Halmahera '94

A University of Bristol Expedition to Indonesia
in conjunction with
Pattimura University, Ambon
The Biological Sciences Club, Jakarta
and
Sub-Balai Konservasi Sumber Daya Alam, Maluku

Final Report

Patron: The Earl of Cranbrook

BP

BRITISH AIRWAYS ENVIRONMENT

BRITISH AIRWAYS ASSISTING CONSERVATION

VIM PROMOVET INSITAM

Report prepared for

The Indonesian Institute for Sciences (LIPI)
and
The Directorate General for Forest Protection and Nature Conservation (PHPA)

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SUMMARY

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Timing and participants

Between the 25th June and 25th September 1994 an expedition from Britain and Indonesia undertook a biodiversity study of the proposed Lolobata Wildlife Reserve, Halmahera (1°00N, 127°20E). This was a joint project involving seven University of Bristol students, one student from the Biological Sciences Club (Jakarta), two students from Pattimura University (Ambon) and two members of staff from SubSeksi Balai Konservasi Sumber Daya Alam (SbSBKSDA- the local branch of PHPA) in Tobelo. The aims of the expedition were supported by the Directorate General of Forest Protection and Nature Conservation (PHPA) and the Indonesian Institute of Sciences (LIPI). Approximately 450 man days were spent in the field between 23rd July and 10th September.

Purpose

Lolobata, on the northeastern arm of Halmahera is one of four protected areas proposed for the island by the UNDP/FAO National Parks Development project (1981a). Halmahera (and its satellite islands) support many endemic species including 24 bird species, four mammals, one reptile and five frogs (of which four are restricted to Halmahera itself). Although the island is rich in unique species it currently has no protected areas, there have been few detailed biological surveys and new information is required to determine the status of the proposed sites. This expedition collected biological and socio-economic information which will support PHPA's (Directorate General of Forest Protection and Nature Conservation) plans for gazettement and future management of the Lolobata Wildlife Reserve.

Implementation

The expedition surveyed five sites along the proposed northern edge of the reserve. Rock type and altitude were assumed to be the major natural agents influencing both structure and floristic composition of the forest. Using this system we classified five different forest types on the peninsula: forest on igneous rocks, forest on calcareous sediments, forest on non-calcareous sediments, forest on alluvial sediments and montane forest (over 700m). Our surveys covered four of these types. Forest on alluvials was not surveyed since the area available for inclusion within the reserve is minimal.

At each survey site variable circular plot surveys (VCP) for birds were conducted; the data collected provided density estimates for each species. Coupled with habitat data we have estimated bird populations within the proposed reserve. Freshwater fish and crustacea were collected from the main rivers at each site; in total approximately 35 species were collected. Data on the occurrence and distribution of mammals and amphibian species was recorded

for each forest type. Snails were collected from a variety of habitats. Three projects were run over a one month period in forest on an ultrabasic complex. These involved live-trapping small mammals, collecting quantitative data on insect diversity and herpetological sampling using a pitfall trap. Socio-economic studies were conducted in the villages near each of our survey sites to determine the extent and type of forest use by the local inhabitants. Additional information was collected on major development projects in the region.

Outputs

A number of species were recorded from the island for the first time during the expedition. These include six new bird records (Masked Booby (*Sula dactylara*), Little Whimbrel (*Numenius minutus*), Black-naped Tern (*Sterna sumatrana*), Horsefield's Bronze Cuckoo (*Chrysococcyx basalis*), Brown Hawk Owl (*Ninox scutulata*), Black-faced Cuckoo Shrike (*Coracina novaehollandiae*) and the Eurasian Tree Sparrow (*Passer montanus*)), one new bat record (Wrinkle-lipped mastiff bat (*Tadarida jobensis*)), four new snails (*Queridomus fimbriosus*, *Lamprocystus V 3605*, *Melanoides clavus* and *Clithon squarrosus*), and one frog (deposited at Bogor Natural History Museum but as yet unidentified). The first survey of freshwater fish was also conducted. Information on behaviour, altitudinal range and threats faced by restricted-range bird species was collected.

Our non-scientific outputs include training two members of staff from the SbSBKSDA office in Tobelo to identify the island's bird species by sight and from calls. We hope that they will continue to use their knowledge of the birds and VCP technique to conduct their own surveys. The SbSKSDA offices at both Tobelo and Ternate were provided with field camping equipment for use during future surveys. Nature Conservation posters on a range of topics including Moluccan parrot, mangrove forest, dugong and marine life protection were distributed and discussed at local government offices and with the villagers of areas we visited.

Main conclusions and recommendations

- The quantitative bird data and circumstantial evidence from mammal distributions suggest that forest on limestone is a particularly important habitat. It supports the highest bird densities and is the primary habitat of some of the island's endemic species. Caves within these regions provide roosts for many bat species. The area of forest on limestone included within the reserve should therefore be maximized.

- Although most coastal land has been cleared for agriculture there are still some important tree roosting sites for the large fruit bats of the genus *Pteropus*, particularly in mangrove areas. These bats are eaten and persecuted because they are perceived to be harmful to fruit crops. The roost sites should be given special protection and an educational campaign, aimed at explaining the role of fruit bats as pollinators and dispersers of seeds of commercially important fruit and timber tree species, should be initiated. Expedition members are currently producing a bat conservation poster for Indonesia.

- The collection of parrots for trade needs further investigation and stricter control measures. Trapping pressure appears to be low in north-east Halmahera but species

such as the Great-billed parrot (*Tanygnathus megalorhynchus*), Moluccan King parrot (*Alisterus amboinensis*) and the Moluccan Hanging parrot (*Loriculus amabilis*) were rarely encountered. There may also have been over-collection of the Chattering Lory (*Lorius garrulus*) which is notably more common further away from centres of human habitation.

- The proposed reserve boundaries conflict with four existing timber concessions. However much of the interior is already designated as Protection Forest (*Hutan Lindung*) and therefore may not be logged.

- Some mineral deposits have been identified in the area. Already there are problems with 'gold panners' who make large unregulated camps along rivers thereby causing erosion, siltation and polluting rivers which are the only water source for coastal villages. Conflict with the mining industry could be one of the main problems faced by the reserve in the future.

- The transmigrant site on the Subaim plains uses large amounts of water for wet rice agriculture. The protection of the water catchments around all the rivers which run into Subaim bay is therefore essential. The forests in this area are also some of the most heavily used for small-scale timber extraction, hunting and shifting agriculture. Immediate protection of these areas is essential to ensure the continued supply of clean water for drinking and farming.

- Three of Halmahera's restricted-range bird species were not recorded during the expedition. These were the Invisible rail (*Habroptila wallacei*), Moluccan cuckoo (*Cacomantis heinrichi*) and Olive honey-eater (*Lichmera argentauris*). Further studies to identify the conservation needs of these species, particularly of *H. wallacei* which is a poor-flying species endemic to Halmahera, would be useful.

- There is still good opportunity for ethnobotanical study on Halmahera, especially amongst the forest-dwelling 'Tugutil' who depend on forest products for their culture. However a resettlement programme aimed at bringing these people out of the forest and into 'modern society' has already started, hence these people are beginning to rely more on conventional medicines. The traditional folk-lore knowledge should therefore be recorded before it is lost.

CONVENTIONS

In this report there are a number of Indonesian terms, acronyms and other expressions which are open to misinterpretation. It is not constructive to avoid their use and we hope the following list may act as clarification.

Anak Desa: This refers to any village which is not the head of the **Desa.**

BKSDA: **Balai Konservasi Sumber Daya Alam.** Based in Ambon the Balai is responsible for conservation in both Maluku and Irian Jaya.

BScC: The **Biological Sciences Club** is a society of natural sciences students and graduates based in Jakarta. It runs its own expeditions and its members have participated in a number of expeditions with foreigners.

Cagar Alam: A strict Nature Reserve.

Desa: The fourth administrative division. This is roughly analogous to a British Parish, on Halmahera it is usually one , but sometimes several villages. It is headed by the **Kepala Desa.**

EBA: Birdlife International have identified the North Moluccas as an **Endemic Bird Area** with 44 **restricted-range species.**

FIT: **Flight Interceptor Trap**, a trap developed recently by the entomology department at the British Natural History Museum **(BMNH)**

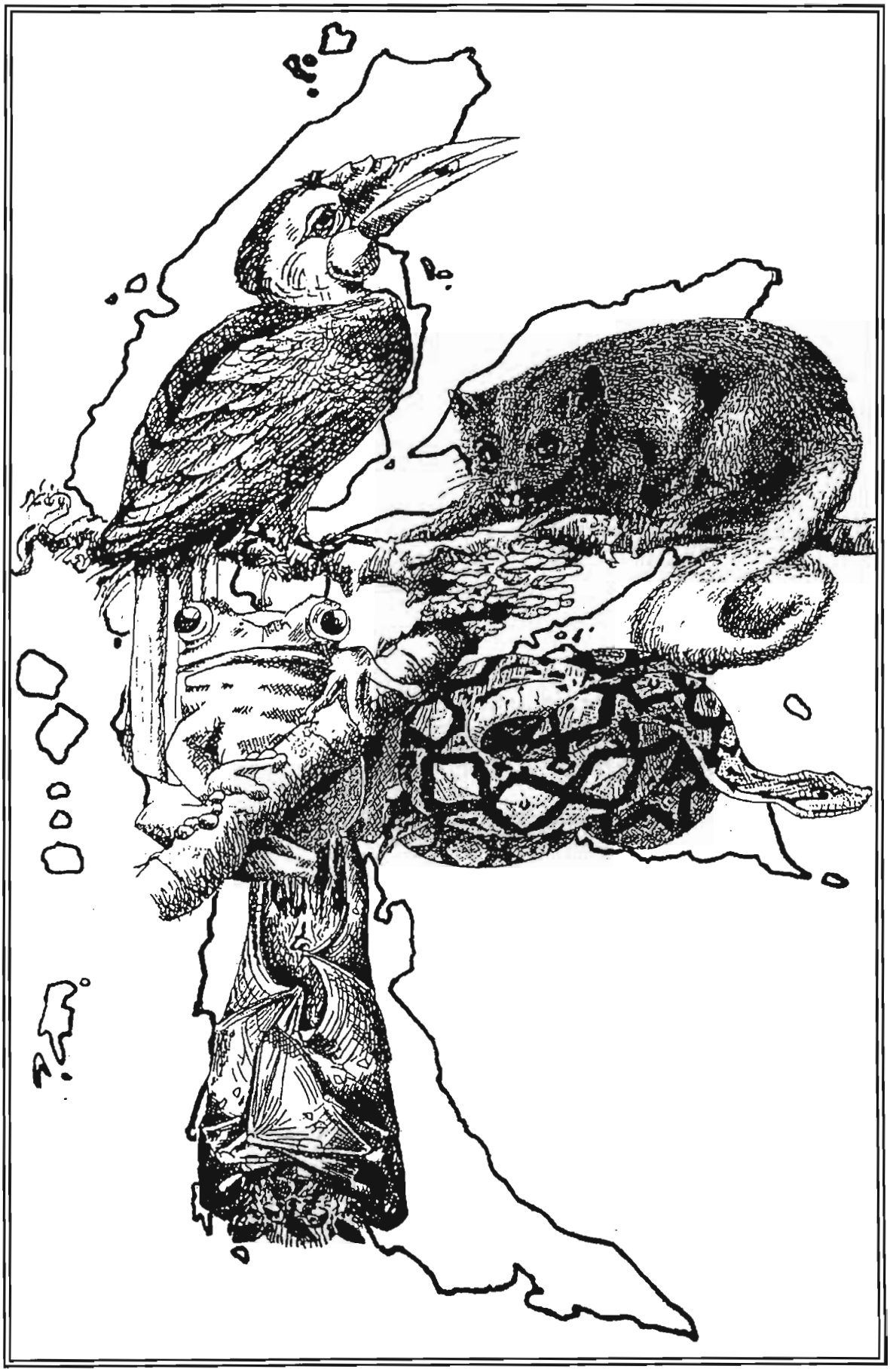
HALTENG: The Kabupaten **Halmahera Tengah** was established in the late 1980s. Its capital is Soasio on Tidore and it includes the central region of Halmahera and the island of Gebe. The proposed reserve lies within this administrative region.

Kabupaten: This is the second level (after **Propinsi**- Province) in the administrative hierarchy. There are now two in the North Moluccas- **MALUT** and **HALTENG.** It is headed by the **Bupati.**

Kecamatan: This is the third division in the administrative hierarchy; it is headed by the **Camat.** There are six of these in **HALTENG.**

LIPI: **Lembaga Ilmu Pengetahuan Indonesia** (The Indonesian institute for sciences). The head office is in Jakarta, with the biological institutes based in Bogor.

Lolobata:	This is the name of a village on Halmahera. It is also the proposed name for the **Wildlife Reserve.**
Maluku:	This is an Indonesian province, the boundaries of which are shown on **map 2.1**. It does not describe a biogeographic region (which the term **Moluccas** sometimes does). To avoid such confusion we have adopted the provincial name **Maluku** throughout the report (but see **North Moluccas**).
MALUT:	The Kabupaten of **Maluku Utara** has its capital in Ternate and includes the islands of Morotai, Bacan, the north peninsula of Halmahera and the southern half of the south peninsula (see also **HALTENG**)
New Guinea	This term is used to describe the whole island, not just the country of Papua New Guinea (**PNG**).
North Moluccas:	This term is used to describe the islands of the Halmahera group, including Bacan, Obi, Morotai, Gebe, Ternate and Tidore. The Indonesian term **Maluku Utara** is not used since this also refers to an administrative region within this island group.
PHPA:	**Direktorat Jenderal Perlindungan Hutan dan Pelestarian Alam** (The Directorate general for forest protection and nature conservation).
Restricted range Sp.:	A restricted range bird species is one with a global range of less than 50,000 Km^2.
SbSBKSDA:	**Subseksi Balai Konservasi Sumber Daya Alam.** This is the local branch of the conservation department (**PHPA**).
Suaka Margasatwa:	See **Wildlife Reserve.**
UNPATTI:	**Pattimura University** is the main university in Maluku province, it is based in Ambon.
VCP:	**Variable Circular Plot**, a method of surveying animal densities which we used for birds.
Wildlife Reserve:	This refers to the Indonesian category **Suaka Margasatwa** which is used for medium to large protected areas with moderate to high conservation importance. Sometimes also called a Game Reserve.



1 PROJECT OUTLINE

1.1 Aim

To collect information to support the establishment and future management of the proposed Lolobata wildlife reserve (*Suaka Margasatwa*).

1.2 Objectives

The expedition surveyed areas along the proposed north-west boundary of the reserve (see **map 4.1.1**). The objectives were to:

1. Collect information on the range of habitats in the area and identify the major vegetation types.

2. Assess the variety, habitat preferences and abundance of birds in the proposed Lolobata reserve.

3. Collect information on the occurrence of mammals in Lolobata, thus providing a species list and estimates of abundance.

4. Collect information on the occurrence of amphibians in Lolobata and its environs.

5. Compile a collection of freshwater fish and invertebrate species from a variety of rivers, recording habitat data for each catch.

6a. Collect quantitative data on insect biodiversity using flight interception traps (FITS).
b. Study seed predation of dipterocarps by insects in Lolobata.
c. Collect spiders for later identification.
d. Collect butterflies for the Bogor Zoology Museum

7. Compile a collection of terrestrial molluscs

8. Record information on the extent of forest encroachment, local infrastructure and development projects.

These surveys were intended to establish whether key species are represented in the area and confirm whether a wide range of habitats are present. The biological data provided in this report and information on planned development projects is intended to help determine the best placement of reserve boundaries.

2 BACKGROUND INFORMATION

2.1 Geographical Setting

Halmahera (1°00N, 127°20E) is the second largest island in Maluku, Indonesia, with a land area of 1.8 million hectares. It is the central island of the North Moluccas which also includes Obi, Bacan, Makian, Tidore, Ternate, Morotai, Gebe and other smaller satellite islands. Halmahera is approximately 320 km long from North to South and 160 km across at its widest point. The land mass consists of four peninsulas which create a K-shape (see **map 2.1**). The proposed Lolobata wildlife reserve is situated on the north-eastern peninsula (see **map 2.2**).

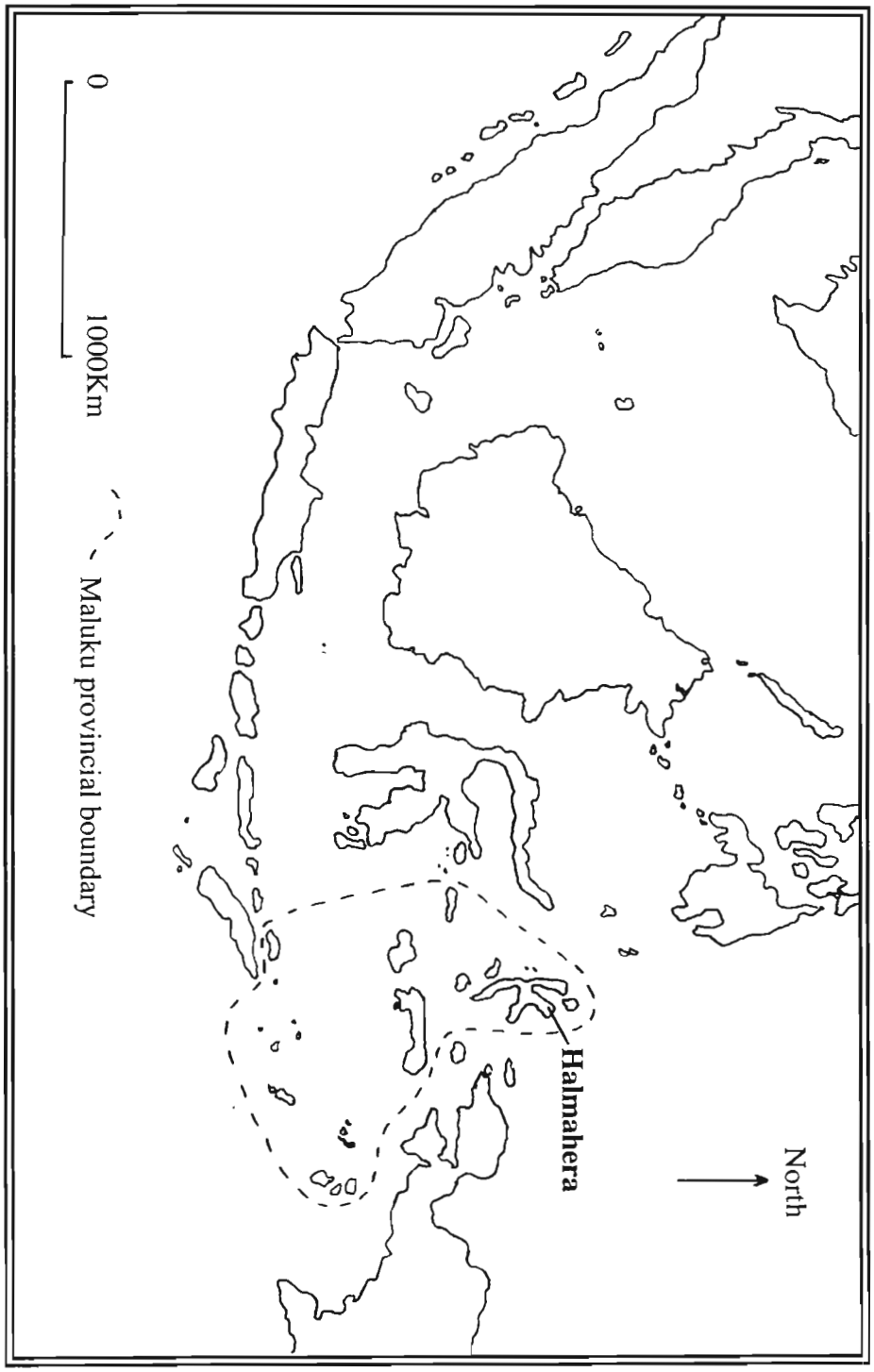
The administrative capital of the Maluku province is in Ambon. Locally the administration of Halmahera is split between Ternate and Soasio on Tidore, the capitals of Kabupaten Maluku Utara and Halmahera Tengah (HALTENG) respectively. Within HALTENG there are six Kecamatans: Tidore, Oba, Wasile, Weda, Patani and Maba. Our research was confined to Kecamatan Wasile although much of the proposed reserve is also in Kecamatan Maba (see **map 2.3**).

2.2 Geology of Halmahera

Halmahera is situated in the centre of a mosaic of microplates at the boundary of Australasia, Eurasia and Pacifica. This region is one of the most seismically active regions of the Earth. In February 1994 the region suffered an earthquake which measured 7.6 on the Richter scale. This caused extensive damage to the town of Kao, on the northern arm of the island. More recently, during our study period, on the 5th, 9th and 12th of August the volcano which forms the island of Ternate, Gunung Gamalama, erupted, blowing away the top 20m of the mountain and covering the mountain's flanks with ash.

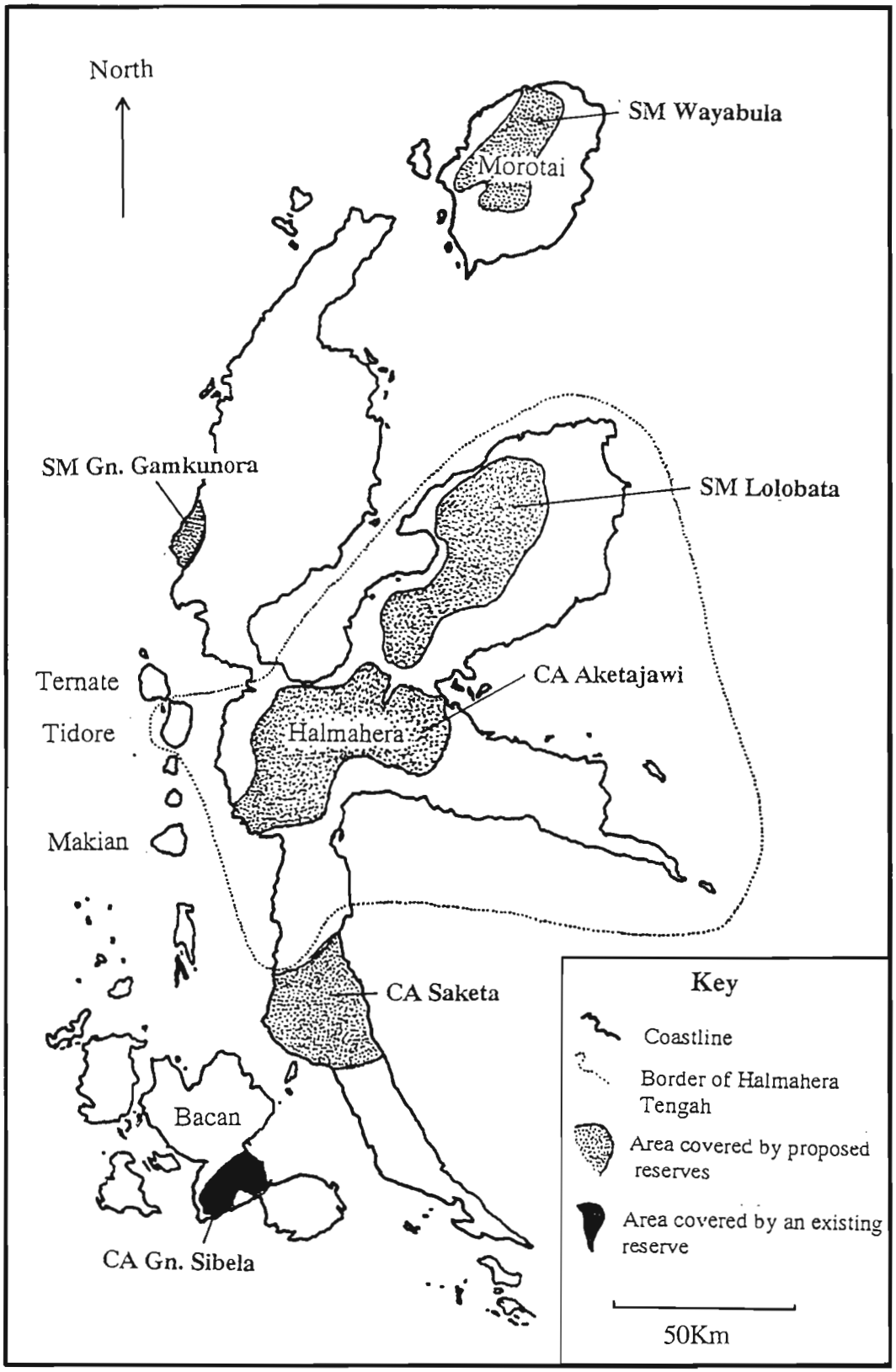
The first comprehensive maps of the region were published by the Indonesian Geological Research and Develpoment Centre (Apandi and Sudana, 1980; Supriatna, 1980). The stratigraphy established by the authors was revised in subsequent papers by Hall *et al.* (1988a; 1988b) and Nichols and Hall (1991). Information from a series of multi-channel seismic profiles across Weda bay shot by the Institut Francais du Petrole (IFP) has been incorporated together with bathymetric data obtained on cruise CD30 of the "Charles Darwin" research ship in 1988 to help with the geological intrpretation.

Western Halmahera is an active volcanic arc above a zone of intense seismicity which characterises the North Moluccan Sea. Eastern Halmahera has a basement of dismemebered ophiolitic rocks with slices of Mezozoic and Eocene sediments overlain unconformably by middle Oligocene and younger sedimentary rocks (Hall *et al.*, 1985). The basement complex was in place by late Eocene to early Oligocene times.



Map 2.1 Indonesia, showing Halmahera and the administrative region of Maluku

Map 2.2 Nature conservation areas in the North Moluccas



2.3 Biogeography

The Moluccas lie to the east of Wallace's line in the transition zone between the Oriental and Australsian biogeographic regions. During the last ice ages sea levels fell and the islands of western Indonesia (Java, Borneo, Sumatra and Bali) were joined by land bridges to mainland Asia. Similarly New Guinea and its surrounding islands were joined to Australia and this is reflected in their present flora and faunas. However, the Moluccas lie in the transitional zone known as Wallacea which was never connected to either of these continents. The flora and fauna are therefore of a more ancient origin mixed with recent colonisers which have dispersed across the water from east and west.

Due to this history a high proportion of species are either endemic to individual islands, small groups of islands or the Wallacean region as a whole. In 1992 Birdlife International (then the International Council for Bird Preservation) published "Putting Biodiversity on the Map: Priority areas for Conservation" which identifies areas with particularly high numbers of endemic species. Endemic Bird Areas (EBAs) are defined as areas supporting at least two birds with a distribution range of less than 50,000km^2 (restricted range species). The North Moluccas are recognised as an EBA with 44 restricted range species. Thirty eight of these are found on Halmahera itself, representing 86% of the restricted range species in the North Moluccan EBA (see **Appendix II**).

2.4 Fauna

Two hundred and seven bird species are recorded from Halmahera, six new records being added by this expedition. Twenty four of these species are endemic to Halmahera and its satellite islands. Parrots are particularly well represented with nine recorded species (two of which, *Cacatua alba* and *Lorius garrulus*, are endemic). The Northern Moluccas also delimit the western most extent of the family Paradisaeidae (Birds of Paradise), of which two endemic species are found in the area (*Semioptera wallacii*, Wallace's Standardwing and *Lycocorax phyrrhopterus*, Paradise Crow).

Excluding the introduced *Macaca* nigra of Bacan and domesticated species, there are forty one species of mammal recorded from teh North Moluccas (probably a conservative estimate). Four of these species are endemic (the Cuscus, *Phalanger ornatus*, Morotai Rat, *Rattus morotaiensis*, and two fruit bats, *Pteropus personatus* and *Syconycteris carolinae*). Most of the remaining species are bats, although some records are dubious (these are noted in **section 4.3**).

Halmahera supports ten species of frog of which four are endemic to the island itself (*Hylophorbus boettgeri, H. montanus, H. dubius and Littoria rueppelli*) and one to the North Moluccas (*Oreophryne senkenbergiana*). Also recorded are 19 snake species including the endemic *Tropidonotus halmahericus* and 32 further species of reptile.

The freshwater fish of Halmahera have not previously been subject to extensive study. This expedition collected approximately 35 species which are currently being identified by Dr Maurice Kottelat.

Three species of protected swallowtail butterflies occur on Halmahera (*Ornithoptera croseus, Troides hypolitus* and *T. oblongomaculatus*). Wallace's Giant Bee, *Chalicodoma pluto*, the world's largest bee and an endemic to Halmahera is listed as an endangered species by IUCN's Red Data Book (1991).

2.5 Flora

Below 700m the vegetation is mostly lowland tropical rainforest with a relatively open canopy and some emergent species reaching up to 60m. Preliminary surveys by T.C. Whitmore *et al.* (1987) recorded 34 tree species on two half hectare plots. The species present included representatives of the genera *Canarium, Eugenia* and *Vitex*. We also found species belonging to *Callophyllum, Pometia, Gnetum* and *Diospyros* to be common in lowland forest.

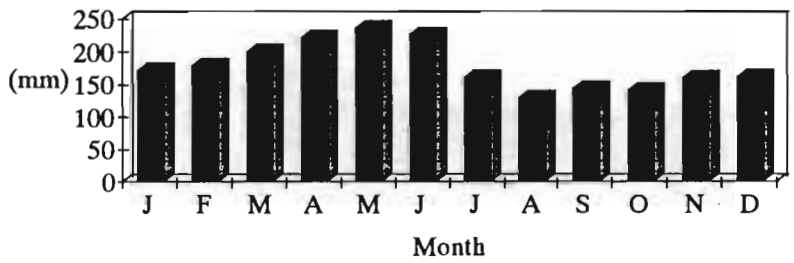
Above 700m the forest becomes montane, with a lower canopy and smaller species in the genera *Diospyros* and *Casuarina* predominating. Some larger species such as *Agathis* and *Anisoptera* spp. are also relatively common, especially on slopes.

2.6 Climate

The North Moluccas have considerable localised climatic differences. Rainfall patterns are most effected, with the wettest regions being the mountainous interiors of Morotai and the three northern-most peninsulas of Halmahera. **Map 2.4** shows the mean annual rainfall and the mean annual number of dry months (< 100mm) in the North Moluccas respectively. We have obtained no rainfall data for the north-east peninsula but it is expected to be similar to that of Tobelo. Monthly rainfall in Ternate and Tobelo are presented in figure 2.1 and 2.2 below. These data suggest that the reserve area is expected to have no dry months and a total rainfall of 2500 to 3000 mm over the year. From May through to October the southeasterly winds bring relatively less rain and in 1994 this period was locally considered to be a dry season.

