopes, the vegetation has developed a wind-faced structure with many trees not exceeding 15 metres in height.

The dominant species on this site being the *Shorea* species (Dipterocarpaceae family) and *Sandoricum* species (Meliaceae family). These trees are shaped by the wind from the northeast, with short trunks and shaven foliage, the forest seems visually as more of a low lying scrub area.

Additional species at this site included; *Ficus sp.* (Moraceae family), rattans including *Calamus* species and *Daemonorps species* (Palmae family), Tongkat Ali (*Eurycoma longifolia*, Simarubaceae family) and *Pandanus* species (Pandanaeae family). These

species are found in abundance in this area. The east side is lacking in many fern species, bryophyte species, lianas and few, if any, epiphytic species. (See Table 4.1).

3) Jungle Centre

This area is characterized by thicker soil in a sheltered valley area, in land, with no coastal views or influence. This is a more typical lowland *Dipterocarp* forest (Dipterocarpaceae family) with *Dipterocarpus* species and *Shorea* species as dominant. The height of some of the tree species reaches above 50m. The understorey is sparse as there is little light, however Tongkat Ali grows well up to 15m.

4) Flora Bay (Telok Dalam)

Behind the chalets on the coast, this is an area that has had most of its natural vegetation lost through agricultural development. The area was once used for paddy fields, but since has been left abandoned due to irregular water. Further development has meant more disturbances with the building of a water treatment plant. The area is on the forest edge and consists of scrubby grassland and pockets of ferns and banana plants as well as *Casuarina equisetifolia* (Casuarinaceae family). The coastal flora consists mainly of *Hibiscus* and *Pandas* species.

5) Perhentian Island Resort to Flora Bay Trail

This trail dissects the island from north to south and passes through high forest, similar forest to that of the PIJT. The mixture of species includes, *Dipterocarpus* species and *Shorea* species (Dipterocarpaceae family) as the dominant species in the upper canopy, Ginger (Costaceae and Zingiberaceae family), Fish Tail Palms (Palmae family), *Musa* sp (Musaceae family), *Pandanus* species (Pandanaceae family) are all present in high abundance on the trail edge, ferns are also present in large numbers.

6) Campsite

This site is located on the west coast of the island, approximately 500 metres north of the most southerly point. The area consists of a variety of habitats, including offshore islets, rocky and sandy beach, a stand of *Casuarina equisetifolia* and scrubby grassland leading to forest edge. The flora is similar to that of Flora Bay with *Hibiscus* and *Pandas* species being abundant.

4.4. Perhentian Kecil

i) *Topography*

The smaller of the two main islands, Kecil consists of three main topographic regions. The southern region consists of one large steep sided hill that starts at the waters edge and peaks at 345 metres above sea level. The east side of this is considerably steeper, with the west coast harboring some sheltered beaches.

The middle area consists of land lower than 15 metres connecting Coral Bay (Pasir T. Aur) to Long Beach (Pasir Panjang). The third region, on the north tip of the island consists of slightly higher, rocker areas, peaking at 105metres.

ii) *Vegetation*

The vegetation on Kecil has been altered and there seems to be little primary Dipterocarp rainforest left. Only in largely inaccessible areas such as the steep sided southern region, are there pockets, surrounded by secondary rainforest. This rainforest has developed due to recolonisation of failed agricultural initiatives in the 1960s.

Within this southern sector there have been pockets of mango, coconut, rubber, banana, Jackfruit and clove plantations. These occur both near the village and on some of the more accessible locations. The clove and rubber plantations have been left as unsuccessful government sponsored projects and most of the plantations have been abandoned and native vegetation is re-colonising.

The northern part of the island is generalized as a scrubby area this is mainly due to the affect of the northeast monsoon. The vegetation has a stunted and shaven appearance and the forest cover and species is similar to that of the East Side survey site. Thus the dominant species being *Shorea* species (Dipterocarpaceae family) and *Sandoricum* species (Meliaceae family).

Table 4.1. Summary description and location of survey sites on P. Besar.

Survey Site	GPS Locations (UTM)	Habitat Description	Map Points
Perhentian Island Jungle Trail	48N 0250126,0653273 48N 0250800,0653037	<i>Dipterocarpaceae</i> and <i>Leguminosae</i> dominant, northern part of the island, coastal influence	S1
East Side	48N, 0252666,0651236 48N, 0252782,0651356	Low shrub forest Monsoon influenced	S2
Jungle Center		Lowland <i>Dipterocarp</i> forest, no coastal influence	S3
Flora Bay	48N, 0250406, 0651516 48N, 0250891, 0652018	Forest edge, grass and scrubland. Old agricultural site.	S4
Flora Bay to PIR Trail	48N, 0250059,0652831	Open trial though high forest.	S5
Campsite	48N, 0249828,0651220		S6

5. METHODS

Ecologically sound forest management, whether for conservation alone or in conjunction with sustainable resource use, will only be successful if the dynamic structure and behaviour of the forest system can be adequately characterised and understood. Baseline biodiversity surveys (as implemented by CCC) provide us with an opportunity to assess ecological changes over space and time, and therefore have a central role in many aspects of tropical forest research, conservation and management.

The terrestrial survey work of the MRICP followed an amended and adapted version of the model recently used on Danjungan Island in the Philippines, where a four-month flora and fauna inventory study was recently completed (Turner *et al.*, 2002a).

It was proposed that the work on the MRICP pilot phase would be composed initially of three major elements that would run during the different stages of the project (see *Project Plan* [Turner *et al.*, 2003a]). These will include:

- (i) Vegetation surveys;
- (ii) Vertebrate surveys;
- (iii) Invertebrate surveys.

The survey work during the pilot phase initially concentrated on Besar Island with reconnaissance trips to the nearby Kecil Island.

5.1. Birds

Point Counts

This technique involves an observer recording all individuals identified, from sightings or calls, during a set time whilst remaining at one location. The duration used in this case was 30 minutes, giving the observer a reasonable amount of time in which to record rainforest birds, as these are often notoriously difficult to identify. Record were only taken if the birds were seen or heard within the habitat type of which that location consisted, i.e. whilst recording those seen or heard in scrubland, those sighted or heard in nearby forest are omitted. To ensure the same individual was not recorded twice, two birds of the same species were only recorded if two individuals were seen or heard at the same time, or at different areas where the same bird could not get to in the space of time that had past.

A total of 24 lists were compiled during a four-week period, consisting of three lists (one taken early morning and two late afternoon) carried out at eight different locations (see Table 6.1).

Species diversity metrics were then calculated from the counts. Three measures of local diversity were calculated for each survey location and these included: Total number of species (S), Shannon-Weiner diversity $H = -\sum (P_i * \log_e(P_i))$ where P_i is the number of individuals of the i th species as a proportion of the total number of all i th species, and Pielou's evenness $J = H / \log_e S$ (Carr 1996).

Further patterns in community composition were assessed using PRIMER (Clarke & Warwick, 1994a). The Bray-Curtis similarity measure was then calculated (from count data) between every permutation of sample pairs (Clarke & Warwick 1994b). The relationship between survey sites was analysed using a Non-metric Multi-Dimensional Scaling (NMDS) ordination and a hierarchical agglomerate clustering technique (Clarke & Green 1988).

5.2. Bats

Mist Netting

Mist-nets (38mm mesh, 6m x 2.6m) were used at various locations representing different forest habitat types and non-forested habitats within the study areas of Besar Island (Table 4.1).

To maximise capture efficiency, nets were established across likely flight-paths such as clearings, along ridges, or by water (Heaney *et al.*, 1989), in a variety of combinations, such as 'Z' and 'T' formations (Kunz *et al.*, 1996), and at heights ranging from 1m to 10m above the ground. High nets were operated on a pulley system, and when possible were complemented by a low net positioned on the same pulley system (following Ingle 1993). Generally, nets were opened before dusk and closed anytime up to midnight, depending on weather and personnel.

Bats captured were identified using Ingle and Heaney (1992) and Francis (2001), sexed by observation of genitalia and nipples, and aged (to adult or juvenile) by assessment of the ossification of the joints of the digits of the wing. Forearm length was measured using dial callipers, and weight using spring balances. When new species were encountered, ear, hind-foot and total length were also recorded.

For each survey night, the location, weather conditions and time the nets were operational was noted. As nets were open for variable lengths of time, net-effort for each location was calculated as hours per square-metre of net.

5.3. Non-volant Mammals

Live trapping

Small mammals were trapped using cage live traps (Dimensions 15cmx10cmx20cm), purchased locally. Traps were set up in a random formation following modified approaches of Heideman *et al.* (1987) and Heaney *et al.* (1989). Traps were stationed with at least 10m spacing between each trap. It was ensured that the traps were wholly within the habitat type being surveyed. Each trap location was marked with a small piece of ribbon/raffia (or similar) tied to a branch above (1m) the trap.

Traps were placed on the ground under suitable cover and alongside natural objects such as fallen trees, logs or branches or under low shrubs. Each trap was baited with peanut butter (or similar) and dry bedding material (dry grass, cotton wool, shredded paper etc) was also placed in the nest box. Traps were set for a minimum of 3

mornings and 3 nights, being left open during the intervening periods. Traps were checked at least twice a day, re-baited as needed, and damp bedding replaced. All trap lines were established in areas where no other surveys are being undertaken to minimise disturbance and enhance capture probability.