Figure 2.1

Mean MonthlyRainfall: Ternate



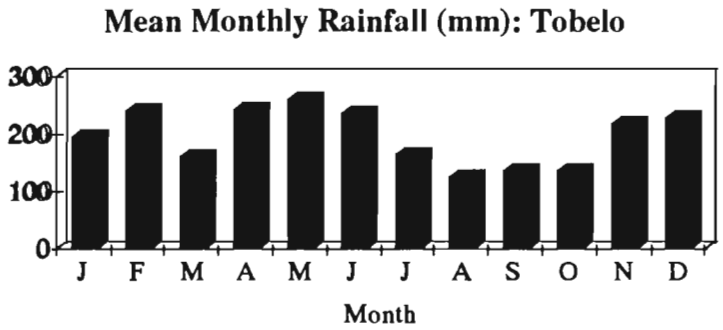


Figure 2.2

During our fieldwork there was little rainfall except over a five day period from the 5th August to 9th August when a total of 63mm fell. There was also a massive downpour (43.5mm) on the 26th August. Most other days were completely dry. The average daily temperature range was 21.9 to 32.2°C; the minimum temperature was 21°C and the maximum was 35°C.

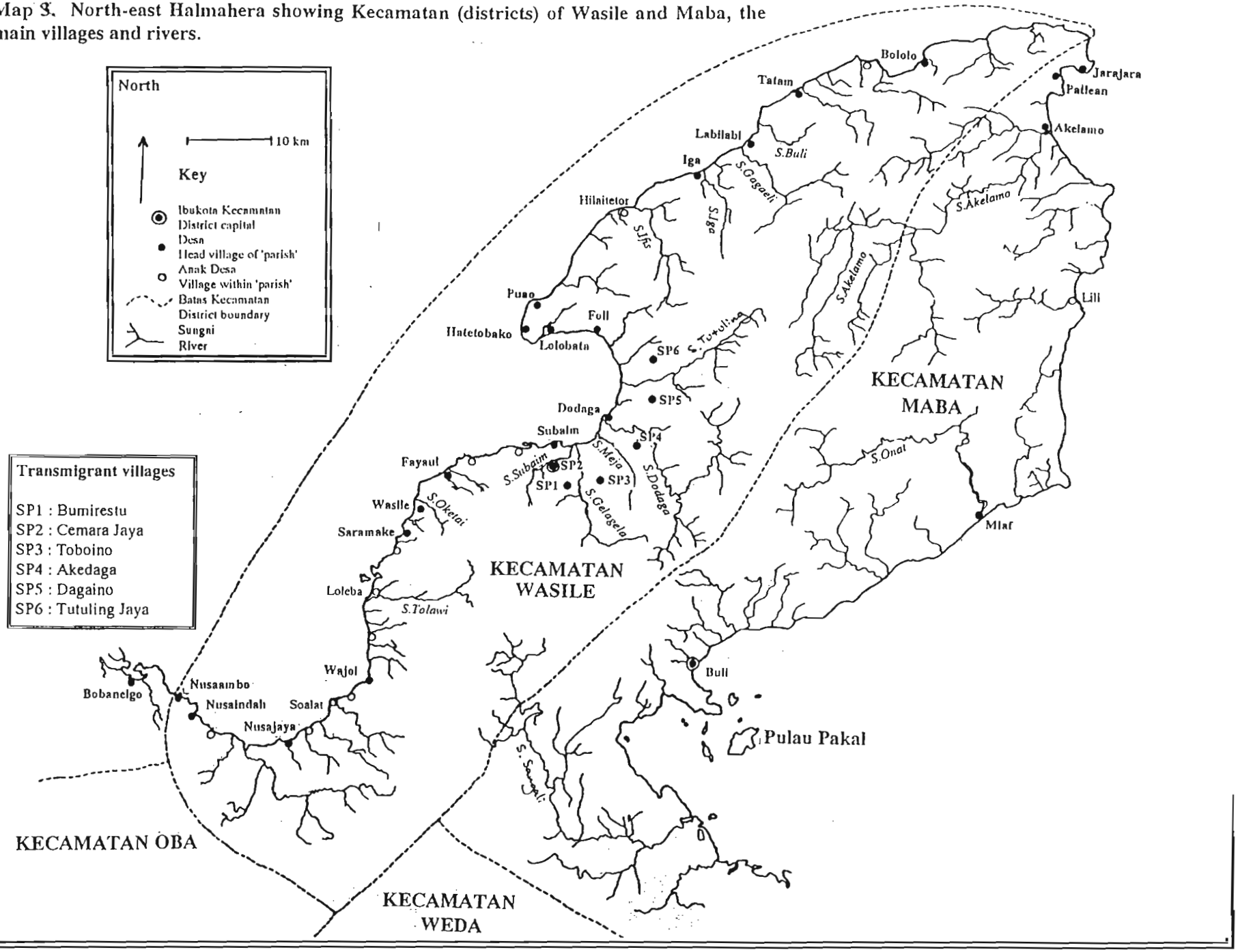
2.7 Demography

The population of Maluku province was 1.85 million in 1990 with an average rate of increase of 2.8% over the last decade (Anon, 1991b). In HALTENG the population was 147,000 in 1993, with anaverage annual increase of 2.93% (s.d. 1.86) over the last 9 years. See **table 2.1** for population census data. According to this information there were 44,947 people living in the region around the proposed reserve (Kecamatans Wasile and Maba) in 1993. The table presents population data obtained by census for the Bupati's office in Soasio. In Kecamatan Wasile the native people are Tobelorese, however there has been a recent influx of newcomers from within Maluku, from Sulawesi and further afield. In the 1980s a transmigration scheme was started at Subaim. There are currently about 10,000 Javanese transmigrants living in the area. There is a smaller transmigration scheme in Nusajaya (formerly Ekor).

Table 2.1. Censused population, by Kecamatan, of Halmahera Tengah for the years 1985-1993.

Year / District	1985	1986	1987	1988	1989	1990	1991	1992	1993
Tidore	35,745	36,253	36,428	36,968	37,828	39,402	39,867	40,260	42,120
Oba	22,550	23,729	23,829	25,214	26,308	29,275	29,914	29,333	29,482
Wasile	21,441	22,728	23,199	24,351	24,827	26,254	27,272	26,590	27,338
Weda	8,700	8,957	9,269	9,693	9,894	10,018	10,024	12,412	12,441
Patani	15,138	14,977	15,247	15,247	15,997	17,809	18,008	18,226	18,205
Maba	13,606	14,197	14,272	14,195	14,638	15,998	16,704	16,884	17,609
Total	117,180	120,864	122,241	125,963	129,492	138,756	141,789	143,705	147,492
% increase		3.14	1.14	3.04	2.80	7.15	1.35	1.35	2.64

Map 3. North-east Halmahera showing Kecamatan (districts) of Wasile and Maba, the main villages and rivers.



Map 2.4 Rainfall patterns in the North Moluccas

Mean annual rainfall (mm) in the North Moluccas

Mean dry months (<100mm) in the North Moluccas

Source: RePPPROT, 1988

The mountainous interior of north-east Halmahera is home to a number of '*orang hutan*', forest people (or *honanga ma nyawa* in local Tobelorese). These populations are often referred to as 'Tugutil', though this term does not appear to define any ethnic group (Chris Duncan, pers. comm.). These people use the Tobelo language and there does not appear to be any basis for the belief that there is a Tugutil language.

The government is pursuing a resettlement project which is especially active in forest surrounding Sungai Dodaga. According to the *Kepala Desa* (head of village) at Dodaga approximately 60 families have been settled in the village, leaving about 20 more along the river. Apparently there is also an American Mission at Lili, on the east coast, but we did not visit that region.

The exact number of forest people is uncertain, though about 1000 is a frequently quoted figure. The Tugutil of the Sungai Dodaga region live in family groups, each occupying temporary homes along the river and depending upon shifting agriculture and hunting.

Many of the coastal villagers are fearful of the 'forest people' and certainly there have been violent clashes in the past. In the S. Tolawi region we were shown two sites where villagers had been killed in the late 1970s. However rumours are commonplace in Halmahera and we heard of at least 3 murder incidents during our study period, all of which proved to be false.

There is an opinion which suggests that some 'Tugutil' are individuals who have fled from the law. The father of one of our guides had returned to the forest having escaped the police. He is wanted for murdering a transmigrant during a dispute over traditional land rights. During colonial times the Tugutil population swelled as the Dutch imposed taxes on coastal villages. Then again during the massive Japanese occupation of Halmahera during World War II many villagers returned to the forest (Chris Duncan, pers. comm.). Japanese attrocities on Halmahera were, by all accounts, horrific. At the end of the war the locals are said to have exacted their revenge. Some Japanese soldiers were able to escape to the forest. In 1973 the world was astounded by the story of Private Nakamura who had been in hiding on the isalnd of Morotai for 28 years. Similar stories are common on Halmahera. One cave I visited had been used by such a group of soldiers. There are still the remains of Japanese tins, bottles and medical kits. Snails had apparently been the staple diet and there were massive piles of empty shells along with the skeletal remains of pig and deer.

Another common story about forest people is that some are the descendants of the first Portuguese explorers who landed on Halmahera about 400 years ago. These '*orang biri-biri*' are thought to have fled to the forest after the Dutch defeated the Portuguese. On two occassions I met hunters who claimed to have met these people, both described them as pale skinned, taller than average Indonesians with long black or brown hair. The fear of '*orang hutan*' expressed by villagers, especially those at Fayaul, Wasile and to a lesser degree at Loleba, meant that we sometimes had difficulty in finding good guides. The presence of these mysterious people was certainly not good for team moral. One of the bird survey teams met a group of Tugutil and both parties apparently ran in opposite directions. Also they seem to have been responsible for the dismantling of one of our mammal trap transects.

3 JUSTIFICATION

3.1. Regional importance

There are approximately 1000 islands in Maluku covering 851,000km² of which one tenth is land. The islands vary greatly in size, climate, geology, topography, flora and fauna. These differences are so great that for conservation purposes the islands were divided into seven biogeographical units by the National Conservation Plan (UNDP/FAO, 1981a). The northern-most of these is the North Moluccas, centred on Halmahera.

Halmahera is the second largest island in Maluku. It contains the widest range of vegetation types, has the most varied climate (UNDP/FAO, 1981a) and supports the second highest number of endemic bird species of any of the Moluccan islands (ICBP, 1992). Due to its importance in the region, four different locations were proposed as protected areas (UNDP/FAO, 1981a; 1981b; 1981c). However gazettement of these areas has not yet taken place and new surveys are required to determine the status of the proposed sites. The largest and most physically varied of the proposed protected areas is the Lolobata Wildlife Reserve.

The proposed reserve area acts as a water catchment for the surrounding settlements. Its rivers are the only water supply for the 45,000 inhabitants living in the region. The rivers flowing into Subaim bay provide water for the irrigated padi fields of Javan transmigrants. The area is home to an estimated 1000 people of the nomadic Tugutil tribe. These people depend upon the forest and the products it yields for the survival of their culture.

3.2. Previous work

A.C. Smiet carried out preliminary ecological studies on the reserve and concluded that it should have a priority rating of 1 in the National Conservation Plan for Indonesia (UNDP/FAO, 1981b). This rating is the highest possible and "is accorded to areas of major conservation importance whose omission from the reserve system would constitute major gaps in the habitat coverage" (UNDP/FAO, 1981a).

In 1993 Frank Lambert surveyed the parrot populations of *Cacatua alba*, *Lorius garrulus* and *Eos squamata* in the North Moluccas calculating minimum populations of 50,000, 46,000 (these are global populations) and 66,000 respectively. The minimum estimated captures for 1991 indicated that *C. alba* and *L.garrulus* were being overexploited. He suggested new reduced annual catch quotas of 1,710, 810 and 1,590 respectively with an allowance for fair division between the islands. He summarised that better training, enforcement, monitoring, research and habitat conservation were all needed for the islands.

Whitmore *et al.* (1987) published tree enumeration data for two half hectare plots from Sungai Oketai near Wasile village. A French caving expedition visited the island in 1988 and mapped a 7.5km cave system (Batu Lubang) on the Sangea river in Kecamatan Weda. A total of 80 animal species, mostly insects, were collected from the cave system (Brouquisse F., 1989).

Hall (1987), Hall *et al.* (1988a; 1988b) and Nichols and Hall (1991) have published data on the geological history of the region with particular reference to the north-east peninsula. Taylor (1990) studied the folk classification system of the Tobelo people, recording local uses for a variety of animal and plant products. The faunal specimens he collected were the

basis for some other publications (*e.g.* Peterson *et al.*, 1990; Koopman and Gordon, 1992). Birdlife International have been working with Balai Konservasi Sumber Daya Alam (BKSDA) Maluku surveying the proposed Ake Tajawi reserve and will be making initial surveys of Lolobata in early 1995.

3.3 Reserve boundary proposals

The Suaka Margasatwa Lolobata (Wildlife Reserve) was proposed as a result of the UNDP/FAO (1981b) survey conducted by A.C. Smiet as part of the National Parks development programme for Indonesia. A misspelling in the National Conservation Plan (UNDP/FAO, 1981a) has caused this reserve to be listed as 'Lalobata' in most reports since that time. The proposed reserve is listed as having an area of 189,000 hectares, however we recalculated it as 126,000 hectares based on the proposed boundaries (FAO, 1981b; FAO, 1981c) and we use this figure in the report. The boundary is indicated on **map 3.1**. From Wasile it runs north-east parallel with the coastline but about 2km inland. It then excludes the lowlands around Subaim bay, continuing parallel to the coastline about 6km inland until it reaches Sungai Gagaeli. From here the boundary runs inland passing to the north of Gn. Iga (1306m) and then south-east past Gn. Isalat (1070m) to Sungai Onat. It then follows the river upstream and around Gn. Watileo (1307m) and then west to Sungai Oketai at Wasile. This boundary is intended to protect the watercatchments that are essential to the future development of the region.

A second proposal appears on the Ministry of Transmigration land use maps (RePPPROT, 1988). We calculated the total area as approximately 125,000 hectares. The boundary is outlined on **map 3.1.**

A third proposal appears on the PHPA map of conservation areas in the North Moluccas (PHPA, 1993). The reserve proposed on this map is much larger, approximately 244,000 hectares. However some of the boundaries are unrealistic, for instance the whole area around Subaim bay is already being farmed as part of the transmigration scheme.

In addition to these proposals a number of Protection forest (Hutan Lindung) areas already exist on the peninsula. These have been marked out by the department of forestry and the boundaries are well known by local people. Protection forest is the lowest category in the Indonesian protected area system. It is used for medium to large areas of natural or planted forested land on steep slopes liable to erosion. The main priority is to protect important catchments, to prevent landslides and erosion; conservation priorities are not so high as to justify reserve status (MacKinnon *et al.*, 1989). Growing of food crops, human settlement and commercial logging are not permitted in Protection forests. The existing areas of Protection forest are marked on **map 3.1**; in total they cover approximately 106,000 hectares.

Map 3.1 Comparison of the three proposed boundaries for the Lolobata wildlife reserve and the existing Protection forest

Boundary proposed in the National Conservation Plan

Source: FAO, 1981c

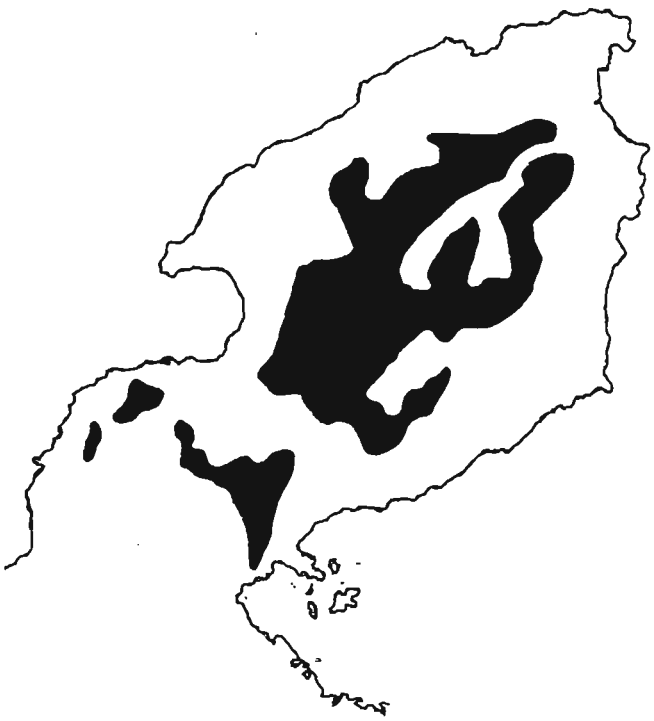
Boundary proposed by Ministry of Transmigration

Source: RePPPROT, 1988

Boundary proposed by PHPA

Source: PHPA, 1993

Existing Protection Forest (Hutan Lindung)



Source: PKDTII HALTENG, 1993

4.1 HABITATS

Report by Tristan Hugh-Jones.

Aim

To obtain vegetation transects and soil profiles for each different habitat type surveyed. The results were intended to complement the faunal surveys by providing an accurate description of vegetation structure and some information on species composition.

Choice of survey area

Rock type and altitude were assumed to be the major environmental variables influencing both the structure and floristic composition of the forest. It was decided that for the nature of our study the geological map proposed by Supriatna (1980) should be simplified into four categories according to lithology. This classification is summarised in **table 4.1.1**.

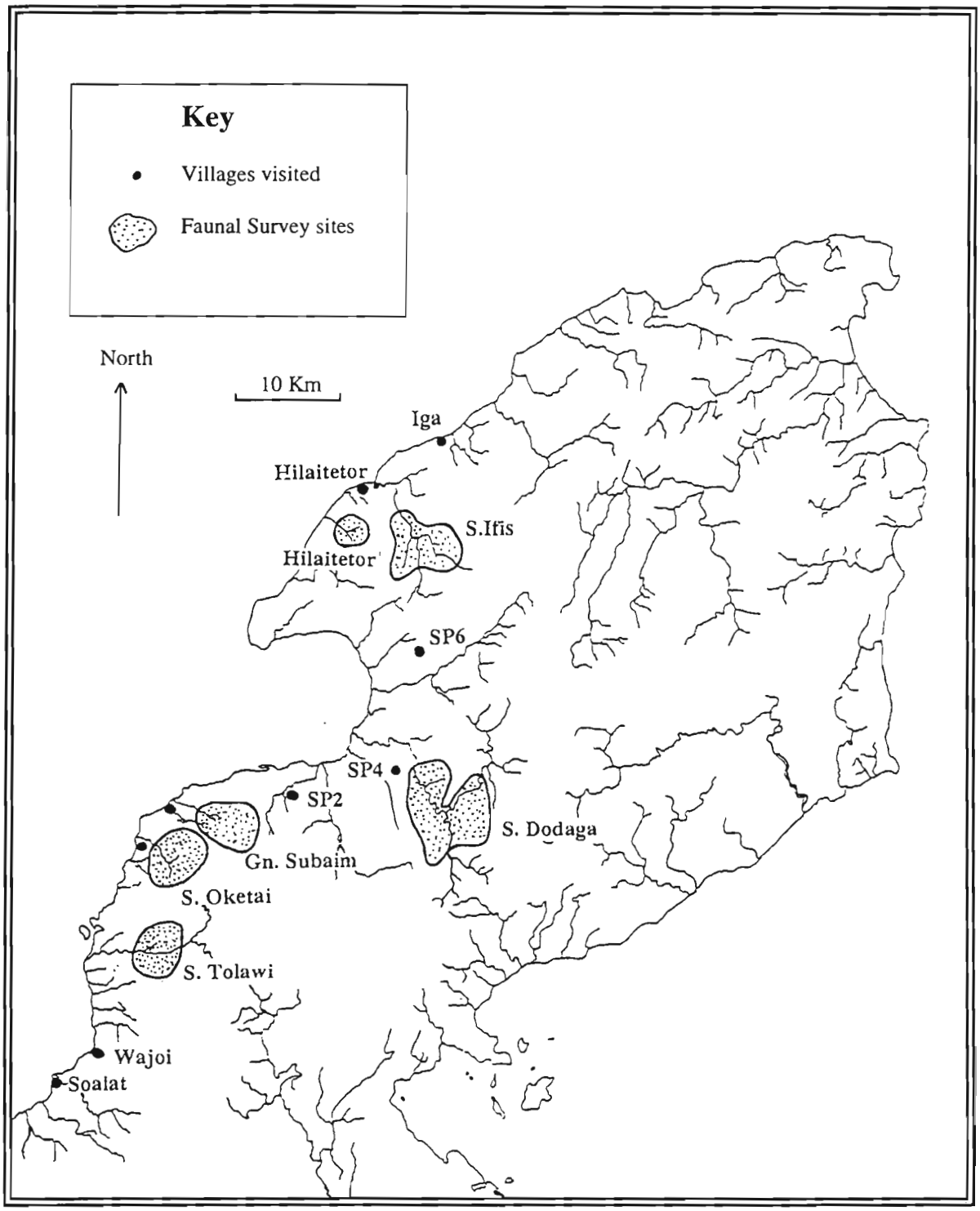
Table 4.1.1. Habitat categories used by this project, classified according to lithology.

Our classification	Supriatna's classification	Description of parent rock material
Alluvial	Alluvial	Gravel, sand, mud and boulders and terrace deposits.
Calcareous sediments	Reef limestone	Reef limestone, marl and sandy limestone
	Tingteng Formation	Limestone, calcareous sandstone and marl
	Tutuli Formation	Limestone, marl and calcareous sandstone
Non calcareous sediments	Dorosagu Formation	Interbedding of sandstone, siltstone, claystone, shale, conglomerate and limestone
	Weda Formation	Sandstone, claystone, siltstone, marl, limestone and conglomerate
	Dodaga Formation	Interbedding of siltstone, claystone, sandstone, marl and limestone
Igneous	Igneous rocks	Diorite, andesite and gabbro
	Kayasa Formation	Lava and breccia of andesitic and basaltic composition
	Bacan Formation	Breccia and lava of andesitic and basaltic composition
	Complex of ultrabasic rocks	Serpentinite, dunite, basalt, gabbro and diabase

All areas above 700m were considered as a fifth habitat type (montane) irrespective of the underlying rock formations. Further research may indicate that differences between montane areas on different rock types are important.

Map 4.1.1. indicates the sites which were surveyed during the expedition. **Map 4.1.2** shows the extent and distribution of the five habitat types.

Map 4.1.1 Expedition survey sites. The names of each site correspond to the name by which each site is referred in this report.



Results from the bird surveys have provided abundance densities for some species in four of the five habitat types. Multiplying these densities by the habitat area should provide an indication of the total population for these species.

Table 4.1.2 compares the area of each habitat that would be included within the reserve depending upon which of the three proposals are followed. The areas of each habitat occurring within existing Protection forest (*Hutan Lindung*) are also included. These figures do not account for man-made disturbances.

Table 4.1.2 Comparison of existing proposals showing areas of each habitat type that would be protected.

Proposal	Approximate area originally covered by each habitat type (km^2)					
	Total area	Alluvial	Igneous	Non-calcareous	Calcareous	Montane
UNDP/FAO	1260	65	340	410	220	225
RePPPROT	1250	5	380	395	190	280
PHPA	2440	135	595	1070	280	360
Protection forest	1060	10	200	365	115	370

See Reserve boundary proposals (section 3.3) for further detail.
Proposal references are UNDP/FAO (1981c); RePPPROT (1988); PHPA (1993).

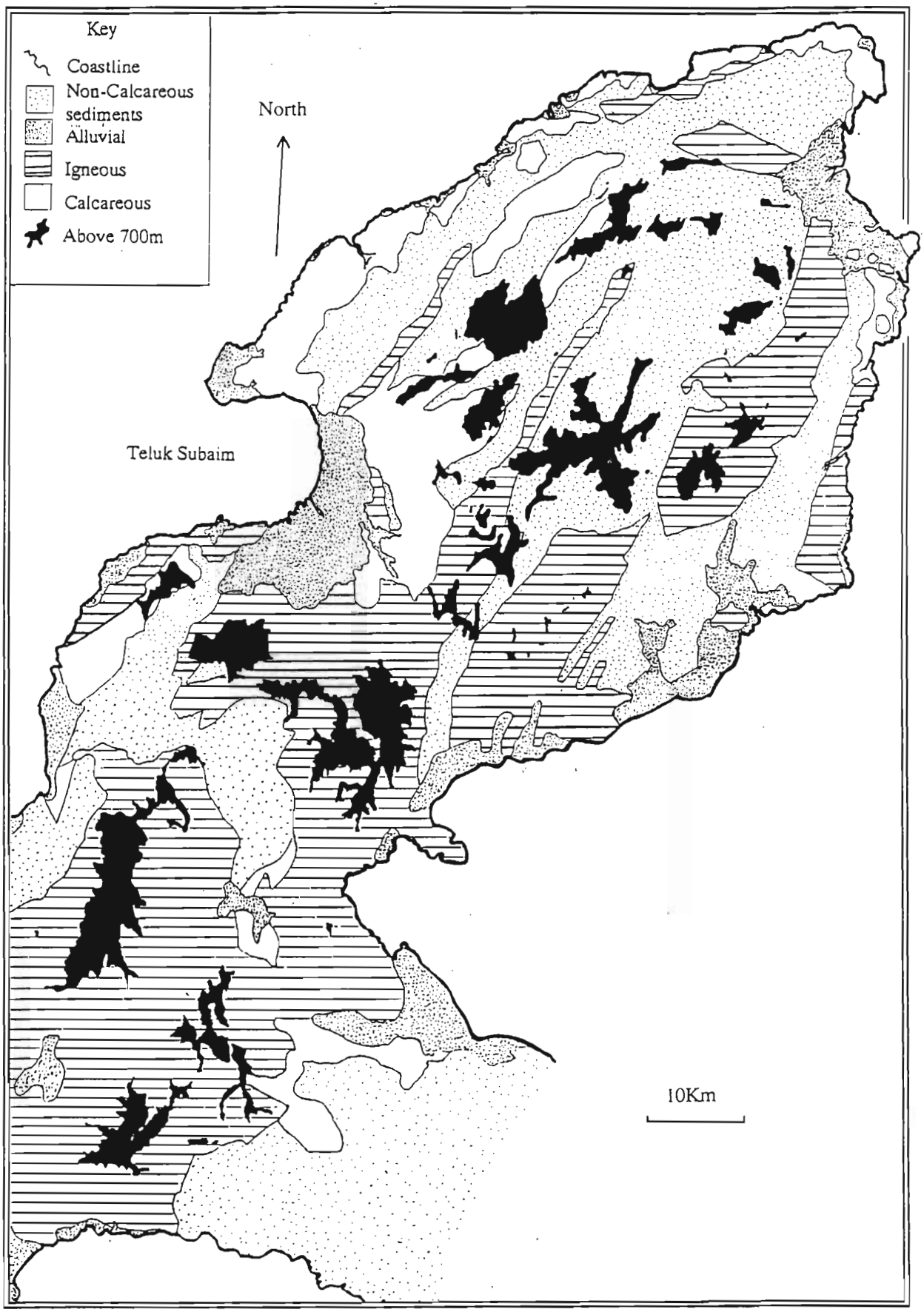
Almost all forest on alluvial soils on the north-east arm has been cleared for agricultural use. We decided not to survey this habitat since the area which could be included within the reserve boundaries is minimal.

Methods

The geology of the area was recorded using the map published by Supriatna (1980), and was verified by field observations. At each site a soil profile was produced with the use of an auger. Each soil sampling site was located on a slope, on typical ground cover on the marked transect. Several holes were bored in close proximity so that an accurate documentation of the profile horizons could be obtained. The soil was then studied to determine horizon depth, moisture status, colour (using a Munsell colour chart), texture, stone content, structure, calcium carbonate content and any other noteworthy features.

Tree profile transects were recorded for each of the six faunal survey sites. Since most of the reserve area is hilly, all transects were located on slopes. A 20 x 100m plot was marked out parallel to the slope. The plot was then subdivided into 10m sections so that the tree locations could be accurately plotted. All trees greater than 20cm girth were measured and any trees that were less than 20cm girth, but more than 2m high, were counted and classed as 'saplings'. The girth size (at 1.3m height), height to the first branches (using clinometer) total height, and the canopy spread were all noted. Although Tobelo names for each tree were recorded, only the most common species at each site have been listed in the following results. Lists of Tobelo tree names and their scientific equivalents are given in Hildebrand (1951), Anon. (1983) and Taylor (1990).

Map 4.1.2 Habitat classification according to lithology and altitude



Description of survey sites

Forest structure

Figures 4.1.1 and **4.1.2** presented opposite show the relative distribution of tree heights and girths at each of the six transect sites. In both cases the pattern of number of trees in each height category is typical of most tropical forests. The majority of trees are short (0-5m) saplings which have negligible growth rate until they are able to take advantage of gaps in the canopy. A similar relationship occurs for tree girth and many studies have demonstrated that the girth and height are linearly related. In both graphs saplings have been excluded, but the number counted in each 0.2 hectare transect is given below in **table 4.1.3.**

The frequency distributions of heights and girths were analysed statistically with chi-squared tests. To ensure high power of the test analysis of the girth frequency distribution only considered 9 girth categories (20-29.9,...,100-109.9cm); only 7 height categories (0-4.99,...,30-34.99m) were included in the analysis. Assuming a significance level of 5%, there was no significant difference in girth distributions between sites ($c^2 = 43.7$, d.f. = 40, $p > 0.1$).

There were significant differences in tree height distributions between sites ($c^2 = 63.7$, d.f. = 30, $p < 0.001$). Partitioning of the chi-square value according to sites suggests that Subaim and Hilaitetor contribute heavily to the chi-square score. Indeed when these two sites are excluded from the analysis the chi-square test is not significant, suggesting that there is no difference between tree heights at the other four sites. At Hilaitetor there were few short trees of 5-10m and few saplings because of disturbance caused during selective logging activities. The differences between Gunung Subaim and the other sites may reflect biologically significant structural differences between the lowland and montane forests. In particular the montane forest appeared to have a more open canopy, possibly because of the paucity of trees in the 10-14.9m height class.

In summary, too few transects were surveyed to determine whether there are real structural differences between the 'habitat' types we identified, based on geological criteria. When differences have been noted, particularly in tree height distributions, there have been other confounding factors such as human disturbance and altitude which could also explain the differences.

Table 4.1.3 The numbers of saplings recorded in each transect.

Survey site	Number of saplings
Tolawi	520
Oketai	435
Gn. Subaim	414
Dodaga	796
Ifis	311
Hilaitetor	147

Figure 4.1.1 Frequency distribution of tree heights at the six survey sites

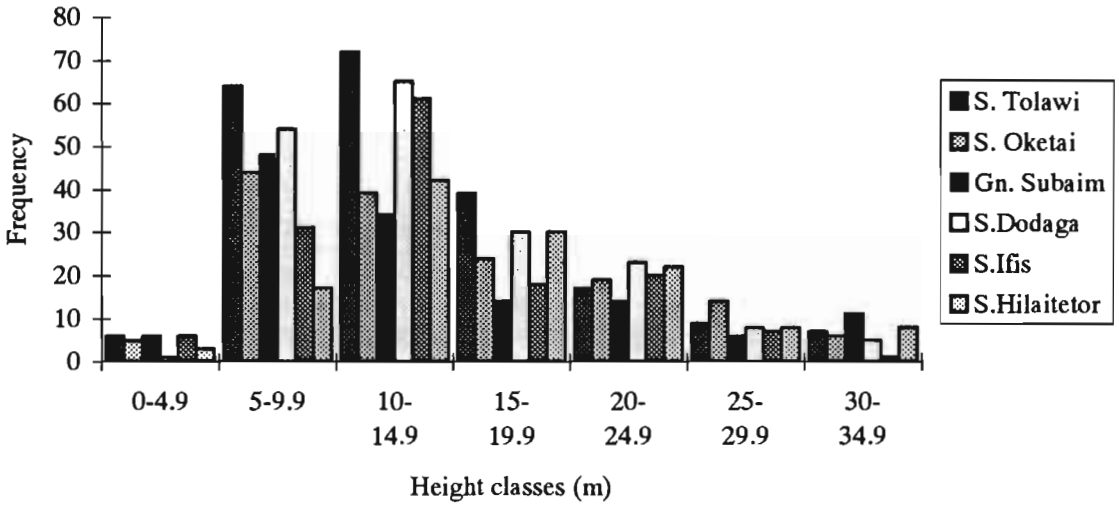
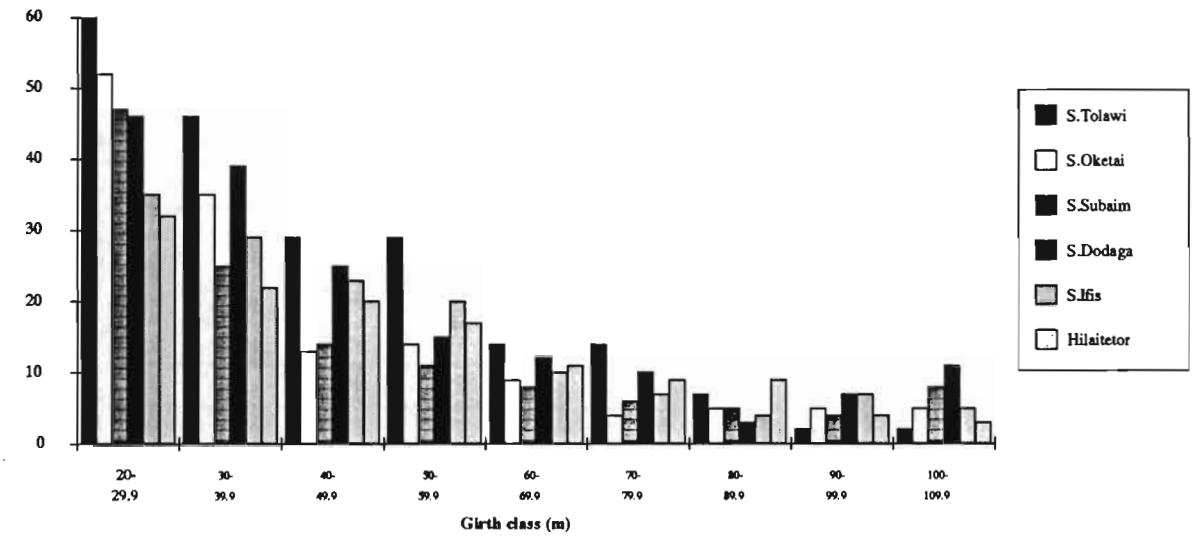


Figure 4.1.2 Frequency distribution of tree girths (m) at the six transect sites



Sungai Tolawi

The Sungai Tolawi region (near Loleba) has been described by Supriatna (1980) as part of the Tingteng formation, consisting of limestone, marl and calcareous sandstone. A main part of this formation is the Subaim Limestone Formation which has been described by Hall (1988) as a sequence of reef and reef associated limestones found in outcrops along the north-west side of the north-east peninsula mainly between Loleba and Subaim which are up to 500m thick. Where the base of the Subaim Limestone Formation is seen, it is either an uncomformable contact with the Ophiolitic Basement Complex, or a conformable transition from conglomerates which rest directly on the Ophiolitic Basement Complex.

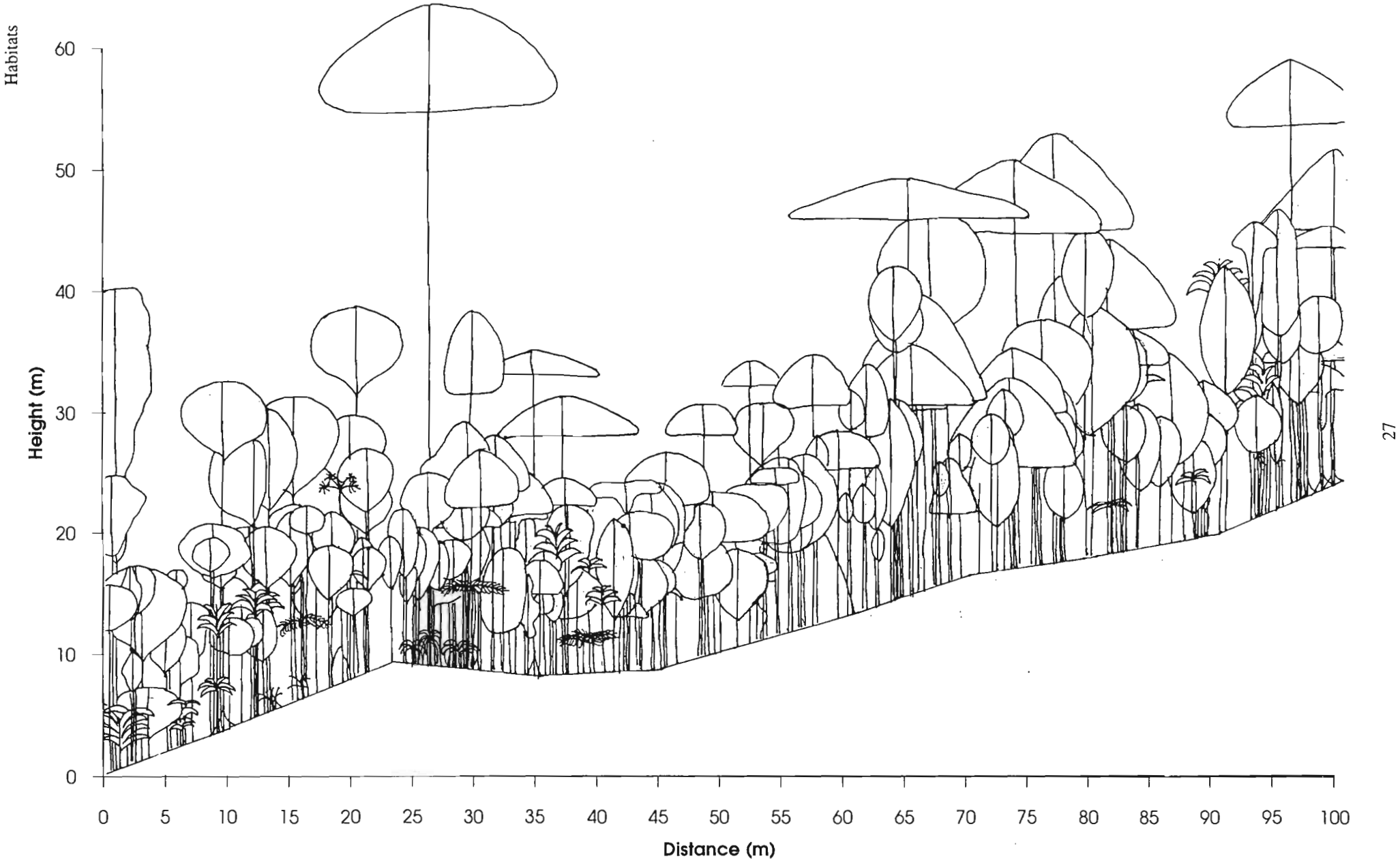
The most common trees observed in this habitat were *Microcos ceramensis* (Tiliaceae), *Diospyros* spp. (Ebenaceae), *Kleinhovia hospita* (Sterculiaceae), *Pometia pinnata* (Sapindaceae) and the dipterocarps *Vatica papuana* and *Anisoptera costata*. The vegetation profile is shown in transect 1. It represents the type of habitat present, and provides an impression of the canopy architecture. Tree height, height to first branches (as shown by the base of the bulb) and canopy spread are indicated.

This site had the highest tree density out of all habitats with an average of 1.09 trees/m^2, but the average tree girth was the lowest (51.1cm). There were 520 saplings in the transect, the second highest number for any site.

Soil profile for S. Tolawi

Depth (cm)	**Description**
18cm above	50% of the surface covered in large stones (14-27cm) Mean size is 21cm (long axis) Dolerite lithology- subrounded Undecomposed leaf litter on and between stones.
0	
	Slightly moist soil 10YR 1/2 Very dark brown loamy sand Very crumbly soil Angular course sand, approx. 20%.
36	Clear boundary
	Dry soil 2.5Y 5/6 Light olive brown loamy sand Stoneless Massive structure High porosity
54	
	Becomes drier with increasing depth Becomes sandier and more crumbly 2.5Y 6/4 light yellowish brown Stoneless
79	End of profile.

Transect 1: Vegetation profile of a 20x100m strip of forest on limestone in the Sungai Tolawi region.



Sungai Oketai

The rocks on Sungai Oketai have been mapped (Supriatna, 1980) and described as a complex basement of ultrabasic rocks, consisting of serpentinite, dunite, basalt, gabbro and diabase. This has been studied in more detail by Hall *et al.* (1988) who have traversed up the river. They found pillowed basaltic lavas which are amygdaloidal, with amygdales up to 4mm with a mean diameter of about 2mm. The lavas are locally associated with bright red manganiferous and silicified mudstones which are interstitial to the lavas.

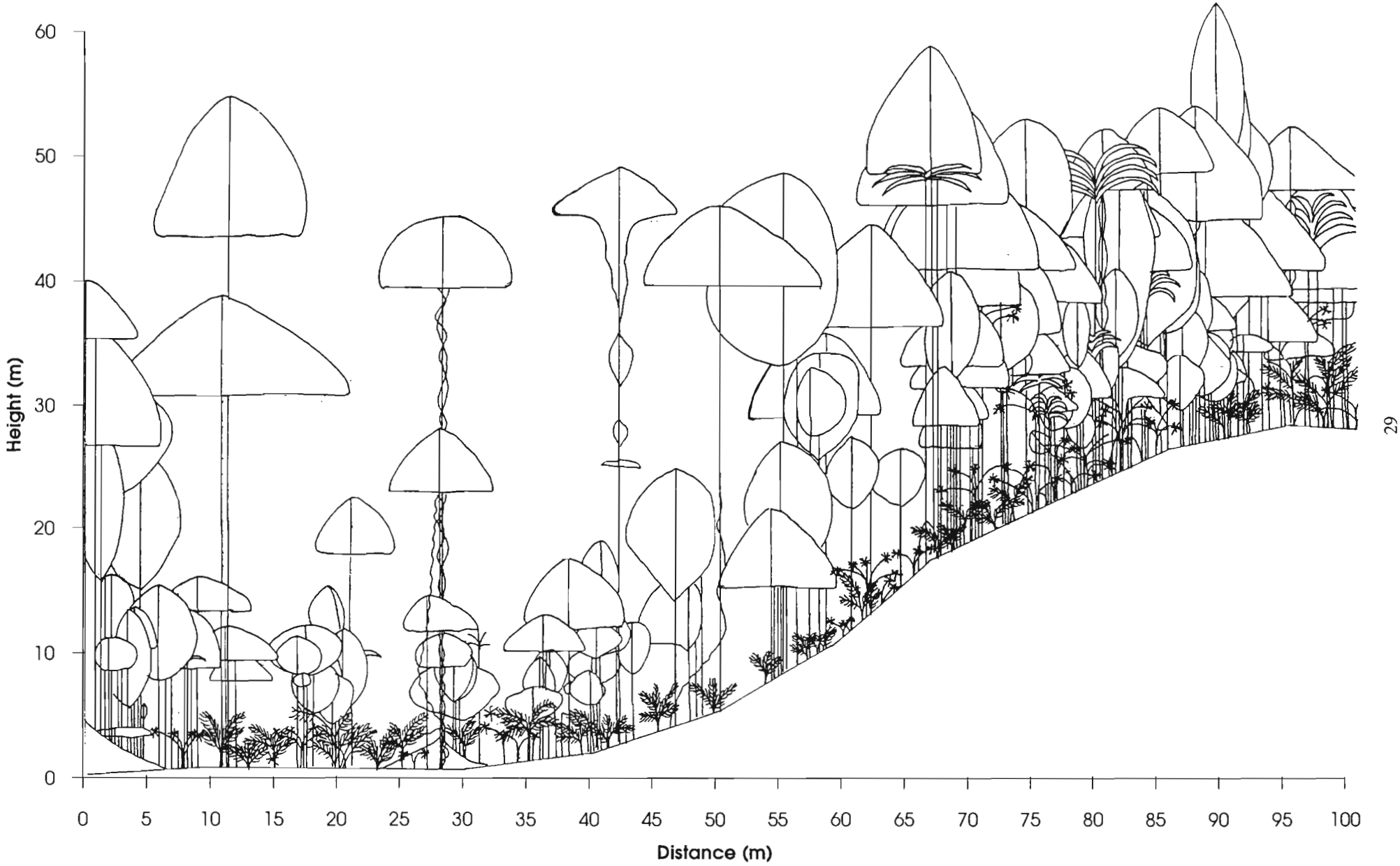
Hall *et al.* (1988) estimate that the Basement Complex actually includes only about 30% ultrabasic rocks, which are locally highly sheared and serpentinized and may be veined by magnesite. Also at Sungai Oketai there are abundant exposures of fine grained, bluish or greenish extremely hard and often massive basaltic tuffs. In most places these are well jointed and fractured, but without obvious layering or other primary structures. In a few places these rocks have definite bedding, grading and other sedimentary structures suggesting wet-sediment deformation. The sedimentary structures indicate that at least some of these rocks are water laid pyroclastics.

Tree species on this transect were not identified. However note that unlike the other sites there was a predominance of rattans, *Calamus* sp., in the understorey. The soil profile differed from the others in that there was little leaf litter. This could be due to the very steep slope on which the sample was taken. The soil was also extremely crumbly, reflecting the dry weather and steep gradient allowing rapid drainage.

Soil profile for S. Oketai

Depth (cm)	**Description**
2 cm above	very little decomposed leaf litter
0	
	Dry soil 10YR 3/6 dark yellowish brown loamy sand Moderately stony - 5mm angular stones Dry, loose, friable structure No Calcium carbonate (<0.5%) More stones and more gritty with depth
42	Distinct boundary
	Dry, very crumbly, gritty soil 5Y 5/6 olive loamy soil Loose consistence No calcium carbonate
86	End of profile.

Transect 2: Vegetation profile of a 20x100m strip of forest on ultrabasics in the Sungai Oketai region.



Gunung Subaim

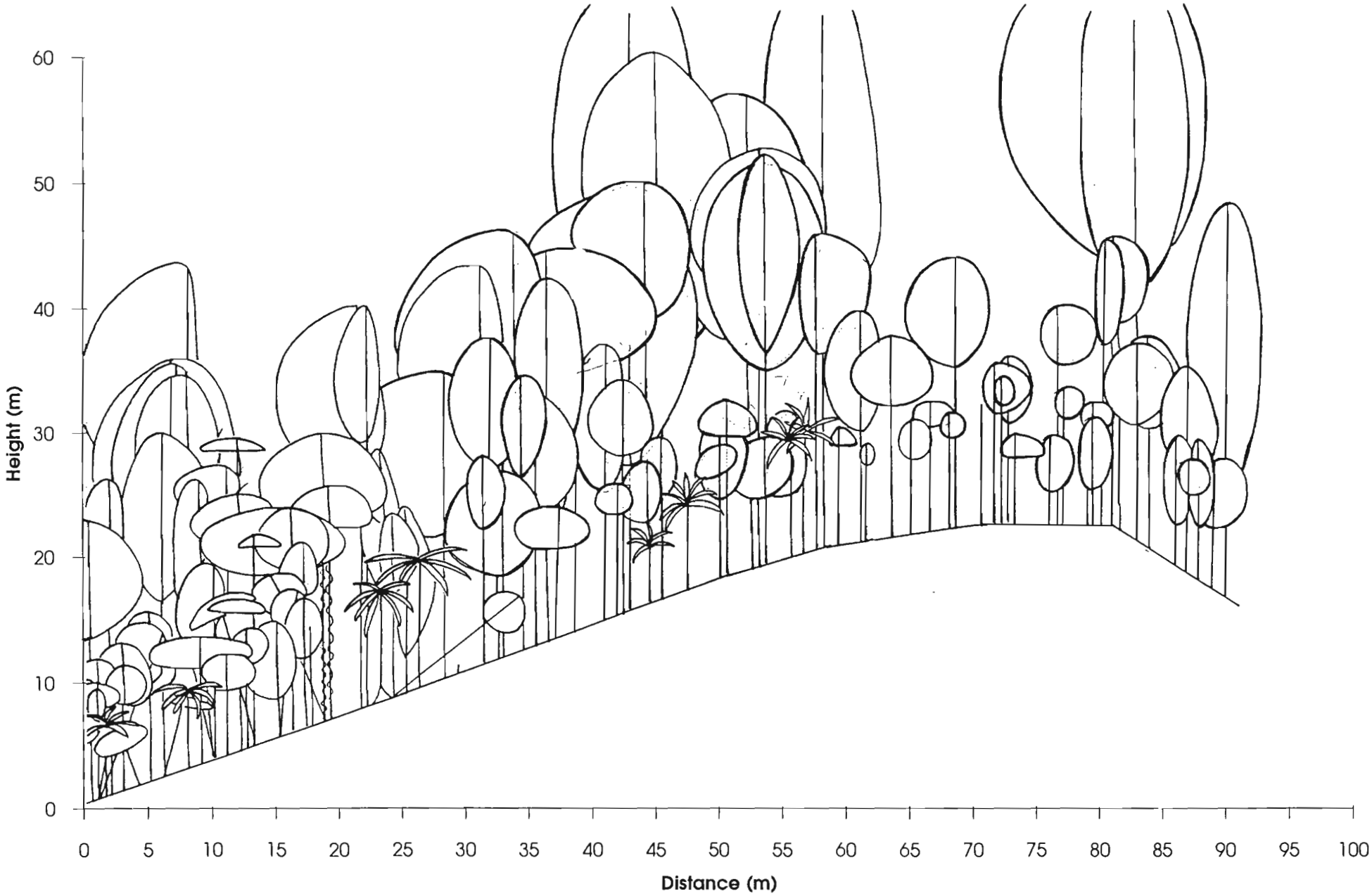
For a geological description see the notes for Sungai Tolawi. The soils on Gunung Subaim were the most stony with large (12-15cm) angular blocks of mudstone (see soil profile).

Prominent species in this transect were *Agathis philippinensis* (Araucariaceae), *Casuarina sumatrana* (Casuarinaceae), *Terminalia* sp. (Combretaceae), *Mastixiodendron pachyclados* (Rubiaceae), *Calophyllum* sp. (Guttiferae) and *Parastemon* sp. (Rosaceae). Many of the trees had smaller leaves than those of lowland species. Although not apparent from the profile, more light was able to penetrate to the forest floor and hence there was a thick undergrowth of grass and small shrubs on this transect.

Soil profile for Gunung Subaim

Depth (cm)	**Description**
6cm above	100% dry leaf litter cover Few rock outcrops
0	
	Dry soil 10YR 3/3 Dark brown loamy sand with gritty texture slightly stony (approx. 10%) Medium angular stones (2-5cm) Strong structure Many roots No Calcium carbonate
21	Diffuse boundary
	Dry soil 10YR 4/4 dark yellowish brown loamy sand Many large angular grey mudstone stones (12-15cm) Loose consistence Granular/blocklike coarse peds
36	End of profile.

Transect 3: Vegetation profile of a 20x100m strip of montane forest on Gunung Subaim.



Sungai Dodaga

The rocks on the Dodaga river are those of the Tutuli Formation (Supriatna, 1980). This is a combination of limestone, marl and calcareous sandstone and is of Late Oligocene/Early Miocene in age.

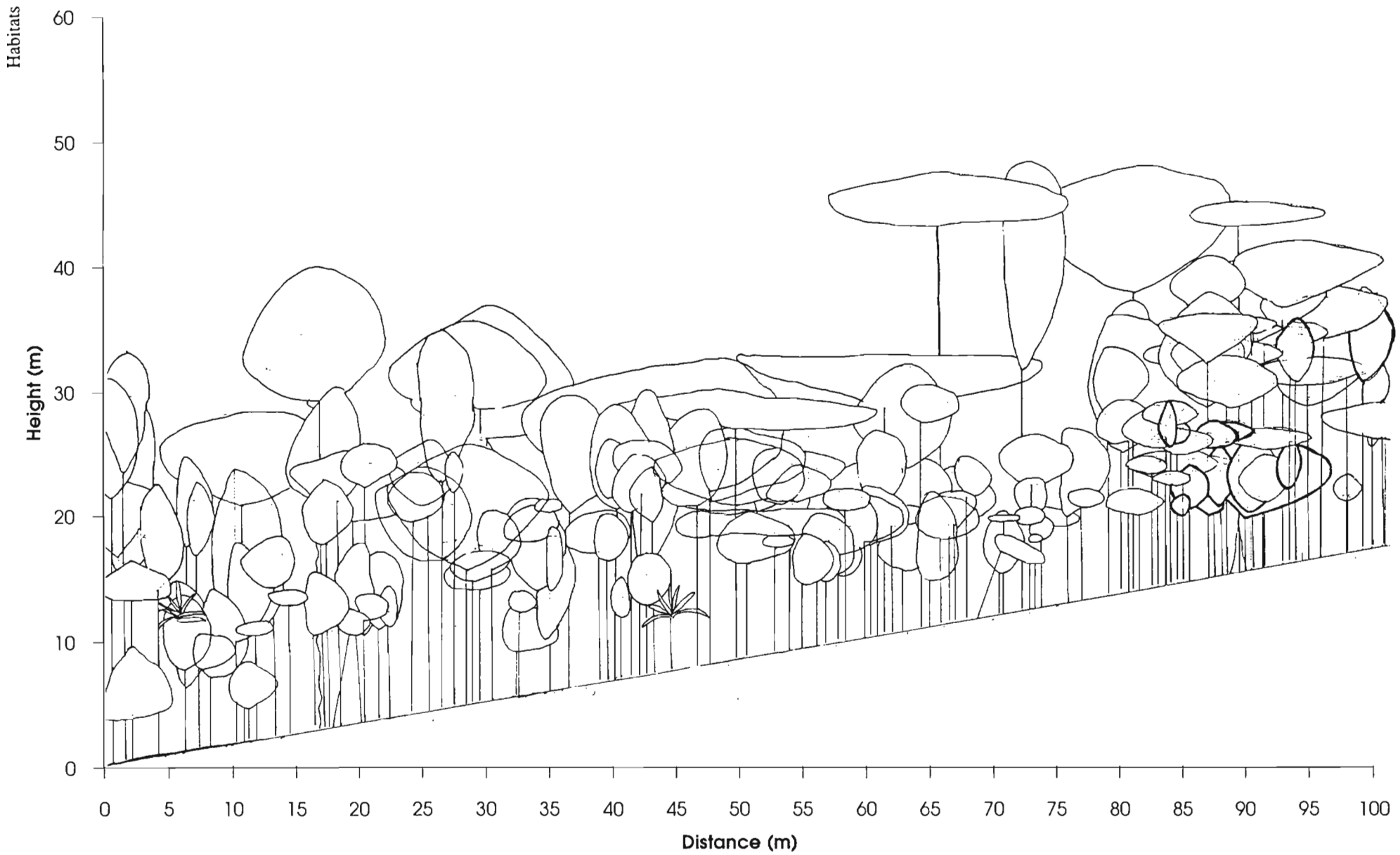
Despite showing the area to be based on calcareous rock, large igneous stones were found on the surface of the soil. It is thought that these were locally derived from an igneous intrusion or were faulted into position. From observations on the river bed and the surrounding area, it is thought that this igneous section only occupies a small part of the whole area, meaning that this habitat can still be classed as "calcareous sediment." Unfortunately only a depth of 28cm could be cored due to the auger breaking. This problem was also incurred at Ifis and Hilaitetor.

The most common trees found in this habitat were *Calophyllum* sp. (Guttiferae), *Microcos ceramensis* (Tiliaceae), *Diospyros* sp. (Ebenaceae), *Saccopetalum* spp. (Annonaceae), *Gnetum gnemon* (Gnetaceae), *Myristica* spp. (Myristicaceae), *Vitex* spp. (Verbenaceae), *Canarium* spp. (Burseraceae), *Pygeum* sp. (Rosaceae), *Vatica papuana* (Dipterocarpaceae), *Litsea* sp. (Lauraceae), *Pimeleodendron amboinicum* (Euphorbiaceae), *Pometia* spp. (Sapindaceae), *Intsia* sp. (Caesalpiniaceae) and *Eugenia* sp. (Myrtaceae). The site had 872 saplings, the largest number at any site, and it also had the second highest number of trees present. The profile seems to have more overlapping tall trees than at Sungai Tolawi.

Soil profile for S. Dodaga

Depth (cm)	**Description**
4.5cm above	Decomposing leaf litter Few igneous intermediate fine crystalline stones Abundance <2%, 20cm long axis Dry
0	
	Dry soil 10YR 3/4 Dark yellowish brown loamy sand Very small subangular stoneless soil Massive compact soil Freely drained Non calcareous Many roots in upper layers
28	End of profile.

Transect 4: Vegetation profile of a 20x100m strip of forest on ultrabasics in the Sungai Dodaga region.



Sungai Ifis

The geology at Sungai Ifis is based on the Weda Group of Late Miocene age which is found along the north side of the north eastern arm. This outcrop area has recently been subdivided by Nichols and Hall (1991) into the Superak, Akelamo, Dufuk and Gola Formations. The Superak and Akelamo Formations were not visited, but studies were conducted on the Dufuk and Gola Formations.

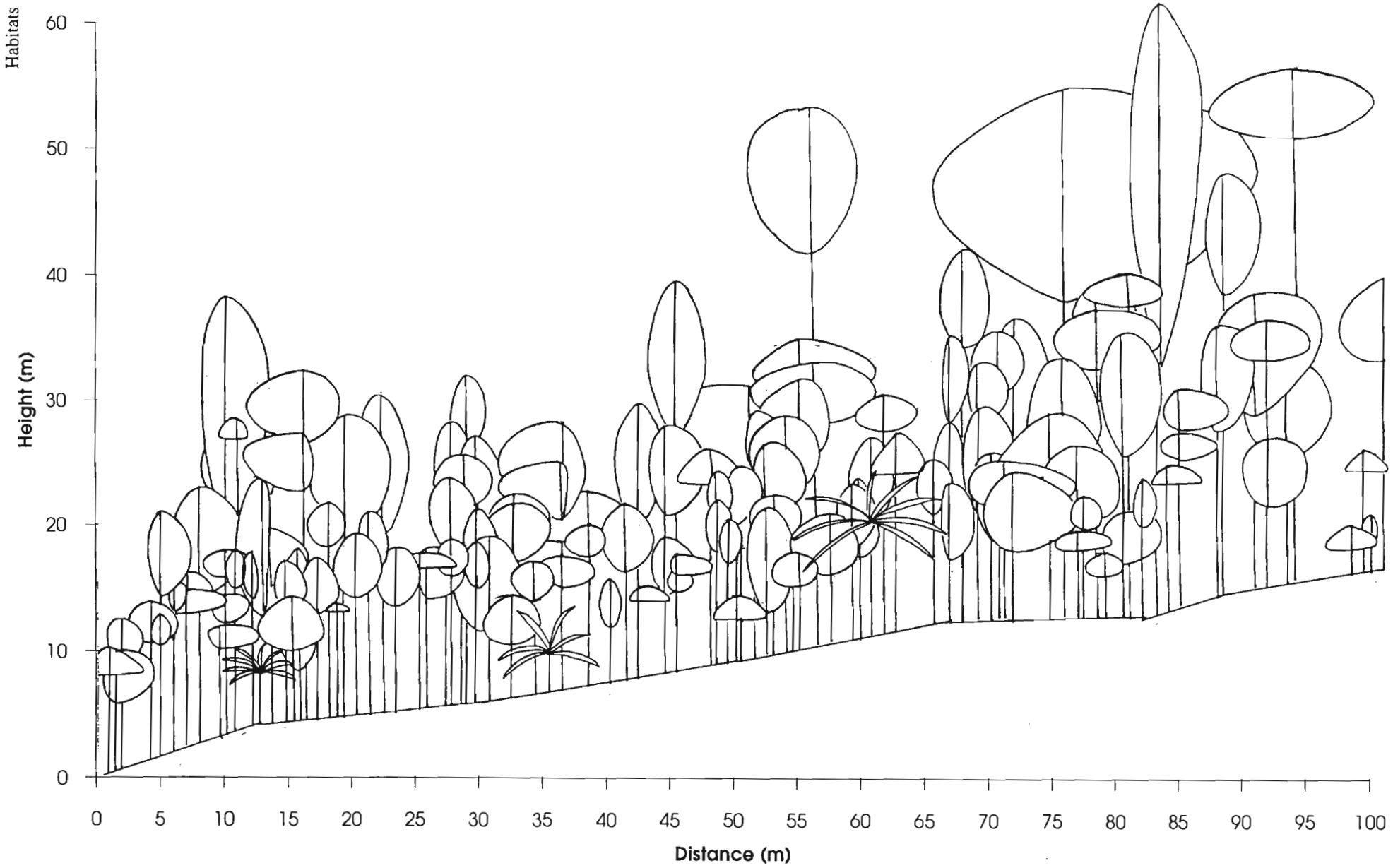
The Dufuk Formation is of sandstones and mudstones with rare conglomerate beds and is up to 1500m thick. Clast supported conglomerates occur mainly in the lower part of the sequence. They form beds less than a metre thick containing well sorted pebbles of volcanic rocks and intrafomational sandstones and mudstones in a sandy matrix. The principle lithology of the Gola Formation is a very pale grey calcareous mudstone with variable proportions of silt and clay in different beds. The formation is much thinner than the Dufuk Formation (only 300m has been seen and it was less extensive in the study area). The soil here had a high proportion of dead and decaying wood on the surface which was not observed to the same extent on the other profiles.