On checking a closed or triggered trap, the contents were emptied into a clear plastic bag. Identification to species level using locally developed keys (Maunder & Turner 2003), age and sex were determined where possible. Biometric measurements and additional notes including site, date, trap location, and comments on breeding condition, health, or recapture were also taken before release.

Visual Encounter Transects

Visual Encounter Transects were not employed as it was realised that this method would not be productive enough for the time and effort required in order to produce any further useful data. Ad hoc walks were undertaken regularly during the day and at night before formal surveying began.

5.4. Herpetofauna

Quadrat Visual Encounter Survey (QVES)

The quadrat method has been shown to be one of the most effective herpetofaunal sampling techniques (Jaeger & Inger 1994). Four observers intensively search a quadrat, which measured 20m by 20m. Each observer begins at one of the four corners of each quadrat and moves at the same velocity in a clockwise direction. This synchronised movement should prevent most of the individual reptiles and amphibians from exiting the quadrat before capture. The four observers should consist of a mix of staff and volunteers. Each quadrat should be searched for 15 minutes ensuring that all microhabitats are investigated on the forest floor and above (without the need for tree climbing).

Transect Visual Encounter Survey (TVES)

Transect Visual Encounter Surveys (TVES) was the method employed to survey herpetofauna. This involved a specified number of people walking along a predefined route (i.e. the transect) of a set distance, for a set amount of time (e.g. 45 minutes). The observers, comprised of staff and volunteers, would walk in the same direction at a certain distance apart, in order to prevent the same animal being recorded twice. Each observer would search all microhabitats present on the ground and above, without having to climb any trees or rocks.

Each individual encountered was captured by hand (gloved), identified, measured to the nearest 0.1mm with callipers, weighed on a Pesola spring scale to the nearest 0.25g, and immediately released at the point of capture. Substrate and height at which individuals were encountered was also recorded. Where identification could not be determined, dorsal and ventral photographs were taken.

5.5. Invertebrates

Transect Walks

The transect walk method with non-random point counts was used to investigate butterfly spatial distribution, diversity and abundance at the different survey sites. The use of such transects also meant that a wide variety of habitats and microclimates (streams, canopy gaps, different aspects, etc.) were surveyed (Hill 1999).

Line transects (500m) were marked out and observation stations were marked every 50m (10 stations in total) for the point counts. Butterflies were surveyed along the transects using methods similar to those described for butterflies in temperate regions by Pollard (1977), and used in previous studies of tropical forest butterflies (Hamer *et al.*, 1997; Hill 1997; Hill *et al.*, 1995; Spitzer *et al.*, 1993; Slade 2001), thus, allowing this study to be compared with diversity studies from other areas.

To ensure a constant duration of observation for each transect walk, a constant speed of 3 minutes per 50m was maintained. During the walk butterflies were observed within an imaginary box around the observer (5m each side, 5m ahead and 5m above). Similarly, at each observation station binoculars were used to record butterflies observed during a 10 minute period within a 10m radius, and at all heights from the ground, in an attempt to include higher flying butterflies. These distances are similar to those used in other tropical butterfly studies (Spitzer *et al.*, 1993; Hill *et al.*, 1995; Hamer *et al.*, 1997). Thus, any differences in butterfly diversity between sites was not due to differences in visibility, because recording is restricted to within 10m of the stations and within 5m of transects (Hamer *et al.*, 1997).

Butterflies that could not be identified to species or genus on the wing were, where possible, caught, and released immediately after identification. During such pauses the timer was stopped. However, if netting was not possible because the butterfly was, for example, flying too high or too fast, it was omitted from the study.

Peak butterfly density was noted to occur around the middle of the day (Hill *et al.*, 1995; Pollard, 1977; Pollard 1988; Walpole 1999). Transect counts were therefore only conducted between 1000hrs and 1500hrs, and only when the weather was good (i.e. sunny, and no rain), as temperature/irradiance differences are known to affect butterfly flight (Pollard & Yates, 1993; Willott *et al.*, 2000). The direction the transects were walked was alternated for each transect to minimise any differences due to time of day, and in an attempt to ensure equivalent conditions.

Each transect was walked two times during each 4 day survey period. Walpole & Sheldon (1999) noted low densities of butterflies beneath the canopy, and concluded that to obtain a sizeable sample, repeated counts were needed along the transect. Hamer *et al.*, (1997) note that although the degree of movement by individuals should not alter the probability of encountering a species, in the absence of sufficient sampling the higher variance for non-sedentary species can lead to possible errors in estimates of relative abundance.

Identification of Butterfly Species

No specimens were taken to aid identification. Taxonomic identification was based on Hoi-Sen (1983).

5.6. Vegetation

Vegetation Inventory

Species-level identifications were not attempted for all specimens during this expedition due to limited taxonomic expertise and support (and lack of appropriate permits for botanical collections).

Habitat Mapping

In order to generate a broad-scale habitat map for P. Besar and P. Kecil, the project used an adapted version of the Phase 1 Vegetation Classification (NCC 1990) where homogeneous vegetation communities are identified and classified according to a number of land cover classes. These classes were modified from UK classes (NCC 1990) to suit the major habitat types encountered on coastal islands in the Indo-Pacific region. Under the standard method habitat ‘parcels’ are delineated using natural boundaries (where possible) or are created by the surveyor and plotted onto existing maps (usually 1:10 000 topographic maps).

An outline map of the island was derived from a Landsat 7 ETM+ satellite image (path: row number 48:05 acquired on 12th July 2001) with 60m spatial resolution was imported into Mapinfo. The outline of the landmasses was then digitised at a high magnification level in Mapinfo and was used as the spatial framework within which to undertake the mapping.

The location and extent of the major habitat types was then superimposed primarily by remote viewing (from vantage points such as peaks, open areas, and boats), and estimating their positions and extents of land use classes by relating them to the natural features and published topographic maps (Aikanathan & Hung 1994). Less obvious habitat types, and qualitative vegetation descriptions, were derived from direct ground surveys and personal observations. This approach follows the method employed by Turner *et al.* (2002a) on Danjungan Island.

6. RESULTS

6.1. Birds

The bird fauna of Pulau Perhentian Besar was found to be fairly poor in terms of species richness. Repeated point counts by MRICP staff and an independent survey by Mike Chong (Asian Raptor Research and Conservation Network – see Appendix 1) revealed a combined total of 19 different species from 11 avian families.

The point counts represented a mix of the major habitats found on the island with several species being located at all surveys sites (Table 6.1). The White-rumped Sharma, Purple throated sunbird and Pied-imperial pigeon were clearly common at all survey sites. The white-bellied sea eagle was again located at all locations but due to the size of the islands relative to the territory occupancy of these species, the counts probably represent the same two-three individuals. The Campsite, East side and Flora bay were the most species rich sites.

The rarer species included the Emerald dove, Black-naped oriole, and the Nicobar pigeon. Each of these species was only located at one or two sites, and in very low numbers. These species were all detected at one or more of the most species rich sites.

Additional species recorded outside of the point count surveys are detailed in the avifaunal comparison with Pulau Redang (Table 6.2). These include species such as the: Asian Palm Swift (*Cypsiurus balasiensis*); Glossy Swiftlet (*Collocalia fuciphaga*); Barn Swallow (*Hirundo rustica*); Collared Kingfisher (*Halycon chloris*); Common / Pintail Snipe (*Gallinago gallinago / stenura*); Arctic Warbler (*Phylloscopus borealis*); and Yellow Wagtail (*Motacilla flava*).

Table 6.1. Inventory of bird species recorded on Pulau Perhentian during point count surveys (mean abundances presented).

Species	Scientific Name	*Mean Point Counts for Perhentian Besar							
		Campsite	Centre	East Side	Flora Bay forest edge	Flora Bay scrub/grassland	Main Trail - Flora Bay to PIR	Perhentian Island Jungle Trail	Turtle Beach Creek
Pacific Reef Egret	<i>Egretta sacra</i>					2			
White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	2	1	1	1	2		1	3
Black-naped Tern	<i>Sterna sumatrana</i>	4		2					
Pied Imperial Pigeon	<i>Ducula bicolor</i>	12	1	9	10	2	11	21	21
Emerald Dove	<i>Chalcophaps indica</i>		1						
Nicobar Pigeon	<i>Caloenas nicobarica</i>								3
House Swift	<i>Apus affinis</i>	2		11		8			
Asian Palm Swift	<i>Cypsiurus balasiensis</i>								
Glossy Swiftlet	<i>Collocalia fuciphaga</i>								
Pacific Swallow	<i>Hirundo tahitica</i>	3		2	4	3			2
Barn Swallow	<i>Hirundo rustica</i>								
Collared Kingfisher	<i>Halycon chloris</i>								
Common / Pintail Snipe	<i>Gallinago gallinago / stenura</i>								
Black-naped Oriole	<i>Oriolus chinensis</i>	1				2			
Arctic Warbler	<i>Phylloscopus borealis</i>								
Yellow Wagtail	<i>Motacilla flava</i>								
Olive-backed Sunbird	<i>Nectarinia jugularis</i>	1							
Purple-throated Sunbird	<i>Nectarinia sperata</i>	4	5	12	5	15	7	8	8
White-rumped Shama	<i>Copsychus malabaricus</i>	1	6	3	4	3	5	6	4
Total abundance		30	14	40	24	37	23	36	41
Species richness		9	5	7	5	8	3	4	6

*Means are based on three 30 minute point counts completed at each location.