The following tree species were identified: *Coltis philippinensis* (Ulmaceae), *Notaphoebe* sp. (Lauraceae), *Sloaneae* sp. (Elaeocarpaceae), *Artocarpus incisus* (Moraceae), *Vitex quinata* (Verbenaceae), *Vatica papuana* (Dipterocarpaceae), *Canarium* spp. (Burseraceae), *Saccopetalum* sp. (Annonaceae), *Eugenia* sp. (Myrtaceae), *Laportea amplissima* (Urticaceae), *Calophyllum* sp. (Guttiferae), *Xylocarpus granatum* (Meliaceae), *Syzgium aromaticum* (Myrtaceae), *Pometia* spp. (Sapindaceae), *Wormia* sp. (Dilleniaceae), *Anisoptera costata* (Dipterocarpaceae), *Pimeleodendron amboinicum* (Euphorbiaceae) and *Microcos ceramensis* (Tiliaceae).

Soil profile for S. Ifis

Depth (cm)	**Description**
7cm above	Dry leaf litter with plenty of decaying wood.
0	
	Dry soil 10YR 4/4 dark yellowish brown loamy sand stoneless (<5%) Compact structure Non-calcareous (<0.5% Calcium carbonate)) Many small roots
13	Wavy boundary
	Dry soil 10YR 5/8 yellowish brown loamy sand with slightly more clay than above Slightly stony; angular small stones with a fine grained sandstone lithology Coarse subangular blocky peds Non-calcareous More moist soil with increasing depth
61	End of profile.

Transect 5: Vegetation profile of a 20x100m strip of forest on sandstone in the Sungai Ifis region.



Hilaitetor

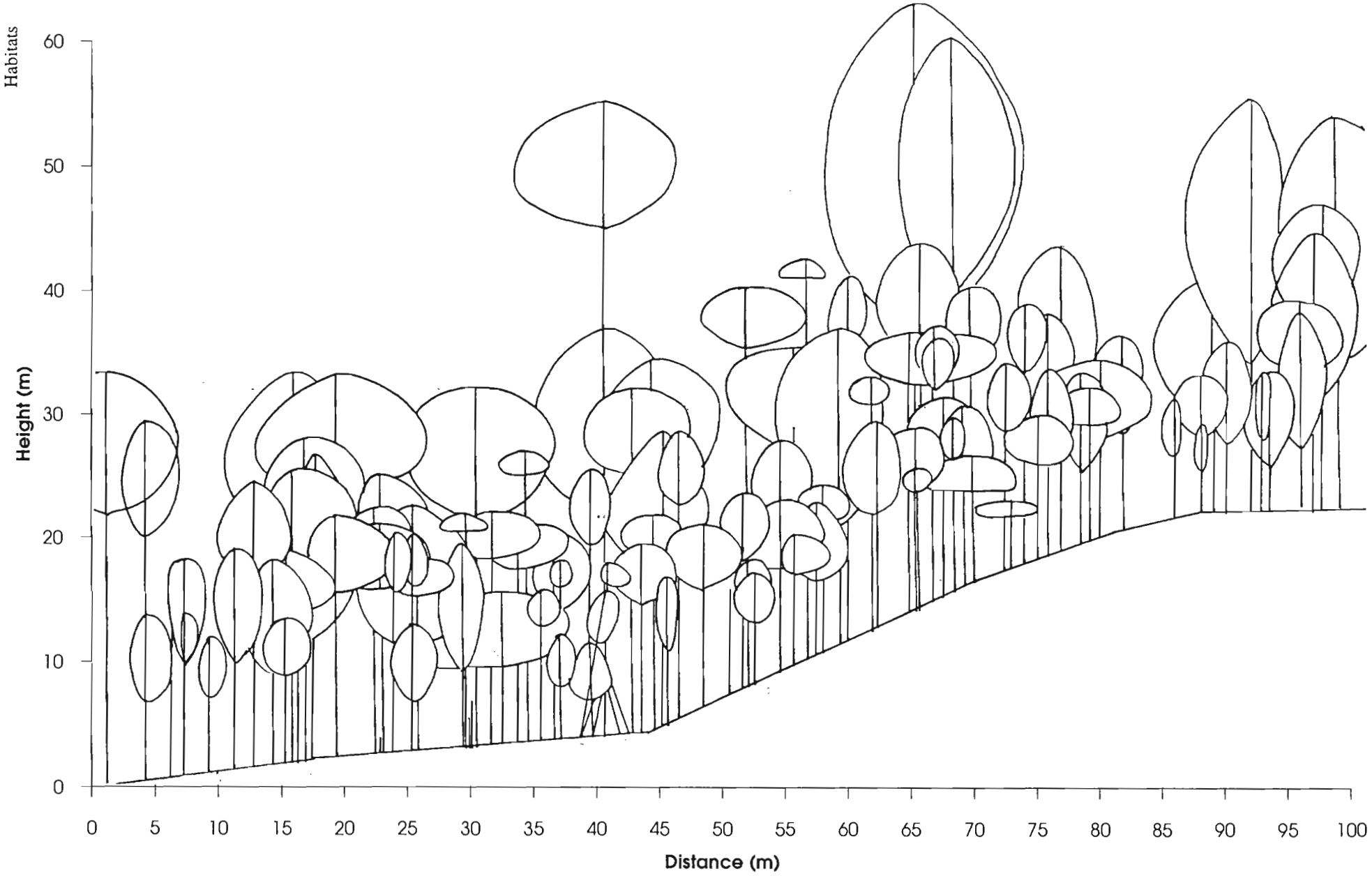
The site at Hilaitetor was on Quaternary reef limestone, marl and sandy limestone, which is the dominant rock type exposed on the coast north of Lolobata on the north east arm. Although based on Quaternary limestone, the soil showed no calcium carbonate content when tested with 2M HCl, even though the limestone was observed only 50m away in a river bed. This site had been subject to disturbance from logging activities. Some larger trees have obviously been removed, others have been left where they fell. This site had the lowest number of saplings found at any site.

Similar tree species to the S.Ifis site were recorded, they included: *Pometia* spp. (Sapindaceae), *Litsea* (Lauraceae), *Calophyllum* spp. (Guttiferae), *Canarium commune* (Burseraceae), *Vatica papuana* (Dipterocarpaceae), *Laportea amplissima* (Urticaceae), *Saccopetalum* sp. (Annonaceae), *Coltis philippinensis* (Ulmaceae), *Nauclea mitragyna* (Rubiaceae), *Pimeleodendron amboinicum* (Euphorbiaceae), *Myristica* sp. (Myristicaceae), *Anisoptera costata* (Dipterocarpaceae), *Eugenia* sp. (Myrtaceae), *Koordersiodendron pinnatum* (Anacardiaceae), *Cananga odorata* (Annonaceae), *Notaphoebe* sp. (Lauraceae), *Diospyros* sp. (Ebenaceae), *Cerbera* sp. (Apocynaceae), *Microcus ceramensis* (Tiliaceae), *Tristania* sp. (Myrtaceae), *Pygeum* sp. (Rosaceae) and *Anthocephalus macrophyllus* (Rubiaceae).

Soil profile for Hilaitetor

Depth (cm)	**Description**
4cm above	Dead dry leaf litter with much decaying wood
0	
	Slightly moist soil 10YR 4/4 dark yellowish brown loamy sand Slightly stony- very small subangular stones Coarse angular blocky peds- moderately friable Non-calcareous !!! (<0.5% calcium carbonate)
35	Clear boundary
	Slightly moist soil 7.5 YR 5/8 strong brown loamy sand slightly stony- small subangular basalt stones compact structureless soil Non-calcareous !!! (<0.5 calcium carbonate)
73	End of profile.

Transect 6: Vegetation profile of a 20x100m strip of disturbed forest on limestone in the Hilaitetor region.



As mentioned above, almost all records gathered at VCP stations are from bird vocalizations. To prepare the observers for VCP, one week was spent at the beginning of the expedition birdwatching in the nearby Wasile coconut plantations and gardens to familiarise the observers with the vocalizations of the bird species present. As the vegetation was less dense here, birds could be more easily found by sight once heard. Calls not heard then were learnt during the fieldwork, either by attempting to see a bird giving an unknown call or logging the call so that it could be identified later, upon further experience, or consultation with colleagues and field guides. Colour photographs of specimens of the endemic species were taken into the field. The following field guides were used on the expedition:

Beehler, B.M., Pratt, T.K. and Zimmerman, D.A. 1986. *Birds of New Guinea*
MacKinnon, J. and Phillipps, K. 1993. *A field guide to the Birds of Borneo, Sumatra, Java and Bali*
Simpson, K. and Day, N. 1994. *Field Guide to the Birds of Australia*
Hayman, P., Marchant, J and Prater, T. 1986. *Shorebirds An Identification Guide*
Harrison, P. 1985. *Seabirds An Identification Guide*

Estimating distances in metres was also practised extensively during the training week (and several weeks before the expedition in the UK by RF) to ensure as high a degree of accuracy as possible during the fieldwork period. Checks between the main observers revealed a high degree of consistency of distance estimation.

Six study sites were visited during the course of the expedition (see **map 4.1.1**), and transects were placed radially from each camp (of which there were more than one at three sites), with stations placed at least 400m apart to minimize the risk of counting individual birds at more than one station. This was necessary to make the stations independent for analysis. Distances between stations were initially measured accurately by pacing, and subsequently by knowledge of the time taken to walk an appropriate distance. Stations were often placed more than 400m apart, particularly where the transect followed a path in the forest, as walking speed was quicker. It was found that ten minutes walking time was usually sufficient to cover 400m.

Transects were usually conducted along paths cut at the time, which often necessitated a longer walking time, or along river courses or ridges. Where the latter two routes were employed, the stations were usually placed about 50m perpendicular to the linear feature to minimize any edge effects. Other transects were placed along existing paths in the forest, but these were usually so small as to have no edge effect.

All VCP survey work was carried out between 0630-0930 and 1630-1830. It was quickly established at the outset of the expedition that these times were when the birds were most active and vocal in the forest, so the number of birds would be maximized by surveying at these times.

Six study sites were visited between 30th July and 9th September 1994. The basic characteristics of the sites are listed in **table 4.2.1**.

4.2 AVIFAUNAL SURVEY

Report by Richard Fuller

Aims

To survey the avifauna found in the Lolobata proposed reserve in different habitat classes and produce density estimates and overall population estimates for the proposed reserve area. The status of the restricted range species found on Halmahera was also reviewed, elucidating their preferred habitats and possible future threats.

Methods

The technique used to survey the avifauna of the proposed Lolobata reserve area was Variable Circular Plot (VCP). This technique involves a series of point counts conducted along a predetermined transect line. It is the only reliable survey technique that has been developed for use in tropical forest (Bibby *et al.*, 1993). There is a series of assumptions associated with it; these are discussed later in the concluding section. In dense forest almost all birds are detected and identified only by their vocalizations, as few birds are ever seen well during VCP. In this study, over 90% of records were generated exclusively from bird sounds. This raises the need for training of observers to recognize the various bird sounds in the forest, which is discussed further below. The primary advantage of this method in a study of this type is that relatively large amounts of data can be generated whilst covering a large area in a reasonably short time. Also, analysis of the data gives rise to quantitative estimates of abundance.

The method generates density estimates for each species individually based on the detectability of that species. For instance, in terms of number of observations, at a given density a species that has a loud call will be detected more often at a station than a species with a quiet call. The method compensates for this by calculating a detection coefficient for each species separately. It is expected that the number of individuals of a given species detected will decline with distance from the observer. A point of inflection is calculated where the number of individuals detected begins to drop off sharply, and all records outside this point are rejected as many birds present were not detected. The records within the point of inflection are used to calculate the density estimate.

Each point along the transect is referred to as a station and the following information for every bird or group of birds seen or heard from the station in a ten minute recording period was noted:

1. Species
2. Number of individuals
3. Sex and Age (where possible to determine)
4. Distance from observer (in metres, usually to the nearest five metres)
5. Whether the bird was perched in a tree, on the ground or flying
6. Whether the bird remained approximately at the same distance from the observer for the entire recording period or moved a substantial distance.
7. Whether sight, sound or both was the method of detection/identification

Table 4.2.1. VCP survey locations

Survey site	Forest condition	Rock type	Dates	No. transects
1. Sungai Oketai	Primary	Ultrabasic	30/7-5/8	63
2. Sungai Tolawi	Primary	Limestone	7/8-12/8	72
3. Sungai Dodaga	Primary (some disturbed)	Limestone	23/8-28/8	96
4. Gunung Subaim	Primary Montane	Limestone	16/8-19/8	65
5. Hilaitetor	Logged	Reef Limestone	2-3/9, 7-9/9	84
6. Sungai Ifis	Primary/Logged	Non-calcareous	3/9-7/9	84

Data was entered onto standard recording forms and later analyzed by computer using the DISTANCE program (Laake *et al.*, 1994). The resulting density estimates were used to calculate approximate population figures for the entire reserve area in the following way.

The study sites surveyed during this expedition were grouped into four main categories based on underlying rock type and altitude:

Table 4.2.2. Habitat classification of each survey site as defined in this study.

Habitat category[1]	Representative sites
Forest on Limestone	Sungai Tolawi, Sungai Dodaga, Hilaitetor
Forest on non-calcareous sedimentary rock	Sungai Ifis
Forest on igneous rock	Sungai Oketai
Montane forest (>700mOD)	Gunung Subaim

Notes: 1. Refer to table **4.1.1** for more details.

The limits of these classes are shown on **map 4.1.2** and the areas of each forest type in four different proposals are shown in **table 4.1.2.** These figures were used to calculate population estimates for each of the different proposed reserve boundaries.

Annotated species list of restricted range species recorded during Halmahera '94

This section aims to provide a qualitative assessment of the status of the restricted-range species observed during the expedition. Following a brief summary of general abundance, any observations on grouping/display behaviour and feeding are presented along with our observed altitudinal range for the species. The most important forest types for each species are mentioned (density estimates in different forest types are presented in **table 4.2.3**). Potential threats to certain species are also discussed. Based on estimated densities, the total populations expected within each of the reserve sites (as defined in **table 4.1.2.**) are presented in **table 4.2.4.**

Moluccan Sparrowhawk *Accipiter henicogrammus*

Only four records of this forest goshawk, listed below:

1 adult	9/8 Sungai Tolawi in primary forest at 65mOD, mobbed by 2 Australian Crows *Corvus orru.*
2 adults	19/8 Gardens at Fayaul at 10mOD.
1 adult	9/9 Hilaitetor in logged forest at 100mOD.
1 adult	25/8 Sungai Dodaga in primary forest at 100mOD.

Observed numbers of this species were too low for analysis and little can be said regarding the safety or otherwise of the population.

Rufous-necked Sparrowhawk *Accipiter erythrauchen*

Only three records of this smaller forest sparrowhawk, listed below:

1 adult	28/7 Wasile coconut plantations at 20mOD.
1 adult	14/8 Gardens at Wasile at 20mOD.
1 adult	8/9 Hilaitetor in logged forest at 100mOD.

Like the preceding species, little can be said about the numbers of this species.

Dusky Scrubfowl *Megapodius freycinet*
Number of VCP records: 115
Estimated current Protection Forest population: **12300** (7600-20200)

Common species throughout. Found in all habitats from primary forest through logged forest to coconut plantations and gardens. Present in low density in montane forest. This species showed some tendency towards nocturnalism, being heard most frequently at night and near dawn and dusk. Many nest mounds were located, up to 40m² in area and 2m high. Although found at all sites, this species was very common at Sungai Dodaga where, ironically, collection of eggs from nest mounds is practised. Forest people living along the river collect eggs for consumption and sale at the nearby towns. Forest on sedimentary rock is the most important habitat for this species, with igneous and montane forest supporting few birds. Observed between 0-1040m OD.

Moluccan Scrubfowl *Megapodius wallacii*

Uncommon species. Seven records, including one juvenile bird at Sungai Tolawi. A low booming call heard once at Sungai Tolawi was identified by guides as an 'ayam hutan', which may relate to this species, but no calling individuals were located. Interestingly, all individuals were recorded on or near river banks, with the individual at Sungai Oketai showing a distinct preference for a particular site along the river bank. Observed numbers of this species were too low for analysis, but birds apparently favoured undisturbed forest as all records were from primary forest. All records <100m OD.

Scarlet-breasted Fruit Dove *Ptilinopus bernsteinii*
Number of VCP records: 73
Estimated current Protection Forest population: **17600** (10900-28700)

Mostly common, but very few in montane forest. Observed singly or in pairs, all records from the canopy. Found in all forest and agricultural habitats. Forest on both types of sedimentary rock was the most important habitat type for this species. Observed between 10-860m OD.

Blue-capped Fruit Dove *Ptilinopus monacha*
Number of VCP records: 43
Estimated current Protection Forest population: **8700** (4700-16000)

Mostly common, but very few in igneous and montane forest. Again only observed singly or in pairs. Found in all forest and agricultural habitats, also observed in mangrove swamps. Sedimentary forests were the only habitat types containing appreciable numbers of this species. An extension of known altitudinal range is reported here, with birds observed between 0-750m OD. The previous highest record was 250m (Lambert and Yong, 1989).

Grey-headed Fruit Dove *Ptilinopus hyogaster*
Number of VCP records: 105
Estimated current Protection Forest population: **12600** (7900-20800)

Mostly common, although apparently absent from Gunung Subaim. Commoner than *P. monacha* at all sites where found. Large flocks containing 20 or more feeding birds were recorded at Sungai Ifis and Hilaitetor, but at other sites, only singly or in pairs. Observed feeding on fig trees *Ficus spp* left after logging had passed by. Birds observed in flocks were found to call only rarely, presumably as a contact call is not needed when the birds flock. This low calling rate from flocking birds means that flocks may have been overlooked in dense habitat, as few fruit doves were actually seen in well forested areas. Although found in all forest and agricultural habitats, sedimentary forest was clearly the most important for this species. Observed between 0-130m OD.

White-eyed Imperial Pigeon *Ducula perspicillata*
Number of VCP records: 310
Estimated current Protection Forest population: **22100** (16900-29400)

Common at Sungai Ifis, Hilaitetor and Sungai Dodaga, where it was the commonest imperial pigeon, uncommon at Gunung Subaim, rare at Sungai Oketai and Sungai Tolawi.

An interesting distribution of records that has no obvious correlates with habitat parameters. However, overall densities indicate that limestone forest was most important for this species. Also common in coconut plantations and heavily disturbed forest. Observed most commonly in pairs. Also seen to roost in pairs, huddled close together. Both sexes call. Observed between 0-850m OD.

Cinnamon-bellied Imperial Pigeon *Ducula basilica*
Number of VCP records: 247
Estimated current Protection Forest population: **80600** (55300-117600)

Common at all study sites. Commonest imperial pigeon at Sungai Oketai, Sungai Tolawi and Gunung Subaim. Present in all forested and agricultural habitats. Very few records from gardens and coconut plantations, indicating that this is a primarily forest species, although still common in logged forest. As it was observed in the lowest forest visited, it is expected to occur down to sea level where the forest extends to the coast. A downwards extension of the known altitudinal range is reported here with birds observed between 30-1040m OD. Lambert (1987) found *D. basilica* down to 250m, but commoner at 800m+.

White Cockatoo *Cacatua alba*
Number of VCP records: 169
Estimated current Protection Forest population: **9300** (6200-14100)

Mostly common, but few in montane forest. A very vocal species, often heard from several hundred metres away, although occasionally seen flying silently particularly near dawn and dusk. Several communal roosts in hollow trees were located with up to 6 birds present. Limestone forest was the most important habitat for this species which was also quite common in agricultural habitats. One large flock was observed at Gunung Subaim that contained at least 16 feeding birds. However, most commonly observed in pairs. Observed in low numbers as a pet species, but as still common in plantations around villages, trapping pressure was presumably low. Birds are, however, more valuable when they have been trained to talk to which end they are often kept for 1-2 years in villages as 'pets'. Both sexes call.
Observed between 0-860m OD.

Violet-necked Lory *Eos squamata*
Number of VCP records: 135
Estimated current Protection Forest population: **112500** (71700-176900)

Common at Sungai Oketai, Ifis, Dodaga and Hilaitetor in forest, but absent from Gunung Subaim and uncommon at Sungai Tolawi. The first four sites had some degree of disturbance, and it may be that this species favoured disturbed forest with secondary growth. Indeed, this species was found to be abundant in coastal gardens and coconut plantations. The most important forest habitat for *E. squamata* was igneous forest. Observed singly rarely, most often in pairs or small flocks. The largest flock recorded was of 32 birds in coconut plantations at Wasile. Both sexes call. Almost all records of this species derive from flying birds, and as this compromises the independence of stations, the results must be treated with caution. On top of this, it is impossible to discern how many birds comprise a flying flock by sound alone.
Observed between 0-160m OD.

Moluccan Hanging Parrot *Loriculus amabilis*

Only a few records of what could be a commoner species. Not heard to call and may be partly crepuscular (White and Bruce, 1986). Sight records from Sungai Oketai and logged forest at Hilaitetor. As most of the fieldwork was carried out in dense forest, it is not surprising that an inconspicuous species such as this was rarely recorded, hence little can be inferred about its population status.

Chattering Lory *Lorius garrulus*
Number of VCP records: 221
Estimated current Protection Forest population: **52500** (39600-69900)

Frequent to uncommon at Sungai Oketai and Sungai Dodaga, common at Sungai Tolawi, Sungai Ifis and Hilaitetor while abundant at Gunung Subaim. The distribution may correlate negatively with proximity to centres of human population. This species was found to be very rare in gardens and coconut plantations, perhaps due to extensive capturing of birds as pets and for the parrot trade. Chattering Lory was a commonly observed 'pet' species, with every village visited containing many birds. This species, like *C. alba* is also kept for training purposes before export from the island. It appears that capture of wild birds may represent a serious threat to this species in the areas visited. At Gunung Subaim where few people regularly visit, and then only to hunt pig, *L. garrulus* was a common species, always occurring in pairs or larger flocks (maximum, 8). Density estimates indicate that montane forest was clearly the most important habitat for this species, but we were unable to determine whether the density differences were due to altitudinal effects or a lack of hunters at this site.

This is a highly mobile species, therefore not ideally suited to the VCP technique. Perhaps absolute densities may be over-estimated here, but the qualitative description of relative abundance still holds. Apparently, the sexes are distinguishable in the field by voice, the female only giving a single type of call, whilst the male's repertoire is much larger with all kinds of chattering calls given. A clarification of known altitudinal range is presented here, with records between 20-1040m OD. White and Bruce (1986) state that *L. garrulus* is found in coastal lowlands.

Giant Coucal *Centropus goliath*
Number of VCP records: 117
Estimated current Protection Forest population: **10300** (6400-16700)

Common in most forest habitats except montane. Almost always observed in pairs or small groups, the groups usually containing two adults and one or more juvenile birds distinguished by their creamy white head. Also observed in cultivated habitats, where less common. Sedimentary forests were the preferred habitat of this species. In agricultural areas we found three groups of *C. goliath* feathers on separate occasions. We suspect that the large size and 'clumsiness' of this species makes it a prime target for catapulting. Both sexes call, as well as juveniles, with a surprising variety. Observed between 0-380m OD.

Moluccan Hawk Owl *Ninox connivens*

Uncommon. Heard on a few occasions in primary and logged forest. Most records from river sides. Fieldwork was not conducted at night to survey nocturnal species. Observed between 0-100m OD.

Halmahera Owlet Nightjar *Aegotheles crinifrons*

Common in more open habitats *i.e.* logged and secondary forest and agricultural areas. Clearings and large rivers through primary forest also provided suitable habitat for this species. Observed between 0-160m OD.

Blue-and-white Kingfisher *Halcyon diops*

Common in gardens and coconut plantations. Also observed in logged and secondary forest and occasionally in primary forest. Almost always in pairs or threes. If this species was common in primary forest, its distinctive call, which is given regularly would have made detection easy. Both sexes call. Too few records were obtained to enable the calculation of density estimates. Observed between 0-150m OD.

Sombre Kingfisher *Halcyon funebris*

Not a commonly observed forest species. At Sungai Dodaga, more common than any other site, as the open forest at this site allowed visual detection of this species which would often sit very still on a low branch for extended periods without calling. Observed more frequently in cultivated habitats, but not very common. Its distinctive call was heard several times, but the elusive habits of this species meant that under-observation definitely occurred. One bird was observed at Sungai Dodaga with a dead snake in its bill. Not enough VCP records were gathered to make any confident statements regarding general population levels. Observed between 30-620m OD.

Azure Roller *Eurystomus azureus*

An uncommon species with records from all forest types, where observed in pairs and threes, the latter usually containing a juvenile bird. Apparently absent from cultivated areas where Broad-billed Roller *E. orientalis* was commoner. Observed between 35-160m OD.

Ivory-breasted Pitta *Pitta maxima*
Number of VCP records: 238
Estimated current Protection Forest population: **14300** (9100-22500)

A very common species, with its loud and distinctive call being within earshot almost all the time, although particularly vocal at dawn and dusk. Records from all forest types and cultivated areas, although most common in limestone forest. The distribution of this species is perhaps further dictated by the presence of areas (often along the tops of ridges) with a substantial area of open, leaf-covered forest floor, where groups seemed to congregate calling to each other. During extended observations of such flocks, it became apparent that certain individuals failed to call, perhaps suggesting that female birds do not call, at least

when in a group. Observed between 0-650m OD, replaced on Gunung Subaim by *P. erythrogaster*.

Moluccan Cuckoo Shrike *Coracina atriceps*
Number of VCP records: 59
Estimated current Protection Forest population: **8200** (5000-13400)

The commonest cuckoo shrike in all forested habitats, largely replaced by *C. papuensis* in coastal cultivated areas. Commonest in sedimentary forest types, but nowhere an abundant species. Often observed in pairs or threes, readily picked out by its loud and distinctive call. Observed between 30-1040m OD.

Halmahera Cuckoo Shrike *Coracina parvula*
Number of VCP records: 10
Estimated current Protection Forest population: **8900** (3100-25200)

Absent from most sites, although common at Gunung Subaim (the only site generating VCP records), and a few records at Hilaitetor, indicating that this may be a primarily montane species as suggested by White and Bruce (1986). An extension of the known altitudinal range for this species is presented here, with observations between 150-900m. The previous known range was 250-500m (Lambert and Yong, 1989).

Rufous-bellied Triller *Lalage aurea*
Number of VCP records: 19
Estimated current Protection Forest population: **13100** (6100-28100)

Common in open habitats *i.e.* secondary forest and cultivated areas with a few records from primary forest, particularly along large rivers. Observed mostly in pairs or small groups (maximum, 5). This habitual grouping contributes to large errors in the population estimate, and little can be concluded except that sedimentary forest types seem to be preferred. Observed between 0-150m OD.

Dusky-brown Oriole *Oriolus phaeochromus*

Found to be uncommon in forested habitats and cultivated areas. Insufficient records were obtained to calculate population levels. Observed between 20-150m OD.

Long-billed Crow *Corvus validus*

Found to be less common than Australian Crow *Corvus orru*, but present at all forested sites and cultivated areas, particularly coconut plantations. Almost always observed in pairs. Both sexes call. Observed between 0-380m OD.

Paradise Crow *Lycocorax pyrrhopterus*
Number of VCP records: 94
Estimated current Protection Forest population: **28800** (17300-48300)

Common at all sites except Sungai Oketai, also found in cultivated areas, particularly coconut plantations where almost always seen in groups (usually about 4-5 birds). The VCP

result will almost certainly be an under-estimate as often only one bird in a group would call at a time, making it impossible to estimate group size, or even establish that a group was present by sound alone. Both sexes call. Montane forest was the preferred habitat of this species. Observed between 0-1040m OD.

Wallace's Standard Wing *Semioptera wallacii*
Number of VCP records: 94
Estimated current Protection Forest population: **15200** (8000-29800)

Present at all sites, but rare at Sungai Oketai, which is forest on ultrabasic rocks. This species appears restricted to forest, as we have no records from non-forest habitats. *S.wallacii* was common in areas of limestone karst where the forest had a preponderance of low trees with a few towering emergents. Several display sites were located on and around such emergent trees, with males displaying singly and in single sex groups to attract females. Density-dependent factors leading to lekking may also operate in limestone forest, which may be attractive to *S. wallacii* for other reasons than display sites.

Again, it is almost certain that VCP will under-estimate the density of this species as it was found that a long period of searching was necessary to locate all birds in a loose standard wing flock. This was because birds often sat quietly for extended periods. Both sexes call with the same frequency. Observed feeding on the outer flesh of small nutmeg-like *Myristicta spp*. Observed between 35-1010m OD.

Slaty Monarch *Myiagra galatea*
Number of VCP records: 70
Estimated current Protection Forest population: **19000** (13000-27800)

Common species of all forest habitats, although interestingly, rare at Sungai Oketai and absent from Sungai Tolawi. Found to be commonest at the logged forest in the Nusa Padma concession (Sungai Ifis and Hilaitetor). This species appears to prefer open forest and edge habitats, as there are few records from the forest interior, although seen deep in primary forest along large river edges and more open ridges. Both sexes call. Observed commonly in pairs and small flocks.
Observed below 150m OD.

White-naped Monarch *Monarcha pileatus*

Interestingly, the distribution of this species seemed to mirror that of *Myiagra galatea*, perhaps indicating similar habitat preferences, although *Monarcha pileatus* was only observed in logged forest and forest edges, most often in small groups. Single sex flocks appeared to be the norm for this species, with more female flocks apparent than male flocks. Both sexes call. That this species occurs in large but widely spaced groups made density estimates too inaccurate. Observed below 150m OD.

White-streaked Friarbird *Melitograis gilolensis*

A fairly common, but inconspicuous species, with a quiet call, hence not enough VCP records to generate a density estimate. Observed in all forest habitats and cultivated areas, particularly coconut plantations. Also found in coastal mangroves where observed feeding

with Dusky Honeyeater *Lichmera obscura* on two occasions. Mostly seen in pairs or small groups, with one adult observed feeding another adult at Sungai Oketai, on flowers of the wild banana, *Musa* sp. Observed 20-960mOD.

Dusky Friarbird *Philemon fuscicapillus*

Only three records, two from Sungai Tolawi in primary forest and one from Hilaitetor in logged forest, but could be a commoner species as it appeared inconspicuous. Observed below 120m OD.

Flame-breasted Flowerpecker *Dicaeum erythrothorax*

Common in cultivated habitats, but also found in open forest and primary forest edges along rivers. Not recorded frequently during VCP as largely detected visually and in forest, a canopy species. Usually found in pairs and small groups, further complicating the accurate calculation of density estimates. Observed below 150m OD.

Moluccan White-eye *Zosterops atriceps*
Number of VCP records: 13
Estimated current Protection Forest population: **4800** (2500-9200)

Again, common in secondary forest and cultivated habitats with relatively few records from the primary forest interior. Always observed in groups feeding in the canopy, and as such an unsuitable species for VCP. Observed below 150m OD.

Top: A local hunter prepares for a trip.

Bottom: Gunung Subaim, the highest peak on Halmahera.

Top: A hunter's shelter built several hours away from the nearest village.

Bottom: Forest clearing for coconut plantations near the coast at Wasile.

Above: Birds collected from Halmahera on sale in Ternate.

Left: *Pitta maxima*.

Below: Secondary regrowth of the forest along an old logging road across S. Tolawi.

Local names for bird species

Bahasa Tobelo is spoken by most of the older inhabitants of the area around Wasile Bay, and is taught to many of the children in most villages. Names were collected from as large a variety of sources as possible, that is a large number of people and using different prompts, *e.g.* sightings in the field, photographs of specimens and plates in field guides. A surprising range of names was received for some species, and all are listed in table **4.2.7** with details of the sources.

Habitat preferences of restricted-range species

Density estimates for each species in the different forest types as outlined above are presented in **table 4.2.3**. Forest on limestone and forest on non-calcareous sediments appear to support the largest proportions of restricted-range species and at higher densities than the other forest types. Montane and igneous forest habitats both support restricted-range species (*e.g.* Halmahera Cuckoo Shrike *Coracina parvula* and Violet-necked Lory *Eos squamata* respectively) only found in much lower densities in other forest types.

So, while the sedimentary forest types provide sheer numbers of birds and thus should be given a high priority when deciding which forest to include in a new reserve, other forest types should also be included to boost the overall number of protected species. Density estimates for other species are presented in **table 4.2.5**.

Population estimates for restricted-range species

Using the habitat classification described above, the density estimates have been converted into population estimates which are presented in **table 4.2.4**. These quantitative data can be used to evaluate different proposals for the new reserve boundary. While the primary aim of a new reserve should be to protect as large an area as possible, these data may help to discriminate between proposals for reserves of similar sizes. Population data for non restricted-range species are presented in **table 4.2.6**.

Table 4.2.3 Density estimates of restricted-range bird species as calculated from VCP results.

Species		Limestone Forest	Non-calcareous Forest	Igneous Forest	Montane Forest	n
Dusky Scrub Fowl	/Ha	**0.21830**	**0.23679**	**0.04706**		
Megapodius freycinet	Min[1]	0.14884	0.1475	0.01905	F[2]	
	Max	0.32019	0.38014	0.11624		
No. of records	(n)	81	28	6	n/a[3]	115
Scarlet-breasted Fruit Dove		**0.23081**	**0.34226**	**0.10882**		
Ptilinopus bernsteinii		0.16806	0.21399	0.04948	A[4]	
		0.31698	0.54741	0.23930		
		47	20	6	n/a	73
Blue-capped Fruit Dove		**0.15106**	**0.15412**			
P. monacha		0.07668	0.07832	F	F	
		0.29758	0.30328			
		30	13	n/a	n/a	43
Grey-headed Fruit Dove		**0.27539**	**0.18952**			
P. hyogaster		0.21380	0.11384	F	A	
		0.35472	0.31552			
		74	24	n/a	7	105
White-eyed Imperial Pigeon		**0.46654**	**0.39439**		**0.051005**	
Ducula perspicillata		0.34990	0.31596	F	0.026306	
		0.62204	0.49228		0.098894	
		203	96	n/a	11	310
Cinammon-bellied Imperial Pigeon		**0.50987**	**1.0186**	**0.39995**	**0.78571**	
D. basilica		0.34708	0.7200	0.24893	0.53384	
		0.74903	1.4410	0.64258	1.15640	
		108	74	22	43	247
White Cockatoo		**0.21688**	**0.14574**	**0.06540**		
Cacatua alba		0.15764	0.09630	0.03704	F	
		0.29840	0.22056	0.11549		
		123	31	15	n/a	169
Violet-necked Lory		**1.45730**	**0.99758**	**2.8934**		
Eos squamata		0.88538	0.60857	1.9195	F	
		2.39860	1.63530	4.3616		
		42	28	65	n/a	135
Chattering Lory		**0.26582**	**0.25657**		**1.0765**	
Lorius garrulus		0.18811	0.17544	F	0.8330	
		0.37563	0.37522		1.3921	
		91	43	n/a	87	221
Giant Coucal		**0.15250**	**0.18131**	**0.08898**		
Centropus goliath		0.10661	0.11614	0.04362	F	
		0.21814	0.28305	0.18150		
		70	34	13	n/a	117
Ivory-breasted Pitta		**0.36166**	**0.17319**	**0.17139**		
Pitta maxima		0.25948	0.10455	0.10207	A	
		0.50408	0.28690	0.28779		

	112	73	53	n/a	238
Moluccan Cuckoo Shrike *Coracina atriceps*	**0.22498** 0.16262 0.31126	**0.14689** 0.08252 0.26146	F	F	
	44	15	n/a	n/a	59
Halmahera Cuckoo Shrike *Coracina parvula*	F	F	A	**0.24030** 0.08493 0.67988	
	n/a	n/a	n/a	10	10
Rufous-bellied Triller *Lalage aurea*	**0.17184** 0.07177 0.41143	**0.30093** 0.14388 0.62941	F	A	
	7	12	n/a	n/a	19
Paradise Crow *Lycocorax pyrrhopterus*	**0.15212** 0.11066 0.20912	**0.21504** 0.11664 0.39644	F	**0.51542** 0.31456 0.84453	
	48	17	n/a	29	94
Wallace's Standard Wing *Semioptera wallacii*	**0.30188** 0.20410 0.44653	**0.23851** 0.11852 0.47996	F	**0.073074** 0.029336 0.182020	
	66	22	n/a	6	94
Slaty Monarch *Myiagra galatea*	**0.19662** 0.12750 0.30322	**0.45243** 0.31140 0.65733	F	A	
	39	31	n/a	n/a	70
Creamy-throated White-eye *Zosterops atriceps*	**0.38401** 0.19938 0.73962	F	F	A	
	13	n/a	n/a	n/a	13

Notes: 1. Minimum and maximum densities are given by the 95% confidence limits.
2. F: too few records to allow analysis with DISTANCE
3. n/a: not applicable
4. A: species not recorded from this habitat type.

Table 4.2.4 Population estimates of restricted-range bird species as calculated from VCP results

Species	FAO, 1981c	RePPPROT, 1988	PHPA, 1993	Existing Protection Forest
Dusky Scrub Fowl	**17500**	**15400**	**37200**	**12300**
Megapodius freycinet Min[1]	10900	9500	32100	7600
Max	28700	25700	60900	20200
Scarlet-breasted Fruit Dove	**24300**	**22200**	**52700**	**17600**
Ptilinopus bernsteinii	15200	13600	32800	10900
	39600	36900	86000	28700
Blue-capped Fruit Dove	**13300**	**10900**	**26700**	**8700**
P. monacha	7600	6100	14700	4700
	23600	19700	48800	16000
Grey-headed Fruit Dove	**17200**	**14600**	**33900**	**12600**
P. hyogaster	11500	9500	22100	7900
	26400	23000	53200	20800
White-eyed Imperial Pigeon	**30800**	**26100**	**63400**	**22100**
Ducula perspicillata	23600	20000	49300	16900
	40400	34300	82000	29400
Cinammon-bellied Imperial Pigeon	**90000**	**87400**	**182200**	**80600**
D. basilica	61500	59600	125500	55300
	131800	128300	265100	117600
White Cockatoo	**14400**	**12500**	**28500**	**9300**
Cacatua alba	9700	8300	19000	6200
	21500	18900	42900	14000
Violet-necked Lory	**180800**	**177700**	**339400**	**112500**
Eos squamata	115400	114200	216000	71700
	283700	277100	534000	176900
Chattering Lory	**45500**	**45500**	**77200**	**52500**
Lorius garrulus	33800	33900	56600	39600
	61600	61100	105900	69900
Giant Coucal	**14800**	**13500**	**31000**	**10300**
Centropus goliath	9300	8300	19400	6400
	24000	22300	50100	16700
Ivory-breasted Pitta	**23200**	**20400**	**43700**	**14300**
Pitta maxima	15200	13100	28000	9100
	35900	32100	68700	22500
Moluccan Cuckoo Shrike	**12400**	**10200**	**25000**	**8200**
Coracina atriceps	8000	6400	15600	5000
	19600	16400	40900	13400
Halmahera Cuckoo Shrike	**6100**	**6700**	**8700**	**8900**
Coracina parvula	2200	2400	3100	3100
	17300	19000	24400	25200
Rufous-bellied Triller	**17200**	**15200**	**39300**	**13100**
Lalage aurea	8000	7100	18400	6100
	37500	32900	84400	28100

Paradise Crow *Lycocorax pyrrhopterus*	**26300** 16000 43800	**25900** 15600 43400	**47900** 28400 81500	**28800** 17300 48300
Wallace's Standard Wing *Semioptera wallacii*	**20200** 11400 37000	**17400** 9500 32800	**40700** 22200 76400	**15200** 8000 29900
Slaty Monarch *Myiagra galatea*	**24200** 16400 35600	**21700** 14800 31900	**56600** 38600 82900	**19000** 13000 27800
Creamy-throated White-eye *Zosterops atriceps*	**11000** 5700 21100	**7500** 3900 14400	**16000** 8300 30700	**4800** 2500 9200

Notes: 1. Minimum and maximum populations indicate the 95% confidence limits.

Assumptions and limitations of Variable Circular Plot

Caution must be taken when interpreting the results presented here as there is a series of assumptions associated with VCP, summarized below. Every effort was made in the field to limit violations of these assumptions. Note that assumptions 1, 2 and 3 are consequences of the VCP methodology whilst the final four assumptions are concerned with the accuracy of the calculated density estimates.

1.All birds at the observer are detected

In tall tropical forest, the canopy can be high above the observer (in the present study the tallest tree recorded was 60m). Consequently, even birds at distance=0 can be a long way from the observer. This is a problem that cannot really be overcome, but rarely was the canopy consistently very high in the forest we surveyed (see **section 4.1**), so this assumption should not present too much of a problem.

2.All birds are detected at their initial location

This assumption clearly presents a serious problem. During the VCP, observers noted whether a bird moved any distance during the recording period, and it was found that amongst most non-flying records, few birds moved a substantial distance. Flying birds may clearly jeopardize the independence of different stations as well as records within one station . For some species *e.g. Eos squamata*, almost all the records are of flying birds, so VCP is not a suitable technique for them. However, flying records made up only a small proportion of almost all species. The observer must use discretion when deciding which calls come from "new" individuals and which from birds that have moved since last heard. In practice, this was found to be easier than may be expected.

3.Observers have equal acuity and accurate distance estimation and identification skills

As mentioned in the methods, a one week training period was carried out at the start of the expedition to prepare the observers for VCP. Observers were trained in distance estimation

and identifying bird vocalizations. Throughout the expedition, checks were made to ensure a consistent standard of data collection.

4.All individual birds call with equal likelihood

This is a reasonable assumption, except in the few cases where female birds apparently call less frequently than males. This may have been the case in *Pachycephala pectoralis* and *Pitta maxima*, but it is not thought to be widespread.

5.Birds are distributed at an even density

This assumption presents a problem when considering flocking species such as *Z. atriceps* or even loosely associating species such as *Semioptera wallacii* and *Lalage aurea*. Where this is likely to present a problem, a comment has been made in the annotated list above.

6.Individual birds are recorded only once

Every effort was made to avoid double counts at and between stations. If birds were heard from a previous station, further distance was walked to minimize double counts.

7.The physical characteristics of the environment make survey conditions uniform

Factors such as canopy cover, density of vegetation and topography of the ground can affect the potential for seeing or hearing birds at a station. It is expected that factors such as these would even out over a large sample size. When rain fell, which usually had the effect of causing birds to seek shelter and create noise reducing detectability, VCP was temporarily halted and continued when the rain stopped. The same applies when loud insects were calling near a station, making it difficult to hear distant bird vocalizations. In particularly bad cases, stations were abandoned in favour of a quieter spot further along the transect.

Advantages of VCP

1.Data generated can be used to evaluate habitat preferences of bird species.

2.The method is quantitative, resulting in a series of density estimates, albeit with large standard errors which are inevitable in a study of this duration.

3.In tropical forest, the environment is more reliably surveyed than with line transects, as a long period of time is spent stationary, when it is possible to hear very distant birds, and pay close attention to unfamiliar calls. This is especially important where the observers have a relatively limited previous experience of the species involved.

Conclusions

Ornithologically, this expedition has shown that the proposed Lolobata Wildlife reserve supports substantial numbers of many restricted-range bird species, and as such deserves full protection. It has been shown that the most important habitat for bird species in terms of

density is forest growing on a limestone substrate. Any new reserve should therefore contain a substantial amount of this type of forest. However, other habitats such as montane and igneous forest must also be included to protect as wide a range of species as possible. Moreover any new reserve should be as large as possible as this seems to be the major factor affecting avian populations.

Some species, particularly Chattering Lory *Lorius garrulus* and White Cockatoo *Cacatua alba* survive in fairly large numbers up to the present, but appear to be under threat from the parrot trade. Steps need to be taken to establish exactly how these species are threatened and the numbers of birds being taken off the island. Of particular importance is a detailed study of the export of parrots from Halmahera. A systematic watch of ports of exit from Halmahera needs to be instigated to record the actual export of parrots from the island. The ability of parrot populations to sustain such a trade should also be investigated.

Many restricted-range species seem to be present in good numbers on the north-east peninsula of Halmahera. Much of the land on the northern peninsula of the island has been disturbed, presumably with serious consequences for the endemic birdlife.The possible effects of logging need to be looked into urgently as most of the proposed reserve area is under actual or imminent threat from logging. Most of the logging we observed in progress on the north east peninsula was being carried out in a selective manner with substantial replanting (albeit of non-native species) along old logging tracks. While perhaps not as severe as clear-felling, logging of this nature must have some effects on avian and other populations in Halmahera.

Two endemic species were not recorded during the expedition, Invisible Rail *Habroptila wallacii* and Moluccan Cuckoo *Cacomantis heinrichi*. Although there are recent records of both species, their status must remain uncertain. Only a limited amount of time was spent in the apparent preferred habitat for each of these species (sago swamp and high montane forest respectively) and a more specific future study could examine these habitats more closely to elucidate the status of these species.

More specific studies in the future could concentrate on individual species and take a more holistic approach to the study of them. In this study, the primary aim was to generate population estimates to help select the optimal conservation macrostrategy. This aim necessitated a general study, with insufficient time to study any one species in great detail. Further in-depth study of high profile and apparently threatened species would refine particular conservation needs and help to direct resources to where they are most needed.

Table 4.2.5. Density estimates of non restricted-range bird species as calculated from VCP results

Species	Limestone Forest	Non-calcareous Forest	Igneous Forest	Montane Forest	Total n
Slender-bill Cuckoo Dove /Ha	**0.28386**	**0.47747**		**0.078883**	
Macropygia Min[1]	0.20988	0.34820	F[2]	0.035243	
amboinensis Max	0.38392	0.65473		0.17656	
No. records (n)	91	54	n/a[3]	7	152
Pied Imperial Pigeon	**0.15582**	**0.10241**		**0.17173**	
Ducula bicolor	0.096347	0.054053	F	0.097934	
	0.25201	0.19404		0.30112	
	42	17	n/a	22	81
Red-flanked Lorikeet	**0.30432**			**0.85531**	
Charmosyna placentis	0.13707	F	F	0.21073	
	0.67566			3.4715	
	39	n/a	n/a	20	59
Red-cheeked Parrot	**0.80313**	**0.80011**	**0.098347**	**0.17201**	
Geoffroyus geoffroyi	0.64278	0.62692	0.054209	0.11003	
	1.0035	1.0211	0.17842	0.26889	
	326	131	16	19	492
Eclectus Parrot	**0.14212**	**0.14082**	**0.1273**		
Eclectus roratus	0.097236	0.083032	0.073938	A[4]	
	0.20773	0.32883	0.21918		
	72	27	21		120
Great-billed Parrot	**0.44219**	**0.065709**	**0.22075**		
Tanygnathus	0.23968	0.024571	0.10238	A	
megalorhynchus	0.81581	0.17572	0.47597		
	41	7	18		66
Blyth's Hornbill	**0.81146**	**0.91218**	**0.46507**	**0.13298**	
Rhyticeros plicatus	0.66113	0.68331	0.3122	0.05995	
	0.99596	1.2177	0.69279	0.29499	
	220	74	42	7	343
Golden Bulbul	**2.4064**	**1.3639**	**1.5303**	**1.8304**	
Ixos affinis	0.90321	0.75276	0.72666	0.84876	
	6.4115	2.4712	3.2229	3.9473	
	43	18	11	9	81
Spangled Drongo	**0.80502**	**0.8005**	**0.31019**	**0.75476**	
Dicrurus bracteatus	0.69798	0.60113	0.19957	0.56045	
	0.9284	1.066	0.48213	1.0164	
	260	98	28	69	455
Australian Crow	**1.8454**	**0.37156**	**0.22915**	**0.14829**	
Corvus orru	1.241	0.23785	0.104	0.071821	
	2.7441	0.58044	0.50489	0.30617	
	65	30	12	9	116
Island Leaf Warbler				**1.3076**	
Phylloscopus	A	A	A	0.75901	
poliocephalus				2.2528	

	n/a	n/a	n/a	27	27
Shining Monarch *Myiagra alecto*	**0.069808** 0.039798 0.12245	**0.11763** 0.04394 0.31488	F	A	
	19	10	n/a	n/a	29
Spectacled Monarch *Monarcha trivirgatus*	**0.50875** 0.31632 0.81825	**0.24586** 0.13795 0.4382	F	F	
	27	15	n/a	n/a	42
Golden Whistler *Pachycephala pectoralis*	**0.13748** 0.094408 0.20022	**0.24567** 0.17028 0.35444	**0.13161** 0.076103 0.2276	**0.09807** 0.052722 0.18242	
	48	36	15	11	110
Shining Starling *Aplonis metallica*	**1.3202** 0.18363 9.4922	F	**1.6013** 0.27048 9.4803	F	
	8	n/a	6	n/a	14
Black Sunbird *Nectarinia aspasia*	**2.9151** 2.0845 4.0766	**5.8101** 3.9539 8.5377	**4.4111** 2.8421 6.8463	**4.4007** 2.995 6.466	

Notes: 1. Minimum and maximum densities are given by the 95% confidence limits.
2. F: too few records to allow analysis with DISTANCE
3. n/a: not applicable
4. A: species not recorded from this habitat type.

Table 4.2.6. Population estimates of non restricted-range bird species as calculated from VCP results

Species		FAO, 1981c	RePPPROT, 1988	PHPA, 1993	Existing Protection Forest
Slender-billed Cuckoo Dove	n	**24700**	**21400**	**31500**	**12900**
Macropygia	Min[1]	17700	15300	22500	9200
amboinensis	Max	35200	30400	44800	18400
Pied Imperial Pigeon		**12900**	**11100**	**16400**	**6700**
Ducula bicolor		7600	6500	9700	4000
		22000	19000	28000	11500
Red-flanked Lorikeet		**32200**	**27800**	**41000**	**16800**
Charmosyna placentis		10700	9200	13600	5600
		106100	91600	135000	55500
Red-cheeked Parrot		**58900**	**50900**	**75000**	**30800**
Geoffroyus geoffroyi		45700	39500	58100	23900
		76500	66000	97300	40000
Eclectus Parrot		**12200**	**10500**	**15500**	**6400**
Eclectus roratus		7700	6700	9800	4000
		21200	18300	27000	11100
Great-billed Parrot		**25800**	**22200**	**32800**	**13500**
Tanygnathus		13300	11500	17000	7000
megalorhynchus		50200	43400	64000	26300
Blyth's Hornbill		**69000**	**59500**	**87700**	**36000**
Rhyticeros plicatus		52300	45200	66600	27300
		92300	79800	117500	48300
Golden Bulbul		**209800**	**181200**	**267000**	**109700**
Ixos affinis		91000	78600	115800	47500
		494200	426800	629000	258300
Spangled Drongo		**41000**	**35400**	**52200**	**21500**
Dicrurus bracteatus		30000	25900	38100	15700
		56400	48700	71800	29500
Australian Crow		**97700**	**84400**	**124300**	**51100**
Corvus orru		63700	55000	81100	33300
		151400	130700	192600	79100
Island Leaf Warbler		**28800**	**24800**	**36600**	**15000**
Phylloscopus		16700	14400	21300	8700
poliocephalus		49600	42800	63100	25900
Shining Monarch		**5700**	**4900**	**7200**	**3000**
Myiagra alecto		2700	2300	3500	1400
		12300	10600	15700	6400
Spectacled Monarch		**27800**	**24000**	**35400**	**14500**
Monarcha trivirgatus		17000	14600	21600	8900
		45600	39400	58100	23900
Golden Whistler		**16500**	**14300**	**21000**	**8600**
Pachycephala pectoralis		10700	9300	13700	5600
		25600	22100	32600	13400

Shining Starling *Aplonis metallica*	**93300** 14000 626200	**80600** 12100 540800	**118800** 17900 797000	**48800** 7300 327300
Black Sunbird *Nectarinia aspasia*	**450000** 307100 660100	**388600** 265200 570100	**572700** 390900 840100	**235200** 160500 345000

Notes: 1. Minimum and maximum populations are indicated by the 95% confidence limits.

Table 4.2.7. Local bird names

Bahasa Tobelo		*English*	*Scientific*	*Number and type of confirmations*
Pole Pole		Brahminy Kite	*Haliastur indus*	One S
Koyoba ngulu[2]		White-bellied Sea Eagle	*Haliaeetus leucogaster*	One S
Kawihi		sparrowhawk	*Accipiter sp*	Many P,H
Kokoruku		Dusky Megapode	*Megapodius freycinet*	Many S,H
Tumara		Invisible Rail	*Habroptila wallacii*	One group P
Ngorniti		Nicobar Pigeon	*Caloenas nicobarica*	One S
Mogoyuku		Fruit Dove	*Ptilinopus sp*	Two P,S,H
Fernemadaguru		"	*Ptilinopus sp*	One P,S,H
Gumuru		Cinnamon-bellied Imperial Pigeon	*Ducula basilica*	Many P,S,H
"		White-eyed Imperial Pigeon	*D. perspicillata*	Many P,S,H
Ngoku		Pied Imperial Pigeon	*Ducula bicolor*	Many H,S
Kukuwu		Great Cuckoo Dove	*Reinwardtoena reinwardtii*	Many S,H
Cicoro		Violet-necked Lory	*Eos squamata*	Many S
Lori		Chattering Lory	*Lorius garrulus*	Many S,H
Busu		"	"	One H
Habiana		Red-flanked Lorikeet	*Charmosyna placentis*	One H
Gofotor dano		"	"	One H
Gotoaka		White Cockatoo	*Cacatua alba*	Many S,H
Siba		Red-cheeked Parrot	*Geoffroyus geoffroyi*	Many S,H
Totoroa		Great-billed Parrot	*Tanygnathus megalorhynchus*	Many H,S
Ohiba	Male	Eclectus Parrot	*Eclectus roratus*	Many S
Ubero	Female	"	"	Many S
Ciungu		Giant Coucal	*Centropus goliath*	Many P,S,H
Ginen		Owl (small)	*Otus spp*	One S
Wuku		Owl (big)	*Ninox spp*	One S
Wuku		Halmahera Owlet Nightjar	*Aegotheles crinifrons*	Two P,H
Ekorikang		Moustached Tree Swift	*Hemiprocne mystacea*	One S
Oeluilumu		kingfisher	Alcedinidae	Many P,S
Poke		Roller	*Eurystomus sp*	One P
Faw faw		Ivory-breasted Pitta	*Pitta maxima*	Many P,S,H
Kohe		Blyth's Hornbill	*Rhyticeros plicatus*	Many S,H
Hilidoro		Cuckoo Shrike	*Coracina sp*	Two P,S
Leleko		"	"	One P
Hueko		"	"	One P
Tagaheha		"	"	One P
Bokeke		"	"	One P
Horogamatatoku		Rufous-bellied Triller	*Lalage aurea*	One P
Gatuaka		Golden Bulbul	*Ixos affinis*	One S
Biawamatotarleo		Slaty Monarch	*Myiagra galatea*	One S
Biawawmataleo		Golden Whistler	*Pachycephala pectoralis*	One H
Burincui		Black Sunbird	*Nectarinia aspasia*	Many H
Sosopeya		White-streaked Friarbird	*Melitograis gilolensis*	One P
Totoai		munia sp	*Lonchura spp*	One S
Ngoroko		Spangled Drongo	*Dicrurus bracteatus*	Many S,H
Koko		Wallace's Standard Wing	*Semioptera wallacei*	One H
Gogohumutu		"	"	One P
Wogono		crow sp	*Corvus sp*	Many S,H

Notes: 1. 'P' indicates identification from a photograph
2. 'S' indicates identification by sight in the field.
3. 'H' indicates field identification from call

SURVEI BURUNG

Laporan dari Rahman Dedi, Biological Sciences Club, Jakarta.

Metodelogi

Sebelum kita mencatat suatu jenis burung pada pengamatan burung, yang perlu diperhatikan oleh para pengamat, yaitu kitaharus mengetahui dan mengamati dengan pasti ciri-ciri (karakteristik) dari burung yang dilihat, seperti : warna bulu burung, baik yang terletak di sayap, ekor maupun pada bagian lainnya, bentuk dan warna paruh, bentuk dan warna kaki serta suara atau vocal dari burung tersebut, hal ini dilakukan untuk menghindari kesalahan pada pemberian nama.

Pada expedisi Halmahera '94 dalam survey biologi khususnya burung(Ornithologi) di hutan Halmahera, metodelogi yang digunakan yaitu Variable Circular Plot (VCP). Dengan metode ini kita dapat mengetahui penyebaran (distribusi) dan perkiraan jumlah populasi dari setiap jenis burung yang ada, dengan cara mencatat dari setiap burung atau kelompok (group) burung (Bibby *et al*, 1992).

Teknik dari Variable Circular Plot (VCP), yaitu dengan membuat beberapa stasiun pada line transect, lalu setiap pengamat berhenti pada stasiun untuk beberapa lama, kira-kira 10 menit untuk mengamati, mendengar dan mencatat burung, hal ini dilakukan dari stasiun ke stasiun. Yang perlu diperhatikan dan dicatat (record) dalam VCP, antara lain :

1. Jenis burung.
2. Jumlah anggota burung.
3. Jenis kelamin/ umur jika tahu.
4. Jarak antara pengamat dan burung.
5. Keberadaan burung; di pohon/ tanah.
6. Aktifitas dari burung, seperti hinggap di pohon, terbang dan makan.
7. Pendekatan deteksi/ identifikasi melalui suara (vocalisasi) atau melihat langsung.

Pembahasan

Tujuan dari Expedisi Halmahera '94 yang difokuskan pada penelitian biologi khususnya keanekaragaman hayati (Biodiversiti), merupakan suatu pengusulan (proposed) perencanaan pembuatan Taman Nasional, sebagai suatu kawasan konservasi untuk pelestarian flora fauna yang terdapat di pulau Halmahera.

Kecamatan Wasile yang terletak di Pulau Halmahera, merupakan wilayah dari Kabupaten Daerah Tingkat II Halmahera Tengah, yang berpusat di Soasio, Tidore. Setelah lapor diri untuk melakukan expedisi dalam hal penelitian biologi, pada kantor Bupati di Soasio, Tidore. Dimulai dengan menggunakan kapal Ferri dari pelabuhan ferri Bastiong, Ternate menuju ke Halmahera, dengan lamanya waktu kira-kira 85 menit kita akan tiba diSidangoli, dari sini kita lanjutkan dengan jalan darat (carter Bus) untuk menuju Bobenego, lalu dilanjutkan dengan menaiki perahu motor kira-kira 5 jam, kita akan tiba di Desa Subaim yang merupakan letak Kec. Wasile berada. Di Desa Subaim kami harus bermalam, untuk keesokan harinya kami harus melapor pada kantor Kecamatan dan Kepolisian setempat. Setelah itu, dengan menggunakan perahu motor tempel melanjutkan perjalanan laut, kira-

kira 2 jam akan tiba di Desa Wasile, yang merupakan pusat kegiatan untuk Expedisi Halmahera '94 ini.

Survey biologi yang dilakukan selama kira-kira 2 bulan lamanya, yang dipusatkan pada Desa Wasile; di sekitar Sungai Okitai, yang didominasi oleh batuan dari jenis ultrabesic rock igneous, dan 4 Desa lainnya yang kami singgahi, seperti : Anak Desa Loleba; di Sungai Tulawi, didominasi dengan batuan calcareus sedimen, Desa Fayaul di Gunung Subaim didominasi dengan batuan calcareus sedimen yang sama, begitu pula jenis batuan yang mendominasi habitat pada Sungai Air Dodaga di Desa Dodaga, sedang di Anak Desa Hilaitetor ada 2 kategori, yaitu di Sungai Ifis dengan type habitat non calcareus sedimen dan hutan Hilaitetor dengan type habitat dari batuan calcareus sedimen. Dari expedisi ini, kami telah mencatat kira-kira 140 jenis burung yang terdapat pada hutan yang kami survey dari semua Desa yang kami singgahi.

Dari 140 jenis burung pada Expedisi Halmahera '94 ini, anggota jenis hanya ada 1 jenis burung Rangkong, yaitu *Rhyticeros plicatus* (Blyth's Hornbill). Jenis burung ini selalu dijumpai disemua Desa, dengan populasi terbanyak terdapat di Anak desa Hilaitetor.