Table 6.2. Comparison of bird fauna species lists for Pulau Redang and Pulau Perhentian.

Scientific Name	Common Name	Redang	Perhentian
Ardeidae			
<i>Ardea sumatrana</i>	Great-billed Heron	Yes	No
<i>Butorides striatus</i>	Little Heron	Yes	No
<i>Ardeola bacchus</i>	Chinese Pond Heron	No	Yes
<i>Egretta sacra</i>	Pacific Reef Heron	Yes	Yes
Accipitridae			
<i>Haliastur Indus</i>	Brahminy Kite	Yes	No
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	Yes	Yes
<i>Ichthyophaga ichhyaetus</i>	Grey-headed Fishing Eagle	Yes	No
<i>Pernis ptilorhynchus</i>	Oriental Honey Buzzard	Yes	No
Rallidae			
<i>Amaurornis phoenicurus</i>	White-breasted waterhen	Yes	No
Jacaniidae			
<i>Hydrophasianus chirurgus</i>	Pheasant-tailed Jacana	Yes (migrant)	No
Charadriidae			
<i>Charadrius mongolus</i>	Mongolian Plover	Yes (migrant)	No
Scolopacidae			
<i>Numenius phaeopus</i>	Whimbrel	Yes (migrant)	No
<i>Actitis hypoleucos</i>	Common Sandpiper	Yes (migrant)	No
<i>Gallinago species</i>	Common or Pintail Snipe	No	Yes (needs confirmation)
Laridae			
<i>Sterna sumatrana</i>	Black-naped Tern	Yes	Yes
<i>Sterna anaethetus</i>	Bridled Tern	Yes	No
<i>Sterna hirundo</i>	Common Tern	Yes	No
<i>Sterna bergii</i>	Crested Tern	Yes (migrant)	No
Columbidae			
<i>Ducula bicolor</i>	Pied Imperial Pigeon	Yes	Yes (maybe up to 500 individuals)
<i>Chalcophaps indica</i>	Emerald Dove	Yes	Yes
<i>Caloenas nicobarica</i>	Nicobar Pigeon	Yes	Yes
<i>Ducula aenea</i>	Green Imperial Pigeon	Yes	No
<i>Treron vernans</i>	Pink-necked Pigeon	Yes	No
<i>Cuculus fugax</i>	Hodgson's Hawk Cuckoo	Yes (migrant)	No

Scientific Name	Common Name	Redang	Perhentian
Apodidae			
<i>Apus affinis</i>	House Swift	Yes	Yes
<i>Collocalia maxima</i>	Black-nest Swiftlet	Yes	No
<i>Collocalia fuciphaga</i>	Edible-nest Swiftlet	Yes	No
<i>Collocalia esculenta</i>	Glossy Swiftlet	No	Unconfirmed ²
<i>Cypsiurus balasiensis</i>	Asian Palm Swift	No	Yes
<i>Apus pacificus</i>	Pacific Swift	Yes (migrant)	No
Alcedinidae			
<i>Alcedo atthis</i>	Common Kingfisher	Yes	No
<i>Halcyon chloris</i>	White-collared Kingfisher	Yes	Unconfirmed ²
<i>Ceyx erithacus</i>	Black-backed Kingfisher	Yes (migrant)	No
Hirundinidae			
<i>Hirundo tahitica</i>	Pacific Swallow	Yes	Yes
<i>Hirundo rustica</i>	Barn Swallow	Yes	Unconfirmed ²
Oriolidae			
<i>Oriolus chinensis</i>	Black-naped Oriole	No	Yes
Turdidae			
<i>Erithacus cyane</i>	Siberian Blue Robin	Yes (migrant)	No
Sylviidae			
<i>Phylloscopus borealis</i>	Arctic Warbler	Yes	Yes
<i>Locustella lanceolata</i>	Lanceolated Warbler	Yes (migrant)	No
Muscicapidae			
<i>Cyanoptila cyanomelana</i>	Blue And White Flycatcher	Yes	No
<i>Ficedula parva</i>	Red-throated Flycatcher	Yes (migrant)	No
Pachycephalidae			
<i>Pachycephala grisola</i>	Mangrove Whistler	Yes	No
Motacillidae			
<i>Motacilla flava</i>	Yellow Wagtail	Yes (migrant)	Yes
<i>Dendronanthus indicus</i>	Forest Wagtail	Yes (migrant)	No
Laniidae			
<i>Lanius cristatus</i>	Brown Shrike	Yes (migrant)	No
Sturnidae			
<i>Aplonis panayensis</i>	Philippine Glossy Starling	Yes	No
<i>Sturnus sturninus</i>	Daurian Starling	Yes (migrant)	No
Nectariniidae			
<i>Nectarinia jugularis</i>	Olive-backed Sunbird	Yes	Yes
<i>Nectarinia sperata</i>	Purple-throated Sunbird	Yes	Yes
<i>Anthreptes malacensis</i>	Brown-throated Sunbird	Yes	No
Ploceidae			
<i>Lonchura striata</i>	White-rumped Munia	Yes	No

6.2. Bats

A total of twenty-nine bats from five species were recorded from the five areas surveyed (Table 6.3). The greatest numbers of bats were recorded along the 'Flora Bay – PIR Trail'. No species of bat was recorded at all sites. Three species were found at both the 'Centre' and 'Flora Bay- PIR Trail' survey areas. Two species were recorded at the 'East side' and 'Jungle Trail' sites and only one individual of one species, *Cynopterus brachyotis*, was found at the Marine Park HQ land site. Of the twenty-nine bats identified, only two individuals of this species were identified, making this the least commonly encountered species. Over half the bats identified were *Hipposideros spp.* Although predominately found along the 'Flora Bay –PIR' Trail, this species also occurred at two other sites, making them the bat species most commonly encountered and widely distributed. Three *Empallonura monticola* were recorded at the 'Jungle Trial' site only. The bat fauna recorded was comparatively different to that previously recorded on Pulau Redang (Table 6.4).

Table 6.3. Inventory of bat species recorded on Pulau Perhentian.

Species	East side	Centre	Marine Park HQ land	Jungle Trail	Flora Bay PIR trail	TOTAL
<i>Rhinolophus sp.</i>	2	1				3
<i>Megaderma spasm</i>	1	2			2	5
<i>Hipposideros sp.</i>		2		1	13	16
<i>Cynopterus brachyotis</i>			1		1	2
<i>Empallonura monticola</i>				3		3
Abundance	3	5	1	4	16	29
Species Richness	2	3	1	2	3	5

Table 6.4. Comparison of bat fauna species lists for Pulau Redang and Pulau Perhentian.

Scientific Name	Common Name	Redang	Perhentian
<i>Hipposideros cineraceus</i>	Least Roundleaf Horseshoe Bat	Yes	No
<i>Hipposideros larvatus</i>	Large Roundleaf Horseshoe bat	No	<i>Hipposideros sp.</i> - needs clarifying
<i>Megaderma spasma</i>	Malaya Vampire	False Yes	Yes
<i>Taphozous melanopogon</i>	Black-bearded Tomb Bat	Yes	No
<i>Eonycteris spelaea</i>	Cave Fruit Bat	Yes	No
<i>Cynopterus brachyotis</i>	Short-nosed Bat	Fruit Last recorded in 1911	Yes
<i>Rhinolophus affinis</i>	Intermediate Horseshoe Bat	Last recorded in 1911	<i>Rhinolophus sp</i> needs clarifying
<i>Emballonura monticola</i>	Lesser tailed bat	Sheath- Last recorded in 1911	Yes

Nine species of bat were recorded from surveys undertaken on Redang and Perhentian. Only two species were common to both locations. Five bat species were recorded during surveys completed in Redang and six species were recorded during the recent Perhentian surveys. Three species recorded on Redang were not found on Perhentian and two species were discovered to be present on Perhentian that were not apparent on Redang. Two bat species collected in Perhentian surveys need taxonomic clarification. The *Hipposideros* sp., thought to be *Hipposideros larvatus*, was not found on Redang. Three bat species found on Perhentian have not been recorded on Redang since specimens were collected in 1911, including the other species which needs clarification but thought to be *Rhinolophus affinus*.

6.3. Non-volant Mammals

Transect walks and ad hoc observations

Only five species were recorded during the transect walks. These included the: Dusky Langur (*Trachypithecus obscurus*), Colugo (*Cynocephalus variegates*), Plantain squirrel (*Callosciurus notatus*), Oriental house rat (*Rattus tanezumi*) and Common Tree Shrew (*Tupaia glis*). All were conspicuous enough to be identified and recorded reliably during these surveys. These species were found to be abundant at all locations, except for Colugos in the coastal scrub areas, from opportunistic sightings during subsequent surveys.

Table 6.5. Comparison of non-volant mammal fauna species lists for Pulau Redang and Pulau Perhentian.