2 jenis burung Pitta dan Maleo, yaitu :

Pitta maxima	(Ivory-Breasted Pitta)
Pitta erythrogaster	(Blue-Breasted Pitta)
Megapodius freycinet	(Dusky Scrubfowl)
Megapodius wallecii	(Moluccan Scrubfowl)

5 jenis burung Pergam, yaitu :

Ducula bicolor	(White Imperial Pigeon)
Ducula basilica	(Cinnamon-Bellied Imperial Pigeon)
Ducula perspicillata	(White-Eyed Imperial Pigeon)
Caloenas nicobarica	(Nicobar Pigeon)
Columba vitiensis	(Metallic Pigeon)

4 jenis burung Hantu, yaitu :

Otus magicus	(Moluccan Scops Owl)
Ninox squampila	(Moluccan Hawk Owl)
Ninox connivens	(Barking Hawk Owl)
Ninox scutulata	(Brown Hawk Owl)

4 jenis burung Punai dan 4 jenis Merpati, yaitu :

Ptilinopus bernsteinii	(Scarlet-Breasted Fruit Dove)
Ptilinopus monacha	(Blue-Capped Fruit Dove)
Ptilinopus superbus	(Superb Fruit Dove)
Ptilinopus hyogaster	(Grey-Headed Fruit Dove)
Macropygia amboinensis	(Amboina Cuckoo-Dove)
Reinwardtoena reinwardtii	(Longtailed Cuckoo-Dove)
Chalcophaps indica	(Green backed-Dove)
Streptopelia chinensis	(Spotted Dove)

- 7 jenis burung Raja Udang, yaitu :

Tanysiptera galatea	(Common Paradise kingfisher)

Halcyon diops (Blue and White Kingfisher)
Halcyon chloris (Mangrove Kingfisher)
Halcyon funebris (Sombre Kingfisher)
Halcyon sancta (Sacred Kingfisher)
Halcyon saurophaga (Beach Kingfisher)
Alcedo azurea (Azure Kingfisher)

- 8 jenis burung Elang dan 1 jenis Elang Laut, yaitu :
Pandion haliaetus (Osprey)
Haliastur indus (Brahminy Kite)
Accipiter erythrouchen (Rufous necked Sparrowhawk)
Accipiter henicogrammus (Moluccan Goshawk)
Accipiter meyerianus (Meyer's Goshawk)
Hieraaetus morphnoides (Little Eagle)
Falco moluccensis (Moluccan Kestrel)
Haliaeetus leucogaster (White-Bellied sea Eagle, Elang laut)
Aquila gurneyi (Gurney's Eagle)

8 jenis burung Beo (Parrot) dan 1 jenis Kakatua, yaitu :
Charmosyna placentis(Red-Flanked Lorikeet)
Lorius garrulus (Chattering Lory)
Eos squamata (Violet necked lory)
Loriculus amabilis (Moluccan Hanging Parrot)
Alisterus amboinensis (Moluccan King Parrot)
Geoffroyus geoffroyi (Red-Cheeked Parrot)
Eclectus roratus (Eclectus Parrot)
Tanygnathus megalorhynchos(Great-Billed parrot)
Cacatua alba (White-Cockatoo)

5 jenis burung Kepodang, yaitu :
Coracina atriceps (Moluccan Cuckoo-Shrike)
Coracina papuensis (White-Bellied Cuckoo-Shrike)
Coracina parvula (Halmahera Cuckoo-Shrike)
Coracina tenuirostis (Common Cicadabird)
Coracina novaehollandiae (Black-faced Cuckoo-Shrike)

Lain daripada itu, dari jumlah 4 jenis burung Endemik Halmahera, yaitu jenis burung yang hanya terdapat di Pulau Halmahera. Pada Expedisi Halmahera '94 ini, 3 di antaranya telah terlihat dan kami catat. ke 3 (tiga) jenis burung tersebut, yaitu :

Halcyon funebris (Sombre Kingfisher)
Coracina parvula (Halmahera Cuckoo-Shrike)
Oriolus phaeochromus (Dusky-Brown Oriole)

Sedangkan 1 jenis yang tidak kami jumpai, yaitu dari jenis Invisible Rail (*Habroptila wallacii*), karena sulitnya medan yang kami harus masuki dan jelajahi, yaitu berupa rawa Sago yang merupakan type habitat yang disukai oleh jenis burung tersebut.

Selain itu, jenis-jenis burung lain yang dapat kita jumpai, pada semua type habitat di Pualu Halmahera, yaitu :

Lalage aurea	(Rufous-Bellied Triller)
Ixos affinis	(Golden Bulbul)
Dicrurus bracteatus	(Spangled Drongo)
Corvus validus	(Long-Billed Crow)
Corvus orru	(Australian Crow)
Lycocorax pyrrhopterus	(Paradise Crow)
Semioptera wallacii	(Standard-Wing Bird of Paradise)
Myiagra galatea	(Slaty Monarch)
Monarcha trivigatus	(Spectacled Monarch)
Monarcha pileatus	(White-Naped Monarch)
Pacycephala pectoralis	(Golden Whistler)
Rhipidura leucophrys	(White-Browed Fantail)
Lonchura malacca	(Black-Headed Munia)
Centropus goliath	(Giant Coucal)
Aegotheles crinifrons	(Halmahera Owlet Nightjar)
Caprimulgus macrurus	(Large-tailed Nightjar)
Hemiprocne mystacea	(Moustached Tree Swift)
Aplonis metallica	(Shining Starling)
Melitograis gilolensis	(White-Streaked Friarbird)
Philemon fuscicapillus	(Dusky Friarbird)

4.3 MAMMAL SURVEY

Report by James L. MacKinnon

Aims:

1. To compile a mammal list for the proposed Lolobata Wildlife reserve.
2. To collect information on the abundance of each species.
3. To survey the study area for Megachiropterans (Fruit Bats). Such a survey is recommended in the IUCN Conservation Action Plan for this group (Mickleburgh *et al.*, 1992).

Implementation:

Information on the occurrence of mammal species was collected in a number of ways:

A) A small mammal trapping project was conducted over a one month period in ultrabasic forest at our study site on a tributary of S. Oketai.

B) The local people at each study area were asked if they knew of any bat roosts or caves in the vicinity. All known roosts/caves were investigated and the number of animals in each was recorded.

C) Mist nets were used in all the survey areas for capturing bats. All captured animals were identified, weighed, measured and then released.

D) Additional information on mammal occurrence was collected opportunistically. This included information such as records of mammal tracks, information derived from local hunters and sight/hearing/smell records.

Due to the qualitative nature of much of the information gathered the results are in the form of an annotated list.

Annotated Species List

The nomenclature follows Corbet and Hill (1993). Altitudinal ranges given reflect those recorded during the expedition and are expected to be conservative. The IUCN ratings quoted for megachiropterans are taken from Mickleburgh *et al.* (1992); Red data book status is taken from IUCN (1991).

<u>Infraclass Marsupiala: Marsupials</u>

The marsupials are represented by ten species from three families in the Wallacean region. Two species from two families occur on Halmahera. The group is named after the marsupial pouch in which most of the young's development occurs.

Order Diprodontia

FAMILY PHALANGERIDAE (Cuscuses)

Seven species from 4 genera are found in the Wallacean region. Cuscuses are often hunted for food and kept as pets. They have been reported to be carried alive on long canoe journeys as a meat source (Corbet and Hill, 1993) and this may have been a dispersal aid for some species.

Phalanger ornatus Moluccan Cuscus

Flannery (1990) considers this to be a distinct species but some authors retain it as a subspecies of *P. orientalis*. It probably warrants species status since it appears to be more closely related to the New Guinea species *P. gymnotis* and *P. leucippus* than to *P. orientalis*.

Indonesian Name: Cuscus Maluku
Tobelo Name: Kuho

Identification: The male is white spotted with a dark brown dorsal stripe. Ventral pelage is white. Juveniles are orange/brown all over with a thin dark stripe running the length of the back.

Status: This species was reported to be common in all lowland forest types we surveyed. It was commonly seen in the ultrabasic forest of the Oketai study site and was heard on a number of occasions in limestone forest and forest on non-calcareous sediments. This species is often kept as a pet , especially as juveniles. In captivity they eat vegetable matter and fruit.

Distribution: Bacan, Ternate, Tidore, Morotai, Gebe and Halmahera.

Altitude: 0 to at least 150m

Natural History: The call is a high pitched cat-like howl made singly with about 20 minute intervals. One animal was seen sleeping in a tree fern and another was seen feeding on the fruits of *Gnetum gnemon*.

FAMILY PETAURIDAE

Represented by 1 species in Wallacea which is limited to the North Moluccas.

Petaurus breviceps Sugar Glider

Corbet and Hill (1993) list the subspecies as *papuanus* which also occurs on New Guinea. The race has been proposed as a species but an ability to interbreed in captivity supports its inclusion in *P. breviceps*.

Tobelo Name: Gito
Indonesian Name: Oposum layang biasa, locally known as Tupai

Identification: Halmahera's only gliding mammal. Dorsal pelage grey/brown with central black stripe running from nose to tail. Tail is slightly longer than body. Face predominantly white with 3 broad black stripes running from the nose: one over the forehead, and one through each eye to the ear.

Status: This species was reported to be common, especially in coconut plantations and was seen and heard in this habitat type. It was also heard in forest on limestone in the S. Tolawi region. This species is commonly caught and in one household nine animals were being kept as pets.

Distribution: Bacan, Ternate, Halmahera to New Guinea and Australia.

Altitude: 0 to 150m.

Natural History: In New Guinea it is known from primary, secondary, montane and floodplain forest. In the day family groups rest in tree hollows or the central core of strangling figs. They feed on fruits such as *Ficus*, *Saccharum*, beetle larvae and other invertebrates. In New Guinea it appears to be a year-round breeder. Dominant males smear scent from their sternal gland on other members of the group. This behaviour is thought to be a mechanism to promote group cohesion. The call is a high-pitched scream, in antagonistic encounters the animals also produce a hissing sound. The maximum recorded lifespan in the wild is seven years for a female and five years for a male with five and four years respectively being more common (Flannery, 1990).

Infraclass Eutheria Placental mammals

The placental mammals are represented on Halmahera by species from five orders: Insectivora, Chiroptera, Rodentia, Artiodactyla and Carnivora.

Order Insectivora

FAMILY SORICIDAE (Shrews)

Suncus murinus House Shrew

Identification: A small insectivore with the tail shorter than the body, a protruding forehead and relatively long snout. The dorsal pelage is dark grey with spiny hairs all over the tail. Males produce a strong musk-like odour from a large scent gland on the flank. This odour is characteristic and a simple identification feature.

Status: This species was common in villages, agricultural land, secondary and primary forest in lowland areas. It was not noted in montane forest.

Distribution: Widespread but no further east.

Altitude: 0 to 150 metres.

Natural History: The one female we caught in mid August was pregnant. Elsewhere the species is known to breed year-round, each female being capable of producing two litters annually with 1-5 young (average of 3). This shrew is nocturnal, feeding on insects and plant material.

Order Chiroptera

There are 12 recorded species of megachiroptera (fruit bats) and 19 insect-eating microchiroptera from the North Moluccas. Eleven of the megachiroptera and 13 of the microchiroptera have been recorded from Halamhera.

Suborder Megachiroptera

FAMILY PTEROPIDIDAE

The family is divided into four subfamilies of which three are represented in Halmahera: Pteropodinae, Nyctimeninae and Macroglossinae. Pteropids feed on fruits, flowers, nectar and pollen. They feed in the evening and throughout the night, often flying long distances in search of feeding sites. During the day they roost in trees, foliage or the twilight zones of caves. Only *Rousettus* is known to echolocate, producing clicks with its tongue. This system has allowed it to utilise roost sites deep within cave systems. Some species are individual roosters, others roost in small groups and some of the larger *Pteropus* form massive colonies with thousands of individuals.

SUBFAMILY PTEROPODINAE

This subfamily is in need of extensive reclassification.

Pteropus hypomelanus Variable fruit bat, Small flying fox

Identification: Forearm length: 120-150mm. This bat is generally dark brown/black in colour with the mantle varying in colour from pale yellow/gold to a dark red. It has large premolars with distinctive basal ledges. The subspecies for Halmahera is listed as *hypomelanus* by Mickleburgh *et al.* (1992).

Status: IUCN rating of 10. This species was not seen during our surveys on Halmahera.

Distribution: This small island species occurs from the Maldives, the islands off the Malay peninsula and other small islands across the archipelago into the Philippines and New Guinea.

Altitude: Sea level.

Pteropus caniceps Ashy-headed flying fox

Identification: Fore-arm length 135-145mm. The ears are unusually long and pointed. This species also has large premolars with distinct basal ledges. The subspecies is listed as *caniceps* by Mickleburgh *et al.* (1992).

Status: IUCN rating of 10. This species was not recorded during our surveys.

Distribution: Sulawesi, Sula islands, Halmahera, Morotai, Ternate and Bacan.

Pteropus personatus Masked Flying Fox

Identification: Fore-arm length 86-89mm. The face is pale with a large dark facial stripe through the eye giving it a "badger-like" appearance. The teeth are much reduced.

Status: IUCN rating of 10. This species was well described by the local hunters from Loleba in the S. Tolawi region, however it was said to be uncommon. There were no sight records or captures of this species during our survey.

Distribution: This species may be limited to the Northern Moluccas, the Sulawesi and Seram records being regarded as questionable by Bergmans and Rozendaal (1988).

Pteropus conspicillatus Spectacled flying fox

Indonesian name: Kalong kecamata
Local Name: Paniki yakis

Identification: Fore-arm length: 175-185. This bat with a blackish back is Halmahera's largest pteropid. The subspecies *chrysauchen* has a more pronounced pale ring around the eye and slightly weaker dentition than other races (Corbet and Hill, 1993).

Status: IUCN rating of 11. A very large dark fruit bat was described by local people in all the areas visited which is assumed to be this species. It was said to be temporary rooster, using sites for 2-3 months and then moving on, returning at intervals from months to years. Known roosts occur near Loleba village, Pulau Roni, mangrove forest one kilometer north of Wasile village, forest near Gurua, SP2, SP4 and about 10 kilometres south of Hilaitetor. During the study period none of these roosts were being used and this species was apparently absent along the 75 kilometres of coast that we surveyed.

Distribution: Ranges from the Northern Moluccas to New Guinea and south into Queensland, Australia. The subspecies *chrysauchen* is found in the Northern Moluccas and eastward into the Western part of New Guinea.

Altitude: Unknown

Natural History: In Australia this species is common within its range, forming roosts of thousands of individuals in tall trees in swamps and rainforests. Foods include blossoms and fruits, particularly of *Eugenia* and some palms (Flannery, 1990).

Rousettus amplexicaudatus Geoffroy's rousette

Identification: Smaller than any of the *Pteropus* or Halmaheran *Dobsonia*. It lacks the tube-nostrils of *Nyctimene*. The tail is relatively short. The subspecies is *amplexicaudatus*.

Status: IUCN rating of 11. This species was found to be common in all lowland forest types and in montane forest at 820m on Gn. Subaim.

Distribution: From Burma south through the Malay peninsula, throughout the Malay archipelago and eastward into New Guinea. *R.a. amplexicaudatus* is found from Burma to the Moluccas and Timor.

Altitude: 30 to 820m.

Natural History: This species uses echolocation, producing sound by clicking its tongue. This feature allows it to roost deep within caves.

Dobsonia moluccense Greater naked-backed fruit bat

Indonesian Name: Kalong Maluku

Identification: Distinguished as a genus by the totally bare back with wing membranes that meet at the midline. This species is separated from *D. viridis* by its greater size (fore-arm 133-160mm). The subspecies is *moluccense* but Corbet and Hill (1993) record that *magna* may occur on Halmahera.

Status: IUCN rating of 10. There were no definite records of this species during the survey. However one team member saw a large fruit bat (larger than *D. viridis crenulata*) emerging from a limestone cave which may have been this species.

Distribution: Halmahera, Ambon, Buru, Seram, the Lesser Sundas and to New Guinea in the east.

Natural History: Usually it roosts in the twilight zone of caves, sometimes forming immense colonies, at other times singly (Flannery, 1990).

Dobsonia viridis crenulata Greenish naked-backed fruit bat

Hill (1983) summarised the taxonomic history of *D. viridis* and referred *crenulata* to it as a subspecies, but Bergmans and Rozendaal (1988) retain it as a valid species.

Tobelo name: Manolo

Identifcation: Forearm length: 109-129mm. It has greenish fur on the mane.

Status: IUCN rating of 10. The most prominent fruit bat on Halmahera. It was found to occur in all lowland habitats including primary and secondary forest on all rock types. This species appeared to be locally common, presumably with its highest apparent densities being near roost sites.

Distribution: The species is found in Sulawesi, Moluccas and New Guinea.

Altitude: 0 to 100m.

Natural History: A roosting site containing 13 individuals was found in a hollow tree in a disturbed forest block that was surrounded by coconut plantations. In two small limestone caves four and five animals respectively were found roosting in the twilight zone.

Dobsonia sp.

Five hunted specimens of a *Dobsonia* with approximately the same dimensions as *D. viridis crenulata* but much yellower/green colouration were examined. These animals were roosting in a large cave with approximately 600 animals rather than the small groups formed by *D.v. crenulata* that had been observed at the roost. Later another specimen was caught, again in forest on limestone. This colour difference was suspected to be due to differences in reproductive condition since both of the hunted males had enlarged testes, and one female was pregnant. Comparison of the live specimen and *D. v. crenulata* showed no obvious differences in dental characteristics. Later comparison with specimens of the Sulawesi naked-backed bat, *D. exolotea* at the Bogor Museum showed that the colouration was identical. However since no specimens were obtained a definitive identification is not possible. Natural colour variation in bats is common (Paul Racey, pers. comm.) and these records are best treated as colour variants of *D. v. crenulata.*

Thoopterus nigrescens Swift Fruit Bat

The type specimen is recorded from Morty (assumed to be Morotai) but there appear to have been no other records from the Moluccas. The species does occur in Northern Sulawesi and the Sangihe islands.

SUBFAMILY NYCTIMINAE

Nyctimene albiventer Common tube-nosed bat

Indonesian name: Codot tabung biasa
Tobelo name: Guri-guriti

The subspecies *albiventer* is confined to the North Moluccas having been recorded from Halmahera, Morotai and Ternate.

Status: IUCN rating 8. This species was common in all lowland forest habitats.

Distribution: The species occurs in the North Moluccas, Kai islands, New Guinea and the Solomons.

Altitude: 0-200m.

Natural History: Flannery (1990) records that in New Guinea there is usually one in a litter and that it feeds on vegetable matter but also beetles, ants and moths.

Nyctimene celaeno

The record of this species is due to an erroneously labelled specimen of *N. albiventer* in the British Natural History Museum. Hence this species is listed for Halmahera by Laurie and Hill (1954), van Strien (1986) and UNDP/FAO (1981b).

SUBFAMILY MACROGLOSSINAE

Three genera occur in the Moluccas, two which are widespread further to the west and one which is an Australian genus reaching its western limit. One species is endemic to Halmahera. The subfamily is recognised by the long, highly extensible tongue which is narrow and tapers in a point. This group feed on pollen and nectar.

Eonycteris spelea Dawn bat, Cave fruit bat.

Peterson *et al.* (1990) record this species from Halmahera, as do Koopman and Gordon (1992), probably from the same specimens.

Identification: Presence of an external tail and no claw on the second digit is diagnostic of the genus. It is smaller (forearm 61-78mm) than the Borneo and Phillipine species *E. major* (forearm 75-85mm).

Status: IUCN rating of 11. Not encountered during this survey.

Distribution: India, throughout Indochina, south through the Malay peninsula, the Indonesian archipelago and reaching the eastern edge of its range on Halmahera.

Syconycteris carolinae Halmahera Blossom Bat

There are three *Syconycteris* species of which two are found in the Moluccas. *S. carolinae* is endemic to Halmahera and has thus far only been recorded from the northern peninsula at Gn. Gamkonura (Rozendaal, 1984) and the central isthmus at Jailolo, Sidangoli (Flannery and Boaedi, 1992) and Pasir Putih (Koopman and Gordon, 1992).

Identification: It is larger (forearm c.60mm) than *S. australis* (forearm less than 53mm) which occurs in the central Moluccas.

Status: IUCN rating of 8. This species has not yet been recorded from the north-east peninsula.

Distribution: Endemic to Halmahera.

Altitude: Rozendaal caught specimens at approximately 180m.

Macroglossus minimus Common Long-tongued fruit bat

Indonesian name: Codot madu kecil

Identification: This is the smallest macroglossid bat on Halmahera and lacks a tail. The subspecies *nanus* is smaller than other *M. minimus* subspecies.

Status: IUCN rating of 11. A common bat on Halmahera being recorded from all forest types.

Distribution: Widespread

Altitude: 0-830m

Natural History: Often roost singly or in small groups under foliage.

Suborder Microchiroptera

This large suborder is well represented in the Indonesian archipelago. All species use echolocation for navigation and searching for food. Their echolocating abilities make them especially hard to catch and identify since they often avoid mist nets. Many species form large colonies that roost in tree hollows, caves or crevices. Microchiropterans rarely roost in open situations.

FAMILY EMBALLONURIDAE (Sheath-tailed bats)

This family is distinguished by the small tragus, lack of noseleaf and tail which is partly enclosed in a membrane, with the terminal part projecting from the upper surface. They are insectivores and roost individually or as colonies in caves, crevices and overhanging roots, rocks or foliage.

Emballonura nigrescens Lesser sheath-tail bat

Griffiths et al. (1991) have proposed that the species be returned to the original monotypic genus *Mosia* (Gray: 1943). Hence the listing of *Mosia nigrescens* by Koopman and Gordon (1992).

Indonesian: Kelelawar ekor trubus kecil

Identification: This is smaller (forearm 30-37mm) than *E. raffrayana* (forearm 39-41mm).

Status: Not recorded during the expedition.

Distribution: The subspecies *papuana* occurs on Sulawesi, the Northern Moluccas and New Guinea.

Natural History: Small groups roost together in a dense clump under leaves and sometimes caves (Flannery, 1990).

Taphozous melanopogon Black-bearded tomb bat

This species has recently been reported from Halmahera by Koopman and Gordon (1992).

Status: Not recorded during this survey.

Distribution: Widespread from India to Timor; north to the Philippines. Apparently reaching the eastern extent of its range on Halmahera, with additional records for the Aru islands.

Natural History: In Thailand this species often roosts in single-sex roosts, each with 150-4,000 animals (Lekagul and McNeely, 1977).

Taphozous saccolaimus Pouch-bearing bat, Naked rumped sheath-tail bat

Corbet and Hill (1993) retain this species within the subgenus *Saccolaimus*. However Koopman and Gordon (1992) consider it as a distinct genus, listing *Saccolaimus saccolaimus* as a new record for Halmahera.

Status: Not recorded during this survey.

Distribution: Widespread from India, throughout South-east Asia and then occurring across the archipelago with records becoming sparser further to the east. However it is also present in New Guinea and Northern Australia.

Natural History: A gregarious rooster in crevices and hollow trees.

FAMILY MEGADERMATIDAE (False vampire bats)

Megaderma spasma

The holotype is recorded as having come from Ternate, Moluccas (Linnaeus 1758:32).

Distribution: India through to Ternate. Apparently there are no Halmaheran records yet.

FAMILY RHINOLOPHIDAE (Horseshoe bats)

This family is characterised by a complex noseleaf which has a wide anterior leaf (the horseshoe). They are insectivores, catching prey on the wing, and occur in forest as well as open habitats.

Rhinolophus euryotis Broad-eared horseshoe bat

Identification: This species has bright orange colouration to the fur on its back. The subspecies *timidus* is listed by Corbet and Hill (1993).

Status: This species was not recorded during the survey.

Distribution: Sulawesi, Moluccas to New Guinea. Hill and Rozendaal (1989), Peterson *et al.* (1990) and Koopman and Gordon (1992) record this species for Halmahera.

Natural History: In New Guinea this species has been reported as a gregarious rooster with over 1000 individuals found roosting and breeding in a limestone cave at 1720m (Craven and de Fretes, 1987).

Rhinolophus megaphyllus

The species is recorded for Bacan island, the North Moluccas. The classification of the *megaphyllus* group is currently confused but *R.m. truncatus* is the North Moluccan race.

Distribution: Thailand through to New Guinea, the Bismark archipelago and Eastern Australia. There are currently no Halmaheran records.

FAMILY HIPPOSIDERIDAE (Leaf-nosed bats, Trident bats)

Hipposideros ater Dusky leaf-nosed bat

The subspecies is given as *saevus* by Corbet and Hill (1993).

Status: One individual was found roosting alone in a limestone karst cave at 280m.

Distribution: The species occurs from India and Sri Lanka east through South-east Asia across the archipelago and into New Guinea and Australia. The subspecies *saevus* occurs from Burma to the Moluccas.

Hipposideros cervinus Gould's Leaf-nosed Bat

The subspecies *batchianensis* has been recorded from Bacan.

Distribution: Malaya to Australia though there are few records from the Lesser Sundas and Moluccas.

Hipposideros papua Geelvinck bay leaf-nosed bat

Identification: The third supplementary leaflet on the nose of this species is diagnostic.

Status: RDB status of rare. This appeared to be the most common Hipposiderid bat and was recorded from all lowland habitats. Colonies of up to 30-40 animals were found in most of the small caves examined.

Hipposideros diadema Diadem leaf-nosed bat

Identification: Forearm 74-92mm. The large size and complexity of the nose-leaf separate the species from other Halmaheran hipposiderids.

Status: This species was not recorded during the survey.

Distribution: Burma through to the Moluccas. In the North Moluccas this species is recorded from Bacan. Flannery (1990) lists the subspecies as *euotis*. Koopman and Gordon (1992) record this species from Halmahera.

Asellicus tricuspidatus Trident Bat

Identification: The three projections on the posterior edge of the noseleaf are diagnostic.

Status: Not recorded during the expedition.

Distribution: Restricted to the North and Central Moluccas extending as far east as the Kai islands.

Myotis ater

In the North Moluccas there has been one record from Ternate.

Distribution: Philippines, Borneo, Sulawesi, North and Central Moluccas and Mentawi islands (Sumatra).

Myotis muricola

This species is listed by Koopman and Gordon (1992).

Status: Not recorded during the expedition.

Distribution: Widespread, ranging from N.India, throughout South-east Asia and across the archipelgo, reaching its eastern limit in the Moluccas (also recorded from Ambon).

Natural History: In Thailand large maternal colonies with over 10,000 individuals are formed in caves surrounded by primary forest (Lekagul and McNeely, 1977).

Miniopterus australis Little long-fingered bat

Recorded from Bacan

Distribution: Java, Borneo through to East Australia.

Miniopterus schreibersii Schreiber's (Common) long-fingered bat

Status: Not recorded during the expedition. This species was caught on Halmahera by Flannery and Boaedi (1991).

Distribution: Widespread from India east to New Guinea and Northern Australia.

Natural History: In Thailand this species forms large roosts (up to 100,000 animals), usually in large humid caves with subterranean rivers (Lekagul and McNeely, 1977).

Murina florium

Recorded from Bacan

Distribution: The Lesser Sundas, Sulawesi, Central Moluccas, Bismarck Archipelago and North-east Australia.

Kerivoula picta Painted bat

Status: Not recorded during the expedition
Distribution: Widespread from India to the Moluccas where it appears to be at the edge of its range.

Natural History: Roosts under foliage.

Mormopterus beccarii Beccari's mastiff bat

Status: Eight of these bats were caught on the Oketai river in forest on ultrabasic rock. The ease with which they were caught at that site and their absence at other sites suggests that they may be locally common near roost sites. However these bats are considered to be high-flying species and therefore only usually caught in the canopy.

Distribution: This species is also recorded from Ambon, New Guinea and Australia..

Tadarida jobensis Wrinkle-lipped mastiff bat

Corbet and Hill (1993) place this species in the subgenus *Chaerophon*. The species may prove to be conspecific with *T. plicata* which is recorded from Philippines, Borneo and Java westward to India.

Status: Fifteen individuals of this species were caught on the Oketai river in forest on ultrabasic soils. This is the first record of *Tadarida* for Halmahera.

Distribution: Seram, New Guinea, Solomon Islands and Australia.

Natural History: Feeds on moths and beetles. In New Guinea it has been found roosting in small groups (c. 10 individuals) in hollow trees (Flannery, 1990). In the Solomons a huge roost cave has been recorded (Troughton, 1931).

Order Carnivora

Viverra tangalunga Malay Civet

This species has probably been introduced. Corbet and Hill (1993) list his species for Hlamahera and Dr. P. Taylor has collected a specimen from the North Moluccas. However we did not encounter this species and it did not appear to be known by local hunters.

Felis catus Feral cat

On two occasions cat footprints were encountered at a distance greater than 6 kilometres from a village and these were assumed to be feral animals. The presence of such predators may have a serious impact on some of the original island species such as the poor flying rails (including the endemic Invisible Rail, *Habroptila wallacei*) and Moluccan scrubfowl, *Megapodius wallacei.*

Order Artiodactyla

Both of the following species have been introduced into Halmahera. They are hunted in all regions, mostly by bands of 3 or 4 men with packs of ten to fifteen dogs and spears. Elsewhere on the island rifles are used but these are rare in the immediate region of the proposed reserve.

Sus scrofa Wild boar

This introduced species was found to be abundant in most of the forest types. The only place it was not encountered was at S. Dodaga where it appears to have been overhunted. The forest in this region is still inhabited by about 20 families of shifting cultivators. It is also used for hunting by those 'forest people' who have moved out into the nearby village of Dodaga.

Cervus timorensis Rusa deer

This introduced species was also common in all forest types except at S.Dodaga where it appears to have been overhunted.

Order Rodentia

Rattus exulans Polynesian rat

Tobelo name: Karafe

Status: This rat was common in all lowland forest types including secondary scrub and coconut plantations.

Distribution: Widespread, an introduced species.

Rattus morotaiensis Morotai rat

Identification: This medium sized rat is dark brown above with a white ventral pelage. The neck and fore legs are tinged red.

Status: This rat is recorded only from the North Moluccas. It was common in all forest types (though possibly not montane) and was not observed in cultivated areas.

Distribution: Endemic to the North Moluccas.

Rattus rattus Black Rat, Ship Rat

Tobelo name: Karafe

This species was seen in villages and cultivated areas but did not appear to have spread into the forest. The subspecies is recorded as *obiensis* by Corbet and Hill (1993).

Conclusions

The notes in the annotated list outline a number of important points to consider with respect to the conservation of mammals on Halmahera:

1. Many of the species are subject to hunting on some scale, whether for food or, as with most of the fruit bats, in retaliation for the destruction of cultivated fruits.

2. Some of the species are at the edge of their global distribution. These species may be existing under conditions of high natural stress from either physical or biotic factors. They may therefore be more prone to be affected by other pressures such as deforestation or disturbance at the roost.

3. Four mammal species are endemic to the North Moluccas and it is imperative that suitable protection is given to these.

4. One species, *Hipposideros papua*, is listed as rare in the IUCN red data book although it is relatively common in forested areas on Halmahera. Gazettement of a wildlife reserve would ensure protection for a significant part of the global population of this species.

5. Suitable roosting sites are a limiting factor for some bat species (Mickleburgh *et al.*, 1992). For species that roost under foliage, in crevices or in hollow trees there may be many available sites. However those species that require large limestone caves can be particularly susceptible to disturbance. Therefore the inclusion of limestone regions within the reserve boundary should be maximised.

6. There are a number of known cave and tree roosting sites for pteropids which should be given special protection. Already one cave site I visited is marked with a notice from the department of forestry requiring that special permission is granted before entry. However bats at this cave are still hunted. An educational campaign may be necessary to change attitudes towards fruit-eating bats and pointing out their role in the pollination and dispersal of economically important fruit and timber trees.

7. Six wild (or feral) species have been introduced to Halmahera. Two of these (pig and deer) are used as a food source by coastal villagers and the forest people. Since they are exotics and may have caused modifications to the original ecosystem, continuing to allow hunting may not be in contradiction with the aims of conservation. Black rats *Rattus rattus* seem confined to areas around human habitation while Polynesian rats *R. exulans* are found in the forest. *R.exulans* may be competing with the endemic *R. morotaiensis* in the forest however we found no evidence for this and both species occur sympatrically. Feral cats and civets could be important predators of ground birds such as megapodes and rails.

Table 4.3.1. Mammal species recorded from Halmahera.

Species	IUCN Status	Edge of range?	Roost area	Hunted	Distribution
Phalanger ornatus Moluccan Cuscus		n/a[1]	trees	yes	ENDEMIC[2]
Petaurus breviceps Sugar Glider		yes	trees	yes	Australia to N. Moluccas
Suncus murinus House Shrew		yes	n/a	no	Widespread westward
Pteropus hypomelanus Small flying fox	10	no	colonies in trees	yes	islands from Maldives - PNG
Pteropus caniceps Ashy-headed flying fox	10	yes	colonies in trees	yes	Sulawesi to N. Moluccas
Pteropus personatus Masked flying fox	10	n/a	unknown	yes	ENDEMIC
Pteropus conspicillatus Spectacled flying fox	11	yes	colonies in trees	yes	Australia to N. Moluccas
Rousettus amplexicaudatus Geoffroy's rousette	11	no	caves	yes	Burma to New Guinea
Dobsonia moluccense Greater naked-backed bat	10	yes	caves	yes	New Guinea to N. Moluccas
Dobsonia viridis crenulata Greenish naked-backed bat	10	sp. no[3] ssp.n/a	large caves	yes	Sulawesi to New Guinea
Nyctimene albiventer Common tube-nosed bat	8	yes	foliage	possibly	Solomons to Halmahera
Eonycteris spelea Dawn bat	11	yes	caves	possibly	India to N. Moluccas
Syconycteris carolinae Halmahera blossom bat	8	n/a	unknown	possibly	ENDEMIC
Macroglossus minimus Common long-tongued bat	11	no	foliage	possibly	Widespread
Emballonura nigrescens Lesser sheath-tail bat		no	foliage	no	Sulawesi to New Guinea
Taphozous melanopogon Black-bearded tomb bat		yes	caves, single sex groups	no	India to N.Moluccas
Taphozous saccolaimus Pouch-bearing bat		no	crevices, hollow trees	no	India to PNG and N.Australia
Rhinolophus euryotis Broad-eared horseshoe bat		no	limestone cave	no	Sulawesi to New Guinea
Hipposideros ater Dusky leaf-nosed bat		no	caves, crevices	no	India to Australia
Hipposideros papua Geelvinck leaf-nosed bat	R (rare)	no	caves	no	N.Moluccas and Geelvinck Bay
Hipposideros diadema Diadem leaf-nosed bat		yes	crevices, caves	no	Burma to Moluccas

Asellicus tricuspidatus Trident bat		yes	lowland caves	no	New Guinea to Moluccas
Myotis muricola		yes	caves	no	India to Moluccas
Miniopterus schreibersii Common long-fingered bat		no	caves	no	India to Australia
Kerivoula picta Painted bat		yes	foliage	no	India to Moluccas
Mormopterus beccarii Beccarri's mastiff bat		yes	tree hollows	no	N.Australia to Moluccas
Tadarida jobensis Wrinkle-lipped mastiff bat		yes	tree hollows	no	Australia to Moluccas
Viverra tangalunga Malay Civet		yes	n/a	no	Widespread introductions
Felis catus Feral cat		no	n/a	no	Widespread introductions
Sus scrofa Wild boar		no	n/a	yes	Widespread introductions
Cervus timorensis Rusa deer		no	n/a	yes	Widespread introductions
Rattus exulans Polynesian rat		no	n/a	possibly	Widespread introductions
Rattus morotaiensis Morotai rat		n/a	n/a	no	ENDEMIC
Rattus rattus Black rat		no	n/a	yes	Widespread introductions

Notes: 1. not applicable
2. Endemic to the North Moluccas
3. *Dobsonia viridis crenulata* is sometimes considered a species, *D. crenulata* which would be endemic to the North Moluccas.

IUCN status refers either to the species status in the Old World Fruit Bat Action Plan (Mickleburgh *et al.*, 1992) or to its status in the Red data book (1990 edition). For fruit bats the rating of 8 and 10 refer to species for which there are little or no data with which to assess conservation needs, 11 is for species considered to be widespread and common in at least a part of the global range, or where there is no evidence of serious threat to populations.

Further Research

1. The apparent absence of *S. carolinae* from the north-east peninsula is of concern since the establishment of a reserve here may not help to protect this endemic species. Further surveys to determine the extent of this species and its habitat requirements should be conducted.

2. Further research of the large *Pteropus* spp. is needed to determine the reasons for their migration, their preferred roosting sites and the extent of their persecution.

3. The bat fauna of the North Moluccas is still not well known and appears depauperate by comparison to surrounding areas such as the Central Moluccas. All recent attempts to research bats on Halmahera have added new species records (*e.g.* Rozendaal, 1984; Flannery and Boaedi, 1991; Koopman and Gordon, 1992; this study). More complete surveys for the region would therefore be useful.

4. Although the North Moluccan endemic *Pteropus personatus* appears to be present in the proposed reserve area, further research on its habitat requirements would be useful to determine its status and conservation needs.

4.4 ANURAN INVESTIGATION

Report by Robert Knowles-Leak.

Introduction

The previous herpetological research carried out on Halmahera dates back to the late 19th and early 20th century. This research was primarily only specimen collection and cataloguing of the species present. Our investigations involved collecting data on the distributions of those frogs already known to be present and collecting of specimens to be given to the Bogor Zoology Museum.

Only 10 species of frog had been previously recorded on the island. Nine of these were mentioned in van Kampen's review of the amphibia of the Indo-Malayan region (1923). These are listed in table 1. A record of *Rana arfarki* was added by Paul Taylor (1990). Of these ten species 5 are endemic: 4 to Halmahera itself and one to the North Moluccas.

Table 4.4.1 Frogs previously recorded on Halmahera

FAMILY	SUB-FAMILY	GENUS	SPECIES	Notes
Ranidae	Raninae	*Rana*	*modesta*	
			papua	
			rugata	
			arfarki	
Hylidae	Pelodryadinae	*Littoria*	*infrafrenata*	
			rueppelli	*
Microhylidae	Asterophyinae	*Hylophorbus*	*boettegeri*	*
			dubius	*
			montanus	*
	Genyophyninae	*Oreophryne*	*senckenbergiana*	#

Notes: * indicates a species endemic only to Halmahera.
# indicates a species endemic to the North Moluccas

Methods

Two methods of collection were used:

At the S. Oketai study site a 30m pitfall trap was constructed of 50cm high tarpaulin. Sixteen buckets were dug into the ground at 2m intervals along the wall. This trap was run from 29th July to 29th August 1994. Checks were performed every morning and evening.

Lamping at night using headtorches was used at the five study sites visited during the expedition to look for and catch frogs coming down to the riverside at night and to search for tree frogs.

Results

The pitfall trap was not successful. In the month of study it caught no amphibians and few lizards, confirming the difficulty of undertaking such a programme.

The use of headtorches to search rivers and trees proved to be more successful. A good night would provide 20-30 sightings of 2-3 species. All the specimens collected were caught by this method bar one which was captured using a dip net.

Six species of frog were observed and collected in various regions of the proposed Lolobata reserve. These are dealt with individually.

Rana modesta
Specimens of this species were observed at the study sites in Loleba and in the region of Wasile and Fayaul. They were recorded at altitudes between 0-200m OD.

Rana papua
This frog was found to be abundant in all the areas studied at altitudes from 0-850m OD (an extention of the previously recorded altitudinal range for Halmahera of 600m upward). There is great variety in the size, colour and calling pattern of this species. Lowland populations (below 200m) all called with a distinctly frog-like warbling call which starts high and trails off to a slower warble and lower pitch. The population on Gunung Subiam (850m) and a specimen heard high up the Sungai Oketai (250-300m) called with a much deeper and more resonant call which warbled at a higher frequency and did not tail off at the end. This sounds very much like a crow calling (in fact when first heard it was mistaken for a crow). The calls normally came in the form of two repeats of this crow-like sound. The local Tobelo name of both *R. modesta* and *R. papua* is *Kaateko*, meaning 'edible frog', however our guides considered both these species to be 'bad eating'.

Littoria infrafrenata
Several examples of this large tree frog were seen and a single specimen was collected. The frog varies little from the previous descriptions of it. It was observed to be a slow, poor swimmer and a clumsy climber. These traits may lead to an expectation that the frog is subject to predation as easy prey and yet it is abundant. However it was also noted that the local hunters and guides would not catch this frog for food, describing it as inedible.

Hylophorbus dubius
A single specimen of this tiny frog was collected. As one of the island's endemics it is worth noting that either this species is very elusive or scarce in the region studied.

Two other species of frog were collected, neither of these have as yet been identified to species level. One is a very small Ranid frog which is being taken to the British Natural History Museum, London for identification. The other is a large Ranid similar to *Rana macrodon*. This was deposited at Bogor Zoology Museum with Drs. Boeadi for identification. It is worth noting here that the specimen was collected on G. Subiam at 850m and other examples were observed on the S.Ifis at 80m. The animal is caught by the local hunters for food. Since it is common it seems surprising that there have been no previous records of this animal. Possibly Taylor's (1990) record of *R. arfarki* refers to this species.

4.5 THE FRESHWATER FISH OF HALMAHERA

Report by David Robb

Aim: To compile a collection of freshwater fish species from a variety of rivers, recording habitat data for each catch.

Methods

The freshwater and estuarine fish from six rivers running to the western coast of the peninsula were sampled. Sampling was conducted according to a method described by Kottelat *et al.* (1993). A large dip net (60cmx40cm) was used to catch fish which were driven into it using a smaller hand net 25cm in diameter. The mesh of the net was made from mosquito netting. The large net could also be used to drag through leaf material on the river bed. For larger fish a hook and line baited with meat from freshwater prawns was used, although this was of limited use.

The method using the nets was suitable for water up to 0.8m in depth and slow flowing- not more than 12m/min at this depth or the drag on the net was too great to hold it. The water also had to be clear in order to see the fish. Any turbidity generally resulted in the loss of the fish. Using this method various sites on the river were sampled; a site generally being about 50m long, although some were up to 100m. Observations showed that most of the fish in the sites evaded the nets easily and so only a very small percentage of the populations were caught. Some species were always able to evade the nets, escaping to other pools and so were not taken as specimens.

After capture, the fish were transfered to 10% formalin solution for fixing and preservation. The samples were labeled according to the location of the capture. They were stored by this method until removed from the field and sent for identification.

A short description of each of the rivers surveyed follows.

Sungai Tolawi

Lying on calcareous sediments, the stretch of river surveyed lay several kilometres in land. The altitude of the river here was about 50m above sea level and the river was broad (25m on average) and the stretches sampled shallow (maximum depth 70cm), although much deeper pools were present in inaccessible gorges. The forest here was largely undisturbed, with the surrounding trees rising to a height of 40m or more, although at one place a disused logging road forded the river.

The river was liable to sudden spates, having a large catchment area in the centre of the peninsula, even though the surveys were carried out in the dry season. During the survey period it rained for an average of one to two hours per day. When not in spate the river flowed at approximately 15m/min. The water had an average conductivity of 340$\mu S/cm^2$ and an average pH of 8.0.

Sungai Oketai

This is a short river, about 16km long, which is flanked to the east by a high ridge running up to Gunung Subaim. The river runs over non-calcareous sediments and ultrabasic igneous rocks and was sampled over much of its length (**map 4.5.1**).

In its upper reaches the river ran through a boulder strewn bed, dropping from 230m above sea level to 170m over 4km. The river here had an average width of 5m, although the width of the devegetated zone implied that it could swell to about fifteen metres after rain. The river bed consisted of sand and pebble with few leaves able to collect in the shallow glides and rifles (having a flow of approximately 10m/min), which formed the majority of this stretch of river. Small pools occurred (maximum depth 0.4m) between the glides with the occasional deep pool (maximum depth 0.8m) and it was from these that the fish were collected. The surrounding forest was undisturbed primary forest, with trees averaging 15m in height. The water had a high conductivity, averaging 680$\mu S/cm^2$, and an average pH of 8.0.

The upper stretches of the river were separated from the middle stretches by a 20m high waterfall. Below this the river was joined by several major tributaries and swelled greatly in size to an average width of 12m over the next 6km. The river flowed more slowly (about 8m/min on average) over gravel and cobble, apart from two stretches of 500m and 1500m in length, where the river passed through steep sided gorges and in the latter stretch descended a series of small waterfalls of 5m maximum height. Throughout the middle stretches, the river ran through primary forest, which was undisturbed, with trees reaching up to 40m in height often growing right down to the banks of the river. However, in the last 500m when the river approached a village some minimal disturbance had occurred. The conductivity of the water dropped along the middle stretches from 580$\mu S/cm^2$ just below the large waterfall to an average of 500$\mu S/cm^2$ below the second gorge. Above the long gorge, the river was generally shallow with a maximum depth of 0.7m, except in a few deeper pools which were deeper than 2m. Below the gorge, there were many more deep pools and glides and fewer riffles. Most of these pools had a layer about 10cm deep of decaying leaves. Many fish and crustaceans were found in the leaf layer and also amongst tree roots which were in the water at the banks.

The lower stretches of Sungai Oketai ran through cultivated areas, with coconuts being the dominant tree giving shade over the water. The water flowed at approximately 8m/min through this region, with gravel forming the majority of the river bed. The banks were steep sided with many tree roots protruding into the water. Most of the fish in this area were caught amongst the tree roots which formed dense mats of cover. The river was generally shallow, with a maximum depth of 0.5m. The conductivity of the water remained at 500$\mu S/cm^2$ on average, with the pH still at 8.0.

The lowest sites fished were in the estuary, where mangroves were the dominant vegetation. The estuary was short, only about 100m long and the water was exposed to the light, causing the temperatures to fluctuate greatly during the day reaching peak values of 27°C, but dropping to 21°C at night. This contrasted with the rest of the river, which as it was surrounded by forest for most of its course did not fluctuate greatly, ranging from 21°C to 24°C.

Desa Fayaul

The village of Fayaul lies at the base of a long ridge running up to Gunung Subaim. Many small streams run down through the village during the wet season, but during the dry season most of these dry out. This was the situation when the area was surveyed. The two streams investigated were still flowing at their estuaries, but further up they repeatedly went underground, leaving small stretches of water with a maximum depth of 0.25m and an average width of only 0.5m in which the fish congregated. These pools were exposed to light as the vegetation around them was poor, resulting in high water temperatures during the day- up to 29°C- and high salinity in some of the lower pools- 1270μS/cm² was recorded near the estuary of one stream, but no fish were found in that pool- although the higher pools averaged 500μS/cm² as they received slightly more shade.

Sungai Dodaga

Sungai Dodaga is a long river with a large catchment area in the centre of the north-eastern peninsula of Halmahera. At its estuary and lower stretches it is about 40m wide and is navigable by boat for 3km inland. A large transmigration camp is situated near to the river and the land around the lower stretches is heavily cultivated. The lower stretches were not fished as suitable equipment was not available. However, local people fished these waters, catching large eels and various other fish, which we had no means of preserving. The stretch surveyed was about 6km inland. Here the river was shallower, with a maximum depth of 1.1m and an average width of 12m, with an average speed of 6m/min. The bed of the river varied from fine silt and sand to coarse gravel, with the finer sediments forming the majority of the habitat. In slower flowing parts of the river mats of weeds grew. The highest two stations investigated were in open habitat, with the river exposed to light. Lower down the river ran through primary forest with trees of about 25m in height, before emerging to fields and coconut plantations in the lowest stretch surveyed, a further 3km down stream, although still 6km from the coast.

Sungai Ifis

Sungai Ifis is another major river, draining the northern end of the peninsula. The estuary and lower stretches of the river were generally too deep to fish. A small survey was made of the estuary fish, but the main fishing effort was carried out from a distance of 10km inland. The lowest site was in a disturbed region of forest, with a large logging camp just 20m downstream (map 4.5.2). The people from this camp regularly used this part of the river for getting drinking water and also for hunting for the large edible freshwater prawns. Further upstream the river ran through primary forest, undisturbed apart from occasional parties of hunters who went to the forest to hunt pig and deer.

The river in the lower part of the survey area was 8m wide on average with a maximum depth of 1.8m. The bed of the river consisted of small pebbles and gravel and the water flowed at approximately 6m/min. The vegetation here was about 20m high, giving good shade over the water, except in the vicinity of the road where the river was exposed. The exposure allowed some weed to grow and shoals of gobies congregated in this vegetation. Above this area, the river ran through a series of rapids and gorges for about 2km before opening up into forest again and flowing more slowly. The next site surveyed was 4km

above these rapids and here the river was approximately 8m wide with an average salinity of 380μS/cm². The bottom of the river was mainly gravel, although in places the sedimentary bed rock was exposed. Occasionally the river narrowed to form rapids from which a fish was caught using a hook. However, in large pools other large fish were seen which could not be caught. The highest site on the river was just below a large waterfall which was unclimbable.

Several large tributaries ran into the river and two of these were surveyed. The first was slow flowing (2m/min) and mainly shallow, although one long pool reached a depth of 1.0m. The bottom was fine silt and sand and in places weed grew. The forest was secondary, having recovered from a disturbance about ten years before. The water had a higher conductivity than the main river (440μS/cm²), but similar species of fish were found there. The second tributary was faster flowing, with speeds of up to 5m/min being recorded. The stream was shallow (0.4m) for most of the length investigated, although occasionally deeper pools were encountered (1.0m). The conductivity was 320μS/cm² on average with the pH at 8.0, thus being slightly different to the main stream. At a distance of 3km from the main river the tributary descended a set of waterfalls over a distance of about 1km. Above this a logging road crossed over it. The bridge here had fallen in blocking the river. Also logging along the banks of the stream had cleared the vegetation for about 40m from one bank. Further gold prospectors were searching for the metal just up stream and were panning through the silt and digging into the banks. The result of this was a covering of fine silt over the stream bed in this area and suspended solids being carried in the water below the collapsed bridge. The stretch of river from the bottom of the gold panning to the bridge was about 1km long. This was searched for fish, but none were seen, the only life in this entire stretch being a few small prawns.

Other rivers were visited by members of the expedition while other surveys were carried out. These rivers were Sungai Iga, Sungai Meja, and Sungai Opiang. The former is near to Sungai Ifis, also draining the northern end of the peninsula. The later two are near Sungai Dodaga and the surrounding land was heavily cultivated in the areas surveyed. Local guides from these areas caught fish from these rivers and these were preserved. However, no details of these rivers were recorded as there was insufficient equipment to survey them with any accuracy.

A preliminary list of the species of fish collected has been compiled by Dr Maurice Kottelat who kindly carried out the identifications. The genera collected are listed below for each river.

Sungai Tolawi

Stiphodon
Sicyopus
Lentipes

Desa Fayaul

Periophthalmus
Scatophagus
Apogon
Glossogobius
Stenogobius
Butis
Redigobius
Ambassis
Hippichthys
Zenarchopterus
Ambassis

Sungai Dodaga

Microphis
Eleotris
Sicyopterus
Stiphodon
Schismatogobius
Redigobius
Glossogobius
Ophieleotris
Ambassis
Chelonodon
Oreochromis

Sungai Ifis

Sicyopus
Eleotris
Stiphodon
Sicyopterus
Belobranchus

Sungai Oketai

Stiphodon
Redigobius
Glossogobius
Eleotris
Sicyopterus
Chelonodon
Sicyopus
Lentipes
Awaous
Anguilla
Stenogobius
Ophieleotris
Butis
Microphis
Belobranchus
Kuhlia
Terapon
Gerres
Scatophagus

Sungai Opiang

Caranx

Sungai Meja

Toxotes
Hypseleotris
Megalops
Eleotris
Microphis

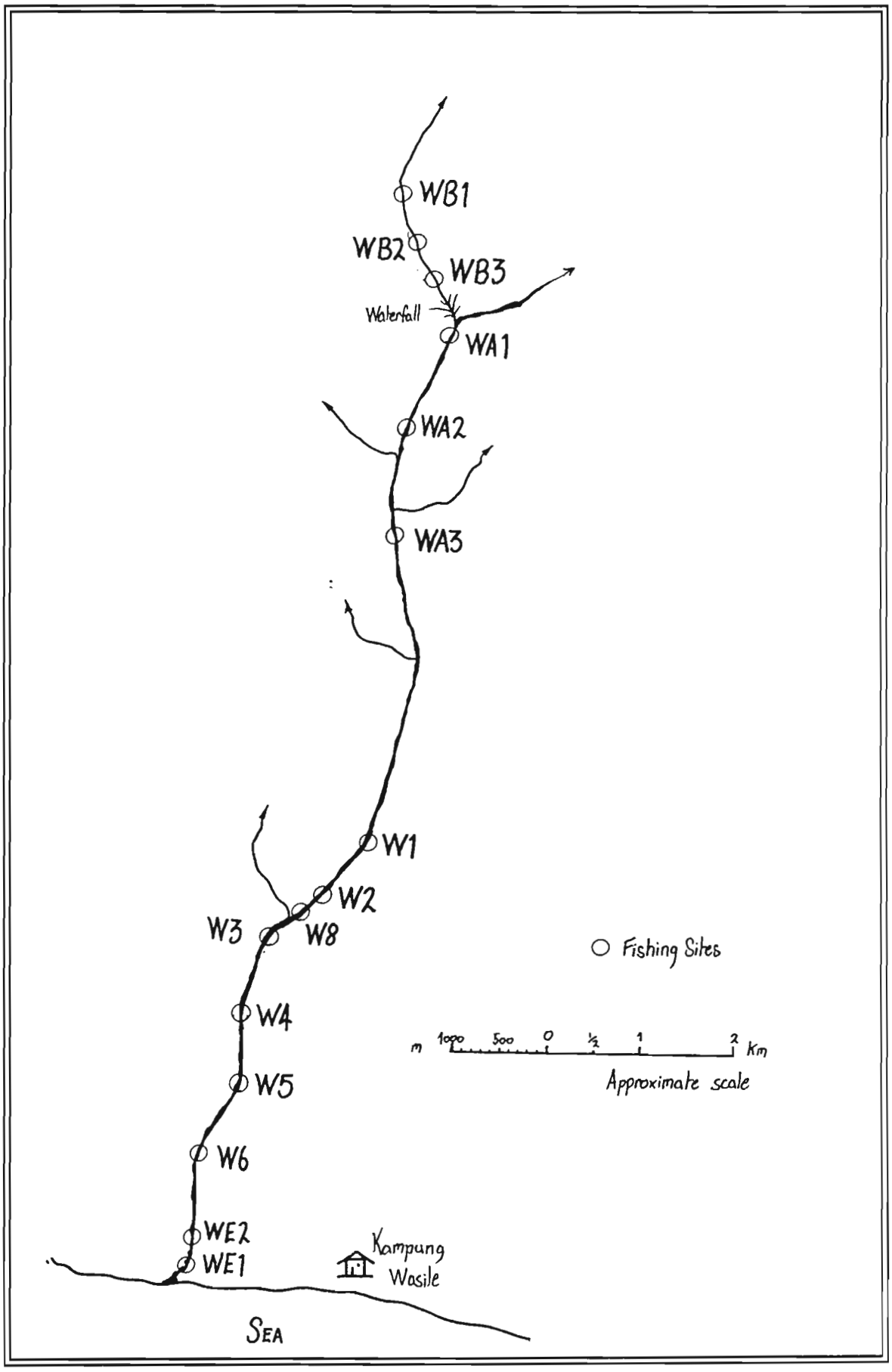
Sungai Ifis Estuary and Lower Stretches

Hippichthys
Microphis
Hypseleotris
Labroides
Eleotris
Awaous
Plesiops
Amphiprion
Glossogobius
Sicyopterus
Stiphodon
Apogonidae

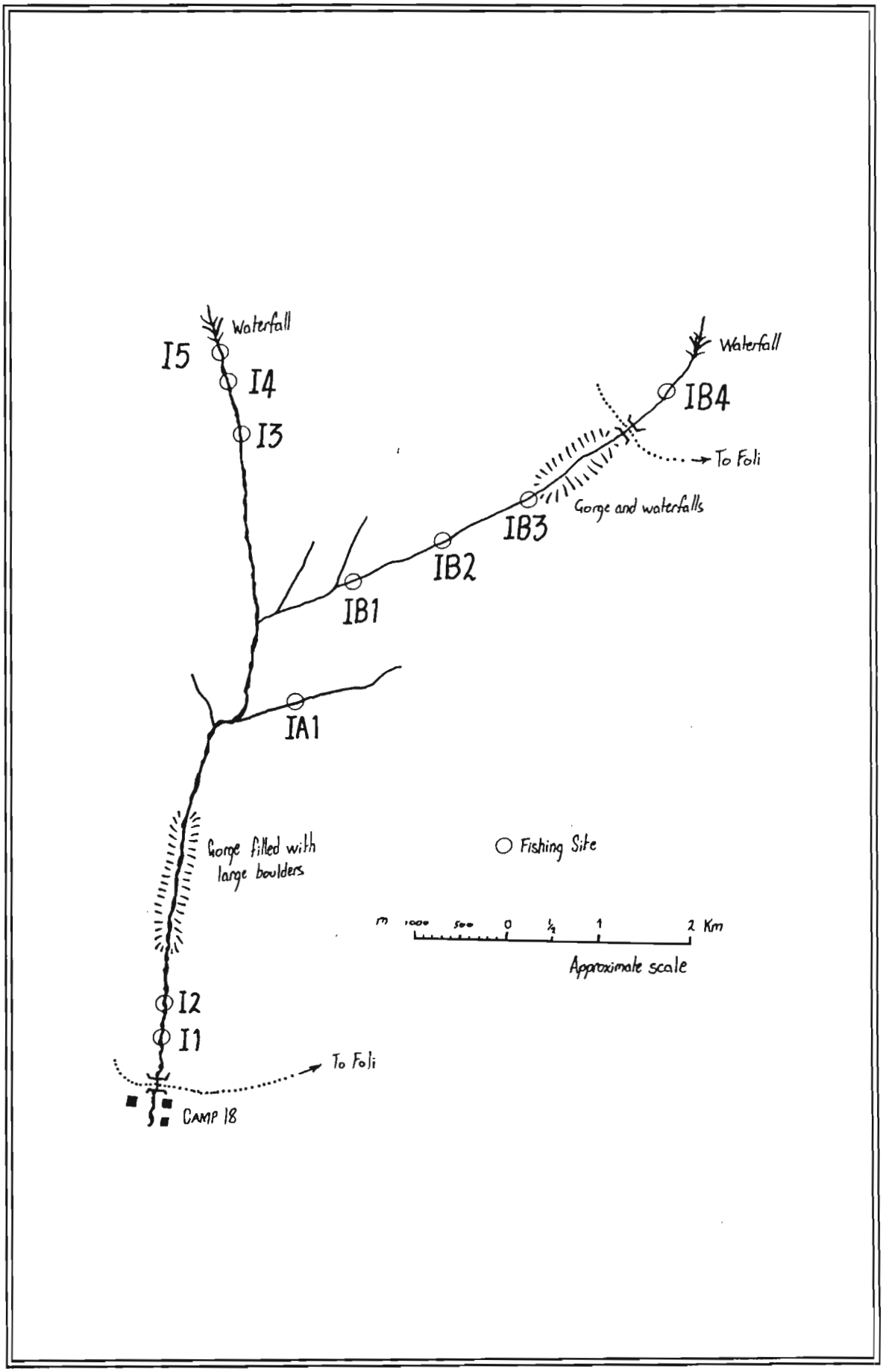
Sungai Iga

Pandaka
Stiphodon
Stegastes
Mugilidae
Ambassis
Abudefduf
Tetraroge
Toxotes
Apogon

Map 4.5.1. Sungai Oketai showing the sites at which fish were collected.



Map 4.5.2. Part of S. Ifis showing the sites at which fish were collected.



4.6 ENTOMOLOGY PROJECT

Report by Lizzie Harper and Dr. Peter Hammond.

Aims

The entomological aims of the expedition were to prepare collections of a variety of invertebrate groups and to run four quantitative Flight Intercept Traps (FITs).

Collections

Due to the need to run the FITs at one site for the duration of the expedition, all collections were taken from the Sungai Oketai region where the base camp was located. Within this region fieldwork was conducted in two areas: immediately around the base camp and at the 'Study site' located about half a mile upstream on a tributary of S. Oketai. Prior to leaving for the field we were asked by members of staff at the Bogor Zoological Museum to collect from some specific groups which we had not previously intended to concentrate upon.

Lepidoptera

Specimens were caught in a butterfly net and preserved with habitat notes in coded paper envelopes. Larger specimens were preserved by ethanol injection. All were stored in an air-tight box containing silica gel to prevent mould formation.

The collection was deposited at the Bogor Zoology Museum for identification by Djunijanti Peggie.