Scientific Name	Common Name	Redang	Perhentian
<i>Crocidura fuliginosa</i>	Southeast Asian White-toothed Shrew	Yes	No
<i>Tupaia glis</i>	Common Tree-shrew	Yes	Yes
<i>Callosciurus notatus</i>	Plantain Squirrel	Yes	Yes
<i>Sundasciurus tenuis</i>	Slender Squirrel	Yes	No
<i>Tragulus javanicus</i>	Lesser Mouse-deer	Yes	No
<i>Macacca fascicularis</i>	Long-tailed Macaque	Yes	Extirpated
<i>Trachypithecus obscurus</i>	Dusky Langur	No	Yes (lots)
<i>Cynocephalus variegates</i>	Colugo or Flying Lemur	No	Yes
<i>Rattus surifer</i>	Rat (possibly Red spiny rat)	Last recorded in 1911	No (yes if Red spiny rat)
<i>Rattus tiomanicus</i>	Malayan wood rat	Yes	No
<i>Maxomys surifer</i>	Red spiny rat	No	Yes
<i>Rattus tanezumi</i>	Oriental house rat	No	Yes

Eleven non – volant mammal species were recorded during surveys undertaken on both islands with only two species being common to both. Seven species were identified during surveys on Redang and six species were listed during the Perhentian surveys. Four species have been sighted on Perhentian which were not recorded in Redang, including the Dusky Langur (*Trachypithecus obscurus*), Flying Lemur (*Cynocephalus variegates*) and two species of rat.

6.4. Herptofauna

Over the ten sites surveyed, forty-nine specimens representing eleven species of reptiles and one species of amphibian were recorded (Table 6.7). One clutch of gecko eggs was also located. Species diversity and abundance of reptiles were greatest at the 'East side' site. Five of the survey sites yielded only one species of reptile. No reptiles or amphibians were found at the 'Flora Bay Resorts' survey area. Eight out of the eleven reptile species were lizards. The green crested lizard was found at six sites but the majority of species were logged at just two sites. The most frequently encountered reptile was the common sun skink, occurring mainly at the 'East side' site with only one individual being recorded elsewhere. Only one specimen of the long-tailed sun skink was observed. The one clutch of Forest Gecko eggs were found at the 'East side' site. A total of five snakes from three species were reported with just one individual found for two of these species. The Common Tree Frog was the only amphibian identified and was present only at the 'Flora Bay – PIR Trail'.

Table 6.6. Comparison of the herptofaunal species lists for Pulau Redang and Pulau Perhentian.

Scientific Name	Common Name	Redang	Perhentian
<i>Draco volans</i>	Common Gliding Lizard	Yes	Yes
<i>Acanthosauria armata</i>	Horned Tree Lizard	Yes	Yes
<i>Mabuya multifasciata</i>	Many-lined Sun Skink	Yes	Yes
<i>Varanus salvator</i>	Water Monitor	Yes	Yes
<i>Varanus bengalensis</i>	Clouded Monitor	No	Yes
<i>Bufo parvus</i>	Frog	Yes	No
<i>Dendrelaphis pictus</i>	Common Bronzeback	No	Yes
<i>Gekko smithi</i>	Forest Gecko	No	Yes
<i>Bronchocela cristatella</i>	Green Crested Lizard	No	Yes
<i>Ahaetulla prasina</i>	Green Whip Snake	No	Yes
<i>Mabuya longicaudata</i>	Long-tailed Sun Skink	No	Yes
<i>Ptychozoon lionotum</i>	Smooth-backed Gliding Gecko	No	Yes
<i>Gekko gekko</i>	Tockay	No	Yes
<i>Tropidolaemus wagleri</i>	Wagler's Pit-viper	No	Yes
<i>Polypedates leucomystax</i>	Common tree frog	No	Yes

Thirteen species of reptiles and two species of amphibians were recorded from surveys carried out on the two islands (Table 6.6). Four species of reptiles were common to both islands. Nine species of reptiles and one amphibian species were recorded on Perhentian that were not recorded in the Redang survey. Only one amphibian species, *Bufo parvus*, was found on Redang but has not been discovered during the Perhentian surveys to date.

Table 6.7. Inventory of the herptofauna recorded on Pulau Perhentian.

	Base Camp Area	Campsite	Centre	East side	Marshy forest behind Flora Bay	Perhentian Island Resort	Water plant scrubland	Perhentain Jungle Trail	Jungle Trail from Flora Bay to PIR	TOTAL
Long-tailed Sun Skink				1						1
Forest Gecko			3	1					1	5
Forest Gecko Eggs				1						1
Green Whip Snake			1	1				1		3
Smooth-backed Gliding Gecko				2						2
Common Sun Skink				15					1	16
Clouded Monitor				1					1	2
Green Crested Lizard	1	2	1				1	1		6
Horned Tree Lizard					2				1	3
Common Bronzeback						1				1
Wagler's Pit Viper				1						1
Common Gliding Lizard			1						3	4
Common Tree Frog									5	5
Total Abundance	1	2	6	23	2	1	1	2	12	50
Species Richness	1	1	4	8	1	1	1	2	6	13

6.5. Invertebrates

Three hundred and seventy eight butterflies of thirty-two species were recorded across the eleven sites surveyed (Table 6.9). Butterfly numbers and species diversity were greatest at the 'Back of Flora Bay Resorts' with 97 specimens of 14 species being recorded there. Fourteen species were also recorded at 'Flora Bay – PIR Trail 1'. Only three individuals of two species were observed at the 'East Side Reserve' site. Over one quarter of the butterflies surveyed were *Cyrestis themire*, with over 60% of these occurring along 'Perhentian Jungle Trail 2'. This species of butterfly was recorded at seven out of eleven sites. Twelve species were documented at just one site and 50% of these were represented by just one individual. Brief comparison with the Redang Lepidopteran fauna (Table 6.8) reveals the limited number of species detected on Pulau Perhentian.

Table 6.8. Comparison of Lepidopteran species lists for Pulau Redang and Pulau Perhentian.

Scientific name	Common name	Redang	Perhentian
Papilionidae Family			
<i>Papilio polytes romulus</i>	Common Mormon	Yes	Yes (<i>Papilio polytes</i>)
<i>Papilio memnon agenor</i>	Great Mormon	Yes	No
<i>Graphium sarpedon luctatius</i>	Common Bluebottle	Yes	Yes (Graphium sarpedon)
<i>Graphium doson evemonides</i>		Yes	No
<i>Graphium agamemnon</i>	Tailed Jay	Yes	Yes
<i>Meandrusa payeni ciminius</i>		Yes	No
Pieridae Family			
<i>Leptosia nina nina</i>	Psyche Butterfly	Yes	No
<i>Cepora iudith malaya</i>	Orange Gull	Yes	No
<i>Phrissura aegis cynis</i>		Yes	No
<i>Appias albina albina</i>		Yes	No
<i>Appias libythea</i>	Striped Albatross	No	Yes
<i>Pareronia valeria lutescens</i>		Yes	No
<i>Catopsilia pyranthe pyranthe</i>	Mottled Emigrant	Yes	No
<i>Catopsilia Pomona Pomona</i>	Lemon Emigrant	Yes	No
<i>Eurema hecaba cuntubernalis</i>	Common Grass Yellow	Yes	Yes (<i>Eurema hecaba</i>)
<i>Eurema blanca snelleni</i>		Yes	No
<i>Eurema sari sodalis</i>	Chocolate Grass Yellow	Yes	Yes (<i>Eurema sari</i>)
<i>Gandaca harina distantis</i>		Yes	No
Danaiidae Family			
<i>Danaus melanippus</i>	White / Black-veined	Yes	No
<i>hegesippus</i>	Tiger		
<i>Tirumala septentrionis</i>	Dark Blue Tiger	Yes	No
<i>septentrionis</i>			
<i>Radena similes persimilis</i>	Blue Glassy Tiger	Yes	No
<i>Radena juvena sitah</i>		Yes	No
<i>Euploea crameri bremeri</i>	Spotted Black Crow	Yes	No
<i>Euploea mulciber mulciber</i>	Striped Blue Crow	Yes	No
<i>Euploea diocletianus</i>	Magpie Crow	Yes	No
<i>diocletianus</i>			
<i>Radena vulgaris</i>	Blue Glassy Tiger	No	Yes
<i>Danaus genutia</i>	Common Tiger	No	Yes
<i>Danaus chrysippus</i>	Plain Tiger	No	Yes

Scientific name	Common name	Redang	Perhentian
Satyriidae Family			
<i>Elymnias panthera panthera</i>		Yes	No
<i>Elymnias hypermnestra agina</i>	Common Palmfly	Yes	Yes (Elymnias hypermnestra)
<i>Mycalesis fusca fusca</i>	Malayan Bush Brown	Yes	No
<i>Orsotriaena medus cinerea</i>	Nigger	Yes	Yes (Orsotriaena medus)
<i>Ypthima baldus newboldi</i>	Common five-ring	Yes	Yes (Ypthima baldus)
<i>Faunis canens arcesilas</i>	Common Faun	Yes	Yes (Faunis canens)
<i>Amathusia phidippus</i>	Palm King	Yes	No
Nymphalidae Family			
<i>Cupha erymanthis lotis</i>		Yes	No
<i>Précis atlites atlites</i>	Grey Pansy	Yes	No
<i>Hypolimnas bolina jacintha</i>	Great Egg-fly	Yes	Yes (Hypolimnas bolina)
<i>Cyrestis themire themire</i>	Little Map-wing	Yes	Yes (Cyrestis themire)
<i>Neptis hylas papaja</i>	Common Sailor	Yes	Yes (Neptis hylas)
<i>Phaedyra columella singa</i>	Short-banded Sailor	Yes	No
<i>Moduza procris milonia</i>	Commander	Yes	Yes (Moduza procris)
<i>Parthenos sylvia lilacinus</i>		Yes	No
<i>Tanaecia julii bougaibvillei</i>		Yes	No
<i>Euthalia aconthea gurda</i>	Baron	Yes	Yes (Euthalia aconthea)
<i>Cirrochroa orissa</i>	Banded Yeoman	No	Yes
<i>Precis orithya</i>	Blue Pansy	No	Yes
<i>Precis iphita</i>	Chocolate Pansy	No	Yes
<i>Athyma nefte</i>	Colour Sergeant	No	Yes
<i>Athyma perius</i>	Common Sargeant	No	Yes
<i>Tanaecia iapis</i>	Horsefield's Baron	No	Yes
<i>Rhinopalpa polynice</i>	Wizard	No	Yes
Riodinidae Family			
<i>Abisara geza niya</i>		Yes	No
<i>Abisara saturata</i>	Malayan Plum Judy	Yes	Yes (Abisara saturata)
<i>kausambioides</i>			
<i>Taxila haquinus haquinus</i>	Harlequin	Yes	No
Lycaenidae Family			
<i>Miletus chinesis learchus</i>		Yes	No
<i>Discolampa ethion thalimar</i>		Yes	No
<i>Neopithecops zalmora</i>		Yes	No
<i>horsfieldi</i>			
<i>Zizina otis lampa</i>		Yes	No
<i>Chilades pandava pandava</i>	Cycad Blue	Yes	Yes (Chilades pandava)
<i>Euchrysops cnejus cnejus</i>		Yes	No
<i>Jamides philatus subditus</i>		Yes	No
<i>Nacaduba subpersuia lysa</i>		Yes	No
<i>Nacaduba berenica icena</i>		Yes	No
<i>Ionolyce helicon merguiana</i>		Yes	No
<i>Prosotas nora superdates</i>		Yes	No

Scientific name	Common name	Redang	Perhentian
Lycaenidae Family (cont.)			
<i>Anthene emolus goberus</i>	Ciliate Blue	Yes	Yes (Anthene emolus)
<i>Anthene lycaenina miya</i>		Yes	No
<i>Arhopala psuedocentaurus</i>		Yes	No
<i>Arhopala aedias agnis</i>		Yes	No
<i>Arhopala aida aida</i>		Yes	No
<i>Arhopala phaenops sandakani</i>		Yes	No
<i>Arhopala sublustris ridleyi</i>		Yes	No
<i>Arhopala corinda acestes</i>		Yes	No
<i>Thamala marciana marciana</i>		Yes	No
<i>Drupadia theda thesmia</i>		Yes	Yes (Drupadia theda)
<i>Hypolycaena thecloides thecloides</i>		Yes	No
<i>Hypolycaena erylus teatus</i>	Common Tit	Yes	Yes (Hypolycaena erylus)
<i>Bindahara phocides phocides</i>		Yes	No
<i>Curetis Santana malayica</i>		Yes	No
<i>Curetis saronis sumatrana</i>		Yes	No
<i>Arhopala athada</i>		No	Yes
<i>Nacaduba beroe</i>	Six-line Blue	No	Yes
Hesperiidae Family			
<i>Hasora badra badra</i>		Yes	No
<i>Tapena thwaitesi bornea</i>		Yes	No
<i>Tagiades jepetus atticus</i>		Yes	No
<i>Tagiades gana gana</i>	Large Snow Flat	Yes	No
<i>Suastus gremius gremius</i>		Yes	No
<i>Hyarotis adrastus praba</i>		Yes	No
<i>Salanoemia tavoyana</i>		Yes	No
<i>Matapa druna</i>		Yes	No
<i>Pirdana distanti distanti</i>		Yes	No
<i>Telicota colon stinga</i>		Yes	No
<i>Parnara naso bada</i>		Yes	No
<i>Pelopidas mathias mathias</i>		Yes	No
<i>Polytremis lubricans lubricans</i>		Yes	No
<i>Caltoris philippina philippina</i>		Yes	No

Table 6.9. Inventory of the Lepidopteran fauna recorded on Pulau Perhentian.

Species	East side	East side reserve	Centre 1	Centre 2	Campsite	Perhentian Jungle Trail 1	Perhentian Jungle Trail 2	Water plant scrubland/grassland	Main trail Flora Bay to PIR 1	Main trail Flora Bay to PIR 2	Back of Flora Bay resorts	TOTAL
Abisara saturata			2			2				1		5
Anthene emolus	9	2		3			13		1			28
Appias libythea											2	2
Arhopala athada		1	1			7	1		5			15
Athyma nefte							2		6	3	1	12
Athyma perius								1			1	2
Celastrina puspa							2					2
Chilades pandava					1						26	27
Cirrochroa orissa										2		2
Cyrestis themire			8	2		20	66		5	6	2	109
Danaus chrysippus					1							1
Danaus genutia								3			1	4
Drupadia theda	3		2	1		2			2	6		16
Elymnias hypermnestra											17	17
Eurema hecabe					1			3	1	7	20	32
Eurema sari						2	1		6	5		14
Euthalia aconthea			2	2					1			5
Faunis canens						2						2
Graphium agamemnon										1		1
Graphium sarpedon											1	1
Hypolimnas bolina						1						1
Hypolycaena erylus						1						1
Moduza procris	1		1					1	1	1	2	7
Nacaduba beroe			4			1						5
Neptis hylas	2											2
Neptis sp.												0
Orsotriaena medus									1		1	2

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Papilio polytes			1				1	2	3	6	10	23
Species	East side	East side reserve	Centre 1	Centre 2	Campsite	Perhentian Jungle Trail 1	Perhentian Jungle Trail 2	Water plant scrubland/grassland	Main trail Flora Bay to PIR 1	Main trail Flora Bay to PIR 2	Back of Flora Bay resorts	TOTAL
Precis iphita												0
Precis orithya								1				1
Radena vulgaris	1				1	2			1	3	7	15
Rhinopalpa polynice						1			1			2
Tanaecia iapis	2			1		2	2		3	3		13
Ypthima baldus								1		2	6	9
Indiv. No's.	18	3	21	9	4	43	88	12	37	46	97	378
Total No. of species	6	2	8	5	4	12	8	7	14	13	14	

Table 6.9 (continued) Inventory of the Lepidopteran fauna recorded on Pulau Perhentian.

6.6. Comparison of Redang & Perhentian Faunas

The faunal species inventories compiled as part of the MRICP pilot phase have been compared throughout this section to a similar study completed on Pulau Perhentian Redang (MNS 1990). The findings of this study and the inventory work of the MRICP are summarised below (Figure 6.1). This indicates that the MRICP has detected a high proportion of the mammal and herptofaunas known to be present on these islands. However, the MRICP detected less than half the known bird and butterfly species.

Additionally, the MRICP did record a number of new species not previously recorded on the Redang study (MNS 1990). New species recorded were documented for each faunal group (numbers given in parentheses): Mammals (7); Birds (4); Herptofauna (10); Butterflies (13). The details of the new species are presented in the earlier sections.

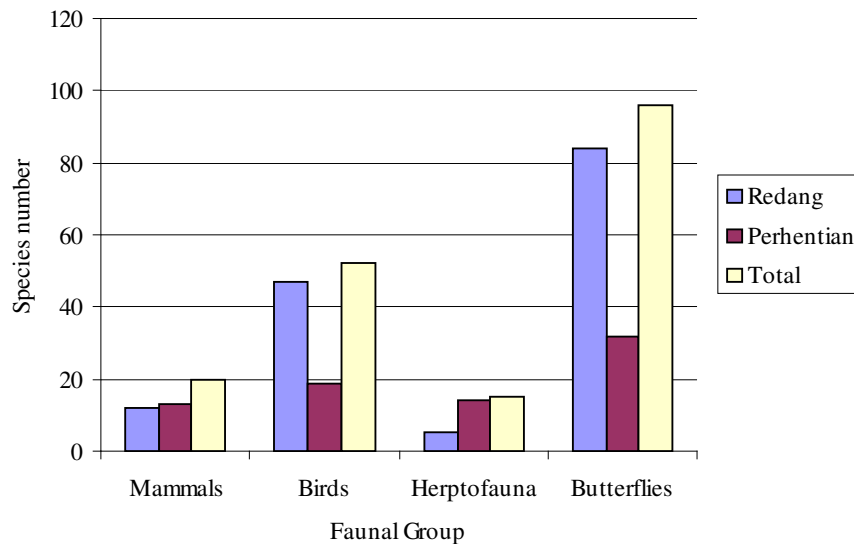


Figure 6.1. Comparison of Pulau Redang and Pulau Perhentian Faunas. Species numbers represent total numbers of species recorded for each taxonomic group. Total represents the combined species total for each taxonomic group.

Clearly more detailed surveys on each island group are required in order to make more detailed comparisons of the fauna.

6.7. Vegetation

The distribution of the major habitat types located on Perhentian Besar and Kecil are given in Figure 6.3, derived from interpretation of Figure 6.2 and field-based surveys.

Primary Forest

This habitat type is composed mainly of *Dipterocarp* forest (*Dipterocarpaceae* family), with *Dipterocarpus* species, *Sindora* species and *Shorea* species as dominant. The height of some of the tree species reaches above 50m in sheltered areas. The understorey is sparse as there is little light, with species present including Tongkat Ali (*Eurycoma longifolia*, Simarubaceae family), Ginger (Costaceae and Zingiberaceae family), rattans such as *Calamus species* and *Daemonorps species* (*Palmae* family), *Pandanus* sp (Pandanaceae family).

In the north of Kecil the forest is slightly affected by the monsoon and as a result the trees do not grow to the heights of those on Besar. The species of canopy and understorey vegetation present are the same. These areas have had little or no disturbance, except for a few trails cut on the western side of Besar.

Secondary Forest / Mixed Plantation

These areas consist of the regrowth of the native species found in primary forest, interspersed with patches of maintained and abandoned plantations. Species such as mango, coconut, rubber, banana, Jackfruit and clove have been planted. Large areas of primary forest on the south of Kecil were subject to a government programme of Slash and Burn in the 1960's, to provide areas of land for the locals to use for plantation agriculture.

Low Coastal Scrub

This habitat is characterized by trees that have shaped by the wind from the northeast, with stunted, twisted trunks, rarely exceeding 15 metres in height and shaven foliage. The forest seems visually to be more of a low-lying scrub area. Dominant species in these areas are *Shorea species* (Dipterocarpaceae family) and *Sandoricum species* (Meliaceae family). On Besar this habitat type has had little disturbance from man, but on Kecil feral goats graze these areas.

Scrub / Grassland

This area consists of a rough grassland with patches of scrub, with *Hibiscus* species being dominant. Pockets of ferns and banana plants are also present, along with *Casuarina equisetifolia* (*Casuarinaceae* family). The natural vegetation of the area was replaced with paddy fields, but this was abandoned due to irregular water. Further disturbances have taken place through the building of resorts and water treatment plant.

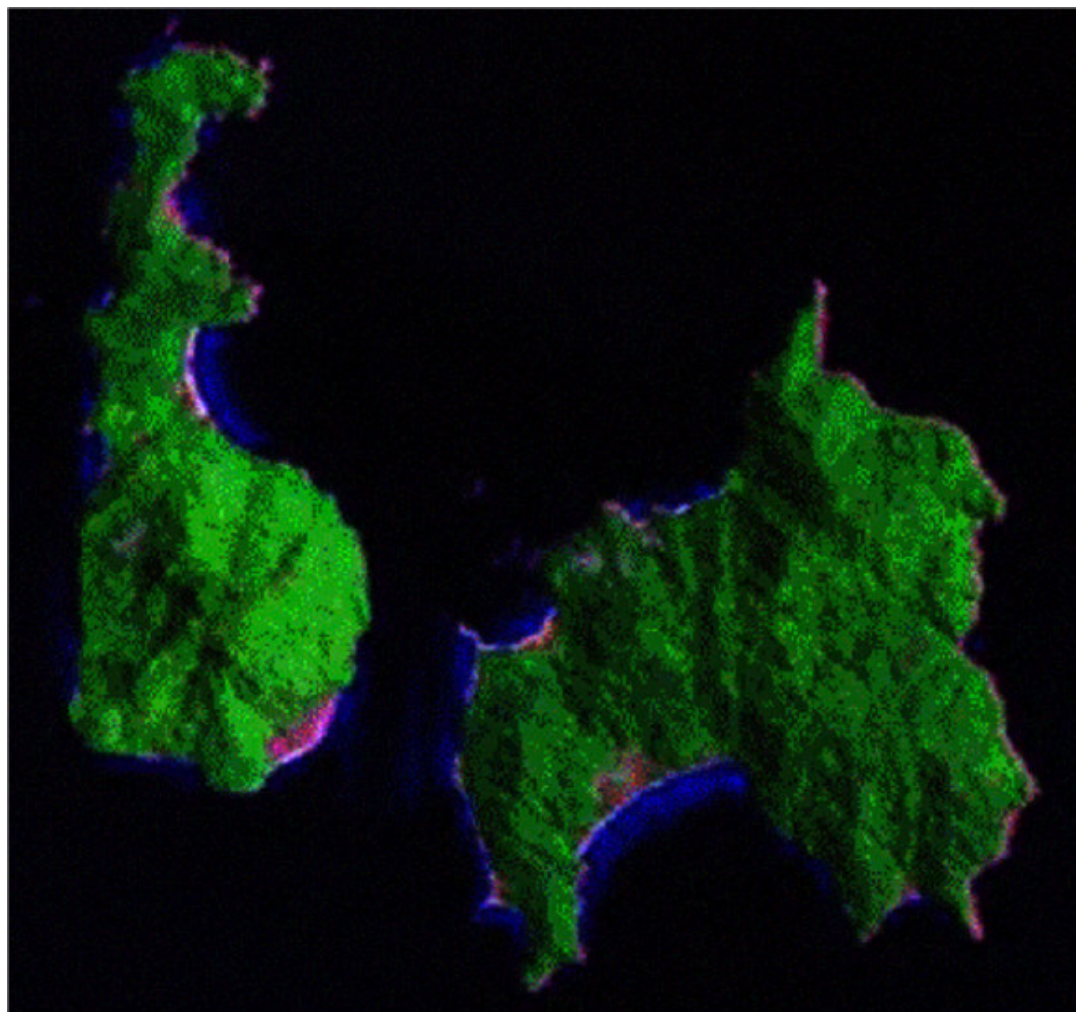


Figure 6.2. Landsat 7 ETM+ satellite image of Pulau Perhentian (path: row number 48:05 acquired on 12th July 2001) with 60m spatial resolution.

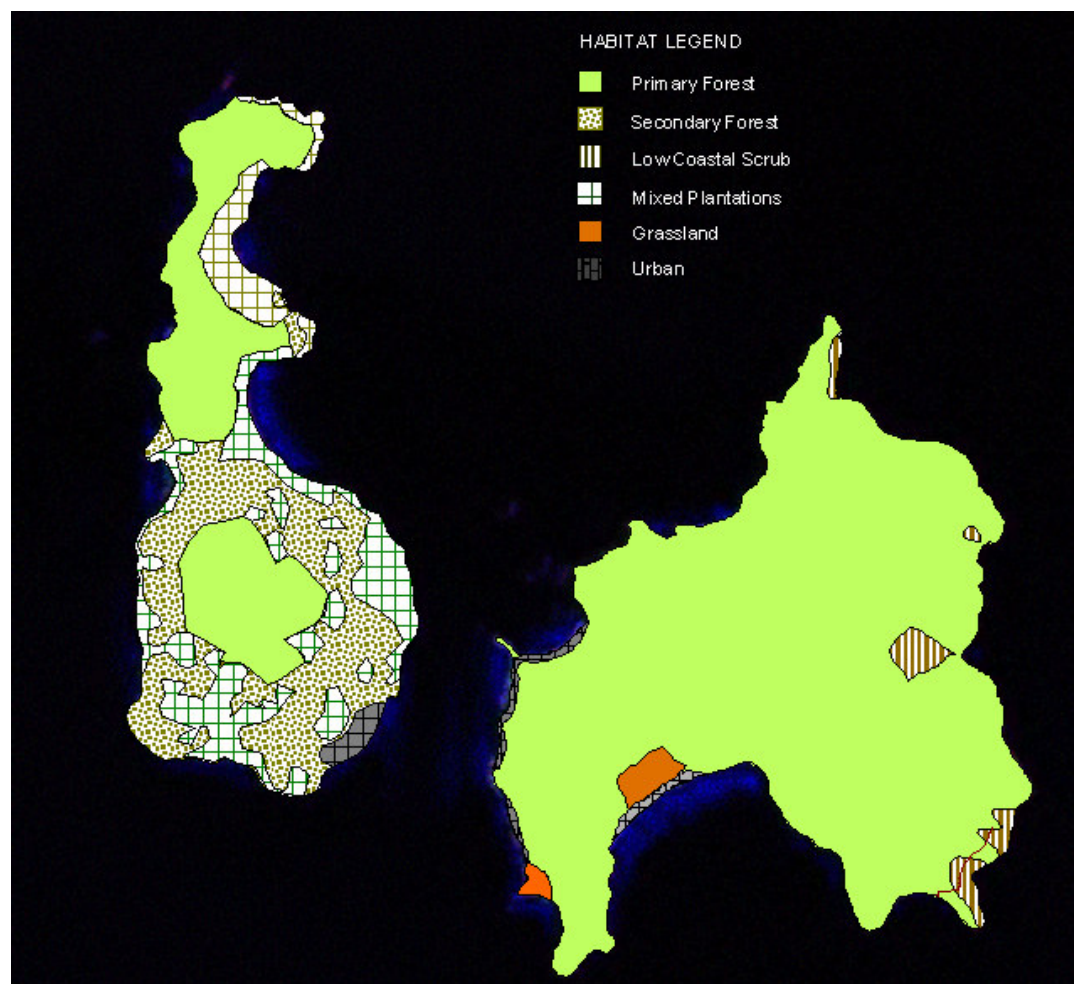


Figure 6.3. Broad scale habitat map for Pulau Perhentian.

7. COLLABORATION AND COMMUNITY

7.1. Meetings

Meetings Held at MRICP Base:

1) Leela Panikkar

Director of TrEES (Treat Every Environment Special)

This NGO is based in KL and raises environmental awareness by encouraging recycling programs, running educational programs in schools and running conservation programs.

The main purpose of the meeting with TrEES was to discuss the proposed planning of an educational program in the local village on Kecil. The school has very few facilities and would benefit from a conservation and environmental awareness program. Due to limited time and staffing issues, this project has been put on hold. However, both CCC and TrEES remain interested in working together. Communication between CCC and TrEES should proceed when there are more personnel on site and the project has been re-established. Implementation of project would show CCC's dedication to this project site. There has been much interest from individuals on the Perhentian Islands to see CCC's involvement in the community and not just limited to ecological surveying.

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2) Mike Chong

Asian Raptor Research and Conservation Network

This NGO is based in KL. The ARRCN has an international subscriber network and Mike Chong is the coordinator of the ARRCN Information Centre as well as one of the Standing Committee members in ARRCN. He is also the Malaysian 'Country Representative' for the Oriental Bird Club (OBC) that is based in the UK. Mike is a freelance bird-nature guide and a nature consultant. He has been involved in many expeditions and was part of the MNS team that surveyed Redang Island in 1990.

Mike Chong visited on the 31st May to 2nd June 2003, accompanying Leela Panikkar (TrEES). During his visit, both Mike and Alexia (PS) conducted bird surveys on both P.Besar and P.Kecil, within this time frame. Although brief, the surveys highlighted

interesting findings throughout the pilot phase – the limited and poor bird species numbers.

Mike expressed a great deal of interest with working with CCC in the future. He has also expressed his wish to return to the Perhentian Islands on a later date to review his last survey on the belief that during monsoon times bird species and numbers will increase dramatically.

A short review of his findings are attached in the appendix of this report.

E-mail: mikechn@pc.jaring.my

3) Rick Gregory

Managing Director, EcoGraphica

Rick has lived and worked in Malaysia for the last 10 years. He is a freelance writer on environmental issues and has been published in many journals and papers including The Star (large Malaysian Newspaper), www.WildAsia.net and the Asian Geographic magazine. He has worked with WWF Malaysia, the UN as well as the Malaysian Wildlife department. Articles have included a rather sceptical look at Marine Parks, MNS expeditions and now the CCC expedition on the Perhentians. He visited from the 23rd May to 25th May 2003.

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Tel: (603) 6258 9546

4) Gary Theseira

Senior Research Officer, Forest Plantation Division, Forestry Research Institute Malaysia (FRIM)

FRIM is a governmental body based outside KL which has done a considerable amount of work within Malaysia and is currently trying to set up more of an international presence. FRIM have been conducting expeditions to gather various plants and inventory areas.

Gary has a great interest in ferns, as well as being an ecosystem simulation expert. He has many other contacts within FRIM and is keen to help, although it is not always easy to contact him! Gary joined MRCIP on the 7th and 8th of June in the company of Leela (TrEES). Gary, Alexia (PS) and Rob (SO) conducted a brief tour of Perhentian Besar, showing various surveying sites on the island. Gary has expressed a keen interest to come back out to the Perhentians, especially with other FRIM staff. Currently, Alexia is working on this proposal.

FRIM
Kepong
52109, Kuala Lumpur

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gwtheseira@hotmail.com
Website: www.frim.gov.my
DID: (603) 6279 7106
Tel: (603) 6279 7000
Mobile: 012 205 8454

Additional Contacts and Details:

5) Dr. Tigga Kingston

Malaysian Bat Conservation Unit

Dr. Tigga Kingston is a bat specialist within MBCU. Tigga has been in contact over email and has expressed an interest in visiting the site to help with bat surveys.

E-mail: tigga@bu.edu
tigga_kingston@hotmail.com

6) Prof Zubaid Akbar

University Kabangsaan, Malaysia, KL

Prof Zubaid Akbar is based within the School of Environmental and Resource Science at UKM, outside KL. He is a leading authority in bats, and through his collaborative work between UKM and Boston University the Malaysian Bat Research and Conservation Unit has been set up. He recommended Tigga (see above) and Prof. Thomas.H.Kunz (kunz@bu.edu) as experts in the bat field.

Alexia (PS) made initial contact with Zubaid in relation to collaboration between UKM and CCC, as well as advertising the role of the Malaysian Scholarship program. He has expressed interest in working with CCC on an advisory basis as well as working to set up field visits for UKM students.

School of Environmental and Resource Sciences
Faculty of Science and Technology
University Kabangsaan Malaysia
43600 UKM Bangi
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Malaysia

E-mail: zubaid@ukm.my
zubaid@pop.jaring.my

7) Dr Loh Chi Leong

Executive Director, Malaysian Nature Society (MNS)

Dr Leong has shown an interest in CCC work in the Perhentians. He has been met in KL by the senior field scientist for marine projects, James Comley. The meeting in KL provided further contacts of people that would be interested in working with CCC, as well as providing volunteers amongst the MNS network. Dr Leong has distributed emails to all the MNS subscribers to inform them of the Malaysian Scholarship program initiated by CCC.

JKR 641, Jalan Kelantan or P.O.Box 10750
Bukit Persekutuan 50724 KL
50480 Kuala Lumpur Malaysia

E-mail: natsoc@po.jaring.my (attn Dr Loh Chi Leong)

Website: www.mns.org.my

Tel: 03 22879422

8) Mr. Nik Maseri

Head of Science and Conservation, Malaysian Nature Society (MNS)

Mr Maseri has expressed his interest in CCC's work out in Malaysia and is helping in advertising for volunteers through MNS.

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Bukit Persekutuan
50480 Kuala Lumpur

P.O.Box 10750
50724 KL
Malaysia

E-mail: natsoc@po.jaring.my (attn Nik Maseri)

Website: www.mns.org.my

Tel: 03 22879422

9) Prof Abdul Latiff

Terrestrial Scientist, UKM

Has been informed of CCC's presence in Malaysia as well as the scholarship program that is being offered.

E-mail: latiff@pkrisc.cc.ukm.my

Tel: 03 892 14144

10) Dr Leong Shown Chong

Coordinator of the MNS Branch, Kelantan

Has been informed of the presence of CCC's work in the Perhentian Islands and of the Malaysian scholarship program that has been offered.

E-mail: shown@tm.net.my

Tel: 09 7442780

11) Affendi Yang Amri

Botany and Terrestrial Ecology, University Malaya

He has expressed a keen interest to send out students to work with CCC. He has a copy of all methodologies and work plan for the pilot phase, as well as information on Malaysian scholarship program. He has been in touch with Alexia (PS) informing that he has circulated the information to both students and teaching staff in this department of the university.

E-mail: affendi@um.edu.my

7.2. Scholarships

CCC has implemented a Scholarship Awards Scheme on the MRICP which is open to Malaysian citizens who are full-time students undertaking education in a relevant subject at a recognized educational establishment within Malaysia. The pilot project welcomed the first scholarship student to the MRICP. Nazura binti Zainuddin, who is a student of the University Malaya attended the the project for the during of the pilot phase, completing the CCC Skills Development Programme, and asisted with all surveys.

CCC is currently liasing with relevant institutions in order to recruit more scholarship students for when the project re-starts in March 2004.

7.3. Community Training and Information Exchange

The MRICP provides as unique situation in which to work Based in the Marine Park Centre in a prime location on Perhentian Besar, this provides ample opportunity to explore and conduct training and information exchange.

Throughout the pilot phase the Marine Park Centre has been a hub for visitor interaction and information exchange on the project (on an ad hoc basis), as well as being a centre for more formal lectures and activities.

As part of CCC continual science training ethic advance lectures have been given throughout the pilot phase. These lectures have been advertised locally to parties in both dive shops, chalets and within the local community. It has been rewarding to see

interested parties joining in with the advance lectures on many occasions. As a result of some of these lectures more interest has been generated and CCC has been invited to give further lectures in dive shops and chalets on both Besar and Kecil.

Education is seen as an important part of CCC's activities, especially the education of the younger generation. As a result both terrestrial and marine projects established a children's educational program once a week for the local children. Activities included painting of healthy and unhealthy ecosystems (both marine and terrestrial), butterfly and insect collection and identification, food web games and story telling. Volunteers, international and local, marine and terrestrial, were fully involved in this program. Through popular demand this small project has been expanded and maintained throughout the pilot phase and in to the future.

Local villages from the kampong (Kecil) were employed to help us with the establishment of survey sites and, when the volunteers arrived, to assist in the surveys. Both individuals provided initial insight to the flora and fauna of the islands as well as guiding us through the tough terrain. Through day-to-day interactions explanations and training were given on techniques of mist netting, bird observation as well as camping and trekking skills. Above all an understanding of why CCC were here on this island and what we hoped to achieve was appreciated by the local staff.

Expansion of community projects and education of both the local community and the tourism stakeholder community should be seen as a long-term goal. The Marine Park Centre is a perfect location for lectures and other activities and the populations on the islands are easily accessible. Through discussions with the stakeholders of the islands there has been a great appeal of CCC's work and demand for more involvement. This in itself shows the positive effect of the projects interaction with the people of the Perhentian Islands.

8. DISCUSSION

Perhentian Besar is clearly an important ecological refuge harbouring a variety of habitats, spanning coastal to forested areas, which in turn support a diverse range of species (based on the taxonomic groups that were studied).

The MRICP pilot study was by no means a comprehensive survey of the biodiversity of the Perhentians and the results presented in the preceding chapters should be regarded as provisional due in part to the methods used and due to the short duration of the project. The faunal inventories are also likely to change throughout the year due to the presence or absence of certain passage visitors or migratory species. The inventories will also likely increase in species richness with more surveyor effort.

This may partially explain the low diversity of bird species observed on Besar Island that is much lower than the diversity previously observed on the neighbouring island of Redang (MNS 1990). Additionally the observed butterfly diversity is also much lower than that of Redang, however, this is probably a result of the restricted spatial extent of the current study and limited taxonomic aids.

Whilst the limitations of the pilot study are acknowledged the results still provide valuable information concerning the terrestrial biodiversity of the Perhentians. Despite these limitations, the study has clearly achieved its initial objectives, which were:

1. Provide a baseline of terrestrial information on the fauna and flora of the Perhentian islands (Besar island).
2. Provide outputs that will include, but are not limited to, a terrestrial habitat data and spatially referenced species inventories for Besar Island.
3. Develop a strategy for longer-term monitoring of key habitats and species in order to underpin conservation and sustainable management (see Recommendations).

8.1. Outcomes

The survey work has resulted in the production of the first broad-scale habitat map for the islands and the first published ecological inventory work for Perhentian Besar with major habitat types identified.

The delineation of the different terrestrial habitat types on the island has also highlighted the diversity of plant communities and the potential for future vegetation inventory work. Observations suggest that the island supports a wide variety of endemic and threatened plant species.

The development of the habitat map has also complemented the faunal surveys. The bird fauna, which consists of a combination of resident (and endemic), migrants and passage visitors,

9. RECOMMENDATIONS

Beyond the pilot project, all islands of the Pulau Perhentian group should be mapped and surveyed in detail and by habitat type according to the methods outlined in this report. This should result in an improved understanding of the spatial and temporal dynamics of the ecological communities inhabiting each island. More detailed surveys such as vegetation inventories, and surveys on additional taxonomic groups could also be completed (as deemed necessary) to fully understand the terrestrial biodiversity of this island group.

A second major component of future work would be to develop a spatial database (GIS) for all data collected and use existing remotely sensed data to develop a digital land cover and land use map for each island (classified using data from field surveys). Field data on faunal and floral groups can then be integrated in to this spatial database, with additional data (socio-economic) where available, to assess potential anthropogenic pressures or opportunities for sustainable use of natural resources. This will ultimately provide a valuable decision support tool to underpin future land management and conservation planning decisions on the island group.

9.1. Future work plan

The pilot project consisted of a rapid survey assessment of six sites on Perhentian Besar, within a 5-week period. Kecil was only briefly surveyed for vegetation cover and bird observation (with Mike Chong and Gary Theserai). Within this 5 week period surveys on the vegetation, birds, bats, non volant mammals, herptofauna and butterflies were completed at all main survey sites and at some of the additional sites. Such a spatial focus and the resultant data illustrate the need for future surveys and provide a foundation from which to be well advised on how to advance with this project.

9.1.1. Recommendations for future surveys on Perhentian Besar

Following the work achieved at four of the main sites (East Side, Perhentian Island Jungle Trail, Jungle Center, and the Main Trail from Flora Bay to Perhentian Island Resort) and the results gained, there is evidence that more surveys need to be completed at each of these and other sites as more species are continually being discovered. This is especially true for butterflies and bats.

Therefore, it is recommended that a suite of faunal and floral surveys as detailed in this report and elsewhere (Turner *et al.*, 2003b) should be completed at the current sites. An attempt should be made to survey different locations on the island, i.e. further into the centre / north east of the island. This area is still relatively isolated and difficult to gain access to. However, it would be informative as a comparison to other more disturbed sites.

9.1.2. Recommendations for future surveys on Perhentian Kecil

As no official surveys or survey sites have been established on Kecil and it is thoroughly recommended that sites be established on the island. There should be at least three main sites ranging in the three main habitat areas: primary forest in the southern part of the island, the northern shrubby area and areas of secondary forest

around areas of plantation.

Other suggestions

- One staff member per 3 volunteers should be present in the field, in order to make it possible for two groups to undertake different surveys. The extra staff member could be another SO, a MO or a locally employed person with rainforest experience.
- Butterfly traps should be used (10 at each site) in order to compliment the transects. There have been species which fly too high in the canopy to catch by hand net. A more comprehensive field guide is also required in order to help identify all species captured.
- Birds should be surveyed until the end of September/October in order to record migratory species. This has been recommended by Mike Chong.
- A more comprehensive guide to bats of Malaysia is needed for identification purposes.

During monsoon time (starts end of October and should finish around February), it has been suggested for safety reasons that the site is moved to the main land. The area of mainland suggested consists of mangrove swamp, peat forest and lowland forest. This area ties in with the island ecosystem and would be seen as a good comparison between sites.

9.2. Beyond the pilot project.

The MRICP will return to the Perhentians in March 2004 as the Malaysia Tropical Forest Conservation Project (MTFCP).

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11. APPENDIX

A Preliminary Bird Survey at Pulau Perhentian Besar, Pulau Perhentian Kecil and their satellite Islands, Terengganu, Malaysia: 31 May – 2 June 2003

A bird survey was carried out from 31 May–2 June 2003, at Pulau Perhentian Besar, Pulau Perhentian Kecil and smaller islands in Terengganu, Peninsular Malaysia. Surveys were carried out on P. Perhentian Besar on 31 May and 1 June 2003, P. Perhentian Kecil and smaller islands on 2 June 2003. The surveys were carried out individually and at other times in the company of Leela Panikkar of Treat Every Environment Special (TrEES) and Alexia Tamblyn (CCC).

Preliminary Results

A total of twelve (12) species of birds were recorded on the three days of surveys on the two main islands and three smaller islands. The 12 species recorded are listed below. Common and scientific names of birds are given followed by the areas where they were recorded:

1. Pacific Reef-Egret (dark morph) *Egretta sacra* – smaller island
2. Black-naped Tern *Sterna sumatrana* – P.P. Besar, P.P. Kecil and smaller islands
3. White-bellied Sea-Eagle *Haliaeetus leucogaster* – PP Besar & PP Kecil
4. Pied Imperial Pigeon *Ducula bicolor* – P.P. Besar and P.P. Kecil & P. Susu Dara Besar
5. Emerald Dove (Green-winged Pigeon) *Chalcophaps indica* – P.P. Besar
6. House Swift *Apus affinis* – P.P. Besar
7. unidentified Swiftlet *Collocalia/Aerodromus sp* - P.P. Besar.
8. Asian Palm-Swift *Cypsiurus balasiensis* – P.P. Besar
9. Pacific Swallow *Hirundo tahitica* – P.P. Besar and P.P. Kecil
10. White-rumped Shama *Copsychus malabaricus* – P.P. Besar and P.P. Kecil
11. Purple-throated Sunbird *Nectarinia sperata* – P.P. Besar and P.P. Kecil
12. Olive-backed Sunbird *Nectarinia jugularis* – P.P. Besar

Discussion on the bird survey

Three new species were recorded in this survey, Emerald Dove, Asian Palm-Swift and an unidentified Swiftlet species *Collocalia/Aerodromus sp*. The three new species were new as compared to an existing list provided by Alexia Tamblyn. Two species, Pacific Reef Egret and Black-naped Tern were confirmed for P. Perhentian Besar. Bird diversity was quite poor, although the habitats on the two main islands appeared to be good. The reason for the obvious paucity of bird species on the two main islands is not clear and could not be determined, as the time spent on this current survey was too short. The low diversity of birds may, to an extent, be investigated by comparing existing bird records in previous surveys of birds conducted on the Perhentian islands and by conducting surveys on a long-term basis.

General Note: Surveys using mist-nets and taped recording playbacks

Surveys of birds using mist-nets and taped playbacks are generally not recommended when the size of survey areas and habitats are small. The usage of mist-nets in Peninsular Malaysia requires a written permission from the Department of Wildlife and National Parks (Peninsular Malaysia). The use of mist-nets without a permit is an offence under the Malaysian Wildlife Act. Mist-nets and taped playbacks may also cause undue stress to birds especially when their territories are small, and during breeding season. For bird and wildlife surveys, it is practical

and more environmentally friendly, to use visual and diagnostic vocalisation identification methods.

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