Odonata

Specimens were collected with a butterfly net and preserved with habitat notes in coded paper envelopes. Later, specimens were injected with ethanol in the thorax and abdomen for preservation. All specimens were stored in air-tight box containing silica gel to prevent mould. The collection was deposited at the Bogor Zoology Museum.

Hymenoptera

Specimens were captured in a butterfly net, in pitfall traps, or by hand and were all preserved in 70% ethanol. The collection was deposited at the Bogor Zoology Museum.

Coleoptera

Specimens were captured by hand, or with pitfall traps. Specimens from the base camp area and the study site were stored separately in 70% ethanol. All specimens were deposited at the Bogor Zoology Museum for identification.

Diptera

As Hymenoptera

Collembola

All specimens were collected with pitfall traps or by floating leaf litter in water. The collection was donated to the Bogor Zoology Museum.

Spiders

Specimens were collected with pitfall traps or by hand from the study site and base camp area, then stored in 70% ethanol. One small collection of specimens from the tree canopy were preserved separately as were some specimens found in a cave. The collection has been identified to generic level by Dr. Deeleman Reinhold in the Netherlands. Taxonomic revision of many Indonesian genera is required and this collection was too small to allow such an undertaking. **Table 4.6.1** lists the specimens that were captured; they have been returned to the Bogor Zoological Museum.

Table 4.6.1. Spiders collected near Sungai Oketai (35-70 metres).

FAMILY	GENUS	Notes
Segestriidae	*Ariadne* sp.	1 male, 1 female
Oonipidae	*Ischnothyreus* sp.	1 female
	Gamasomorpha sp.	1 male, 1 female
	Opopaea sp.	1 male missing abdomen
Clubionidae	*Matidia* sp.	1 male, 1 female
Heteropodidae	*Heteropoda* sp.	1 female, juveniles
	Heteropoda sp.	From limestone cave. large, not *venatoria*. 1 male, 2 females
Ctenidae	*Ctenus* sp.	1 female, damaged
Zodariidae	*Asceua* sp.	1 male
Thomisidae	unknown	1 male
Salticidae	unknown	6 species, none of which adult in both sexes.
Zoicidae	*Zoica* sp.	3 males
	Hahnia sp.	1 male
Theridiidae	*Theridion cf. tenuissimum*	males only
	'Janula'	1 female
Araneidae	*Anepsion* sp.	1 female
Linyphiidae	cf. *Parameioneta* , Locket	1 male

Pitfall Traps

Ten pitfall traps were run at the base camp and ten at the study site. Specimens from these went to a variety of different collections (see above). The traps were plastic cups with black interiors half-filled with water, washing-up liquid (to reduce surface tension) and a small number of hydrochlorate crystals to discourage mould.

The traps were checked and sorted every other day for the duration of the expedition (27/07/94- 30/08/94). Quantitative data on numbers of individuals per order was taken for two weeks, from 15/08/94 until 29/08/94. During this time, two supplementary bucket pitfalls were run at base camp to increase the yield of Collembola, hence the discrepancies between numbers caught at the two sites (see **table 4.6.2**).

Table 4.6.2. Number of individuals from invertebrate orders which were captured in Pitfall traps.

Date	Location	Diptera	Collembola	Hymenoptera	Coleoptera	Spiders	Orthoptera	Lepidoptera	Dermaptera	Tick	Homoptera	Isoptera	Myriapoda	Isopoda
15/08	Ss[1]	17	11	5	15	1	2	1	3	2	2	0	0	0
17/08	Ss	17	30	13	13	3	4	0	5	2	0	2	0	0
19/08	Ss	22	22	29	14	5	0	0	5	0	1	0	0	0
21/08	Ss	30	33	22	8	4	4	0	6	1	0	2	1	0
23/08	Ss	48	18	6	11	1	4	0	4	0	5	1	0	0
25/08	Ss	24	25	23	17	4	0	2	21	0	6	0	0	0
27/08	Ss	15	1	16	5	2	1	1	10	4	1	0	2	1
16/08	Bc[2]	52	26	23	12	7	4	1	1	0	0	0	0	0
18/08	Bc	198	59	37	24	19	1	6	2	0	1	0	0	0
20/08	Bc	115	104	33	22	13	3	7	7	2	13	4	0	0
22/08	Bc	257	53	21	16	6	1	3	3	18	8	1	1	0
24/08	Bc	357	146	32	14	7	2	2	6	1	3	1	1	0
26/08	Bc	203	34	30	19	4	2	4	9	3	20	2	0	0
28/08	Bc	65	86	11	11	5	0	0	4	0	11	1	1	0

Notes: 1.Ss is the study site location
2.Bc is the Base camp location.

Flight Interception Traps

Introduction

Coleoptera (beetles) have been a frequent focus of recent studies aimed at determining the scale of local species richness of insects (and by extrapolation of all terrestrial arthropods) at various tropical sites. Obtaining a good understanding of the size of terrestrial arthropod assemblages at single sites (in moist tropical forests) where these are likely to be richest is an essential first step in estimating the numbers of species to be found at larger spatial scales. Flight interception trap samples have already played a part in establishing empirical relationships between beetle species richness at single sites in temperate and tropical forests and between single site and regional species richness. For example it has been shown that 2 flight interception traps (of the type used in Halmahera) operated each for 2 weeks in a 1-hectare plot, will normally obtain *ca* 18-21% of the beetle species present in that hectare. Samples from Halmahera make a useful addition to those already evaluated from tropical forests in Brazil, Costa Rica, Seychelles, Thailand, Sulawesi, Seram and Queensland, as well as from a range of temperate sites. Furthermore, for examining the relationship between species richness at the local (1 hectare) scale and the size of the 'regional' species pool, samples from Sulawesi, Seram (both already studied) and Halmahera, make an ideal 3-way comparison, as the 3 islands, while of different sizes, are in the same region, at the same latitude, and harbour faunules that are similar in composition at the genus level.

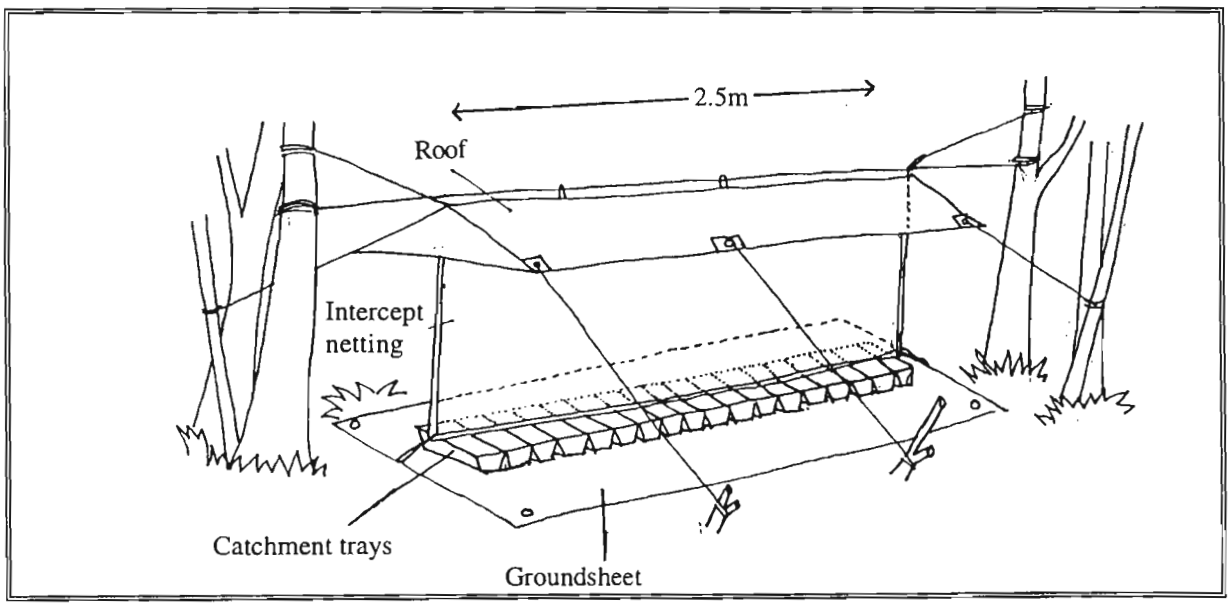
Methods

Four FITs were operated for five weeks, three in one hectare at the study site and one near base camp. These were erected and serviced following the specifications of Dr. Peter Hammond. A brief outline of the process is given below:

The FITs were erected in natural flight paths such as small breaks in vegetation (FIT A and FIT I), a bend of a stream (FIT II), or a dry stream bed (FIT III). They consisted of a tarpaulin roof and ground sheet (these prevent wash-out and mud-splash) and a black net interceptor (1 x 2.5m). The interceptor was tied as taught as possible, then 22 tin foil catchment trays were positioned below the interceptor (see **figure 4.6.3**). These were each filled one inch deep with a solution of water, washing-up liquid and hydrochlorate crystals (inhibiting bacterial breakdown). Insects fly into the interceptor and then fall into the catchment trays which were serviced every other day.

The servicing involved ensuring the interceptor remained taught, that the catchment trays were not empty of solution or leaking, and collection of the insects. This involved discarding leaves and removing large hymenopterans, orthopterans and dipterans for later sorting (general collections). The remainder were seived through a 140 micron strainer and then stored in 70% ethanol. Since the data collected were quantitative, attention was paid to ensure no specimens were left after each service; either in the catchment trays or in the seive. Catches were stored in 70% ethanol in small vials and each week's catch was grouped together. All specimens from FIT A, FIT I, FIT II and FIT III were stored separately. The specimens from FITs I, II and III were identified by Dr. P. Hammond at the BMNH. Data from FIT A (base camp) were sent to Bogor Zoology Museum.

Figure 4.6.3. Flight Interceptor Trap (FIT) in operation.



Information on the microhabitat of base camp and that of the study sites was noted, especially of the areas immediately proximate to the FITs. Information of weather conditions (rainfall, relative humidity and min/max temperature) during the expedition.

conditions (rainfall, relative humidity and min/max temperature) during the expedition. These were made available to the researchers responsible for identification and processing of the specimens. The reason for low numbers of specimens captured in the pitfall traps and general searches is almost certainly a result of the weather which was mostly very hot and dry due to the expedition coinciding with the dry season.

Description of microhabitats

BASE CAMP
Location:40m south-east of Sungai Oketai
Elevation:35m OD (10m above river)

Vegetation was dominated by trees of less than 20cm girth at breast height and there was a large amount of leaf litter. Light penetration was low and the soil remained dry throughout most of the study period due to low rainfall and the sandy nature of the soil. In forested areas the wind speed was low. The river below camp was 10m across with low flow and low discharge. The river banks consist of large boulders, coarse sand and gravel.

STUDY SITE
Location:10-40m west of Sungai Oketai
Elevation:70m OD (5m above river)

Vegetation was mainly small trees with some larger emergents (see **section 4.1**). The soil was dark and slightly moist, especially in the buttresses of trees. There was a shallow layer of undecomposed leaf litter. Windspeed was low due to thick vegetation. The river in the site was small (1-4m across) and had low, slow flow over gravel and large boulders. It followed a winding course, initially flowing south but then altering to a westward direction.

Preliminary results

Analysis of the Halmaheran flight interception trap samples of beetles is under way. Preliminary results suggest that the local species richness (1ha, 50ha and 500ha) of beetles reflects the size of the island and the size of the beetle species-pool for the island as a whole.

Table 4.6.3. FIT catches of Coleoptera from tropical forest in Halmahera

Family Group	Trap 1		Trap 2		Trap 3	
	Individuals	Species	Ind.	Spp.	Ind.	Spp.
Carabidae	-	-	5	3	-	-
Dytiscidae	2	1	6	2	2	2
Hydrophilinae	1	1	13	4	1	1
Sphaeridiinae	2	1	38	5	1	1
Histeridae	3	2	20	7	5	3
Ptiliidae	14	5	137	18	9	4
Hydraenidae	-	-	17	3	1	1
Leiodidae	103	16	195	15	65	10
Scydmaenidae	63	18	23	11	28	13
Omaliinae	-	-	1	1	-	-
Osoriinae	-	-	23	7	3	1
Oxytelinae	20	4	67	9	15	4
Megalopininae	1	1	1	1	1	1
Euaesthetinae	4	3	13	4	2	2
Paederinae	49	10	136	20	36	7
Staphylininae	35	11	158	16	20	8
Tachyporinae	49	3	113	5	32	2
Aleocharinae	293	25	297	43	143	19
Pselaphidae	26	13	40	14	31	9
Scaphidiidae	7	3	55	11	11	6
Scirtidae	-	-	7	1	-	-
Acanthoceridae	1	1	-	-	3	1
Geotrupidae	2	1	13	1	-	-
Scarabaeinae	106	5	72	3	51	3
Rutelinae	-	-	1	1	-	-
Ptilodactylidae	1	1	8	2	2	2
Limnichidae	-	-	57	3	-	-
Buprestidae	-	-	-	-	1	1
Throscidae	9	4	3	1	5	4
Eucnemidae	2	2	-	-	3	3
Lycidae	1	1	2	2	1	1
Cantharidae	1	1	-	-	-	-
Anobiidae	1	1	-	-	-	-
Ptinidae	-	-	-	-	1	1
Cleridae	-	-	1	1	-	-
Lymexylidae	1	1	-	-	-	-
Stylopidae	1	1	-	-	-	-
Nitidulidae	79	9	65	5	52	11
Rhizophagidae	-	-	3	2	-	-
Phalacridae	4	1	-	-	-	-
Sphindidae	6	2	48	4	14	3
Cryptophagidae	1	1	-	-	-	-
Propalticidae	-	-	1	1	-	-
Biphyllidae	1	1	38	4	1	1
Languriidae	-	-	-	-	1	1
Erotylidae	1	1	-	-	-	-
Cerylonidae	1	1	2	2	1	1
Corylophidae	9	3	12	8	18	8
Endomychidae	3	3	2	2	11	4
Coccinellidae	2	2	1	1	2	1
Lathridiidae	5	2	1	1	7	3
Colydiidae	6	1	2	1	7	2
Bothrideridae	1	1	-	-	-	-
Mycetophagidae	-	-	2	1	1	1
Ciidae	-	-	3	1	-	-
Mordellidae	2	2	-	-	4	3
Pedilidae	6	2	-	-	3	1
Aderidae	5	4	1	1	2	1
Alleculinae	1	1	-	-	-	-
Tenebrionidae	1	1	-	-	-	-
Galerucinae	2	2	-	-	-	-
Alticinae	14	3	7	2	20	2
Anthribidae	2	1	-	-	1	1
Apionidae	-	-	1	1	-	-
Otiorhynchinae	-	-	-	-	1	1
Curculionidae	2	2	4	4	5	3
Scolytidae	24	12	215	23	21	9
Platypodidae	-	-	3	2	-	-
TOTAL	976	194	1933	280	645	167

Table 4.6.4. Proportional representation of Coleoptera groups in flight interception trap samples from two lowland tropical forest sites in the Indonesian region: 1. Halmahera ; 2. Sulawesi (Toraut).

Family	% all Coleoptera	
	Halmahera	Sulawesi
Aleocharinae	20	26
Leiodidae	10	2
Scolytidae	8	6
Scarabaeinae	7	10
Paederinae	6	3
Nitidulidae	6	6
Tachyporinae	6	1
Staphylininae	6	7
Ptiliidae	5	7
Scydmaenidae	3	1
Oxytelinae	3	7
Pselaphidae	3	1
Scaphidiidae	2	3
Spindidae	2	<1
Limnichidae	2	<1
Alticinae	1	<1
Sphaeridiinae	1	6
Biphyllidae	1	<1
Corylophidae	1	1
Histeridae	<1	4
Remainder (all <1% at each site)	8	9

4.7 MOLLUSC PROJECT

Report by Dr. Jaap Vermeulen, Rijksherbarium/Hortus Botanicus, P.O. Box 9514, 2300 RA Leiden, The Netherlands.

Methods

A collection of terrestrial and freshwater molluscs from the proposed Lolobata reserve was assembled by Rebecca Dix. Samples were obtained from 21 numbered sites in the area, the localities of which are listed in **table 4.7.2.**

The collecting of the terrestrial molluscs was mainly achieved by sorting through leaf litter; freshwater molluscs were picked from the beds of several major rivers. No soil samples were taken; the collection therefore consists mainly of shells of species larger than 5mm.

The collection sustained some damage during transfer to the Natural History Museum in Leiden: the shipment arrived in poor condition and it is estimated that some 5 specimens were shattered beyond recognition. These were discarded.

Results

The species collected are listed in **table 4.7.1.** The first figure in the Sample number column indicates the locality, the figure between brackets indicates the number of specimens collected at that site.

Discussion

On average, collecting sites on limestone bedrock yielded the largest numbers of species. Although no traces of small species (shells of a size between 0.5 and 5mm) were found in the field, these were certainly present: in some soil brushed off a specimen of *Pyrochilus lampas* 3 species were found, all about 1 mm across: *Queridomus fimbriosus*, *Lamprocystus* V 3605 and an unidentified Endodontid. Undoubtedly more tiny species would have been found if soil samples were gathered from the sites where larger species occur.

Surprising is the comparatively large number of species found on site 15, on non-calcareous loamy sand. Usually few snails live in such habitats. The specimens taken from the site all look fresh, apparently they have not been transported from elsewhere, by floods for example.

Generally fewer species have been found on sites situated on ultrabasic soil. No traces of small species were found in soil clinging to the shells. Elsewhere, *e.g.* on Borneo, areas with ultrabasic soil are usually inhabited by larger species only, rarely smaller species are found.

Although the collection is far too small to say anything with certainty, the collected specimens suggest that, as far as the larger species are concerned, the species composition of sites on limestone soil may differ somewhat from that of sites on ultrabasic soil.

Planispira exceptiuncula and *P. giloloensis* have only been found on limestone, *P. oxytropis* on ultrabasic.

Table 4.7.1. Mollusc species and localities from which they were collected.

Family/ Species	Sample no.	Notes
Cyclophoridae		
Cyclotus dohrni (Kobelt 1902)	16 (2)	Endemic to the North Moluccas
Leptopoma vitreum (Lesson 1831)	1 (1), 10 (2), 15 (1), 16 (1).	Widespread. Listed in Van Benthem Jutting (1959) as *L. perlucidum*.
Pupinidae		
Pupina solitaria (V. Mart. 1864)	5 (1)	Endemic to Halmahera
Camaenidae		
Albersia pubicepa (V. Mart. 1864)	10 (1), 15 (1).	Endemic to the North Moluccas
Obba calcar (V. Mart. 1864)	15 (1)	Endemic to Halmahera
Papuina vitrea (Fer. 1821)	15 (1), 16 (1)	Moluccas, New Guinea.
Planispira endoptychia (V. Mart. 1864)	15 (1)	Moluccas, New Guinea.
Planispira exceptiuncla (Fer. 1821)	10 (1), 21 (3)	Endemic to the North Moluccas
Planispira giloloensis (E.A. Smith 1896)	10 (1), 16 (6)	Endemic to Halmahera
Planispira loxotropis (Pf. 1850)	1 (2), 5 (2), 17 (2).	Moluccas, New Guinea.
Planispira zonalis (Pf. 1821)	1 (1), 5 (1).	Moluccas, New Guinea.
Planispira sp. (juv.)	15 (1)	
Trochomorphidae		
Videna planorbis (Lesson 1831)	5 (1), 16 (1)	Widespread throughout SE Asia.
Videna ternatana (Le Guillou 1842)	5 (1)	Moluccas, Sulawesi.
Euconulidae		
Coneuplecta taeniolata (V. Moell. 1902)	16 (1)	Endemic to the North Moluccas.
Queridomus fimbriosus (Quadr. & V. Moell. 1894)	10 (1)	Widespread but rather rare throughout SE Asia. **New record for Halmahera.**
Ariophantidae		
Lamprocystus V 3605	10 (1)	A very widespread species (Sumatra to the Moluccas and Aru islands) which has escaped all attention so far because of its minute size. I know the species from numerous localities, but I hesitate to describe it as new because it may prove to be an ubiquist for which a name is already available, based on specimens outside the range as it is known to me. **New record for Halmahera.**
Endodontidae		
sp. indet.	10 (1)	Probably a new species, but only a fragment of a shell present, too small to describe it properly.
Bradybaenidae		
Pyrochilus lampas (V. Mart. 1864)	10 (5)	Endemic to Halmahera.
Thiaridae		
Balanocochlis glans (V.D. Busch 1842)	6 (2), 11 (1), 13 (1).	Widespread throughout SE Asia.
Melanoides clavus (Lam. 1822)	7 (1)	Widespread throughout SE Asia. **New record for Halmahera.**
Melanoides granifera (Lam. 1822)	13 (10)	Widespread throughout SE Asia.
Melanoides punctata (Lam. 1822)	2 (1), 6 (4)	Widespread, exact range unknown.
Melanoides torulosa (Brug. 1789)	13 (1)	Widespread throughout SE Asia.
Neritidae		
Clithon diadema (Recluz 1841)	13 (2)	Widespread throughout SE Asia.
Clithon corona (L. 1758)	13 (3), 14 (8)	Widespread throughout SE Asia.
Clithon sqarrosus (Recluz 1843)	3 (1), 6 (2), 13 (1), 18 (7).	Widespread throughout SE Asia. **New record for Halmahera.**
Neritina pulligera (L. 1767)	8 (1), 13 (2), 18 (1).	Widespread throughout SE Asia.

All species except three could be identified up to species level; it can be concluded that the snail fauna of Halmahera is fairly well known as far as the larger species are concerned. Two species had to be left unidentified because of incomplete material (a juvenile specimen and a fragmented shell), for the third the reader is referred to the comments about *Lamprocystus* V 3605. Two out of the three unidentified species are small, less than 5mm. Because the smaller species have never been collected properly, and have been described only incidentally, soil samples from sites with a limestone soil would probably have drastically lowered the percentage of species identified to specific level. In South Sulawesi, where the present state of our knowledge of terrestrial molluscs is similar, the percentage of species identified to specific level may drop to 30% for carefully collected soil samples. A fair number of the unidentified species are undoubtedly undescribed.

It is surprising that two large and conspicuous fresh-water molluscs have been found which represent new records for Halmahera.

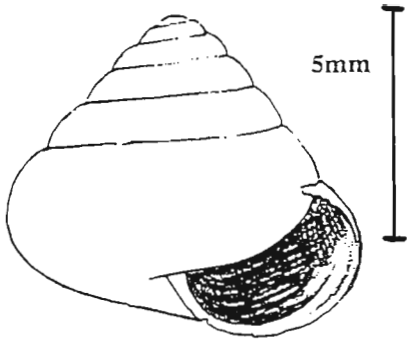
A checklist of the terrestrial and freshwater mollusca of Halmahera has been published:

Benthem Jutting, T. van, 1959. Non-marine mollusca of the North Moluccan islands Halmahera, Ternate, Batjan and Obi. *Treubia* **25**: 25-87.

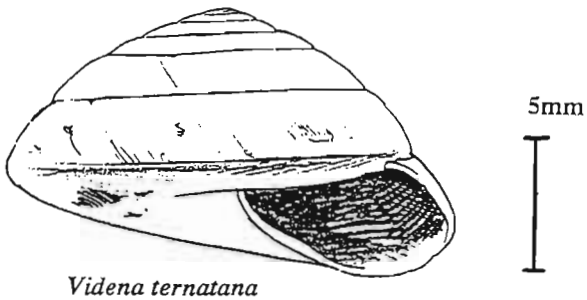
In addition to a duplicate collection, the bulk of this collection has been deposited at the Bogor Zoology Museum, Indonesia.

Table 4.7.2. Localities of mollusc sample sites

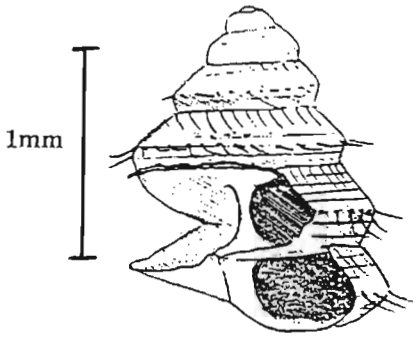
Sample	Date	Altitude	Description of collection site
1	25/7/94	60m	Leaf litter between tree buttresses on ultrabasic soils near S. Tolawi.
2	25/7/94	40m	The river bed of S. Oketai.
3	26/7/94	105m	The river bed of S. Oketai.
4	25/7/94	85m	Leaf litter on ultrabasic soils near S. Oketai.
5	26/7/94	85m	Leaf litter on a steep bank on ultrabasic soil near S. Oketai.
6	26/7/94	40m	The river bed of S. Oketai.
7	4/8/94	40m	The river bed of S. Oketai.
8	13/8/94	35m	The river bed of S. Oketai.
9	3/8/94	70m	Dead wood on ultrabasic soils near S. Oketai.
10	16/8/94	50m	Limestone karst in the S. Tolawi region.
11	13/8/94	35m	An area of sandy river bank at S. Oketai.
12	13/8/94	50m	The river bed of Sungai Tolawi. Five hours walk upstream from Loleba.
13	24/8/94	80m	The river bed at S. Dodaga.
14	24/8/94	20m	Collected from the lower reaches of Sungai Dodaga just outside Dodaga village in shallow water (20cm) with a pebbled bottom in a 20m wide, relatively fast flowing river.
15	23/8/94	80m	Leaf litter layer on non-calcareous loamy sand mixed with a few igneous fine crystalline boulders from S. Dodaga region.
16	15/8/94	70m	Collected from leaf litter on limestone karst in the S. Tolawi region.
17	23/7/94	35m	Collected from the ultrabasic soil between tree buttresses near S. Oketai.
18	27/7/94	30m	Collected from the shallow, rocky river bed of S. Oketai.
19	25/7/94	35m	The S. Oketai river bed.
20	25/7/94	35m	The S. Oketai river bed.
21	Sept. 94	70m	Forest floor of forest on limestone (raised coral reef) near S. Ifis.



Coneuplecta taeniolata

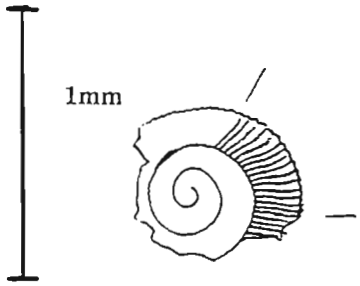


Videna ternatana



Queridomus fimbriosus

Pupina solitaria



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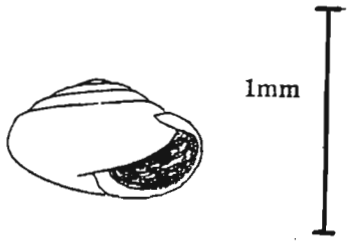
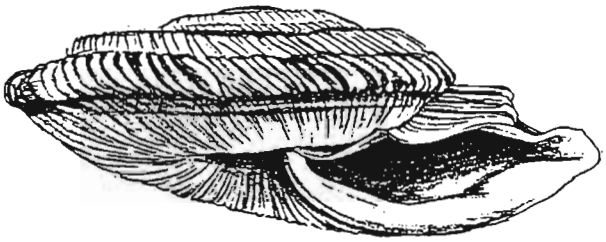
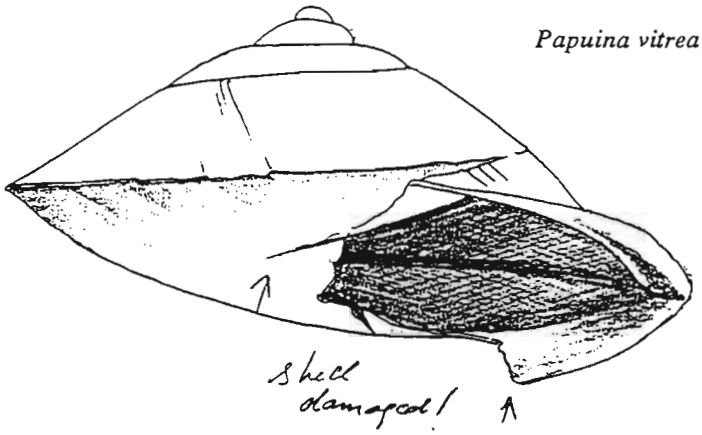


Lamprocystus V 3605

Obba calcar



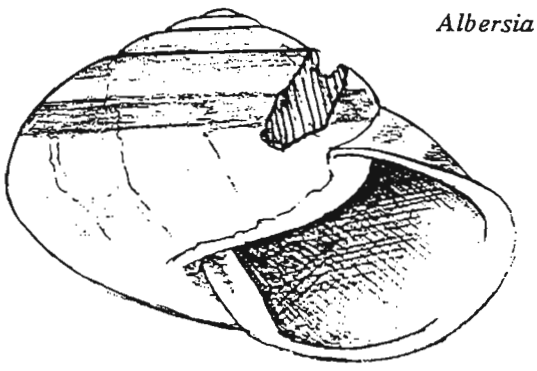
1cm



Papuina vitrea

1cm

Albersia pubicepa



2cm

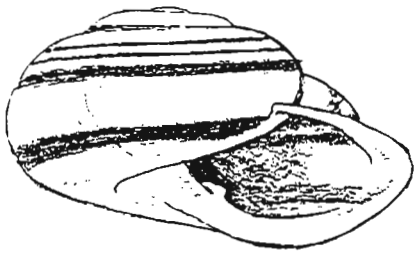
Planispira endoptychia

1cm

Planispira loxotropis

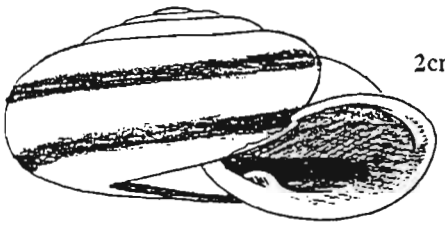
2cm

Planispira exceptiuncula



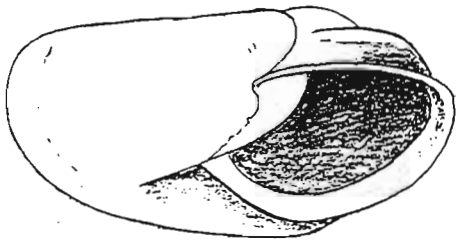
2cm

Planispira zonalis



2cm

Planispira giloloensis



2cm

5 BIOLOGICAL RESOURCES

5.1 Timber

There are four timber concessions on the north-east peninsula. The most southerly is owned by P.T. Erihatu. The company removed timber in the S. Tolawi region during the mid 1980s but operations have now ceased. Another company, P.T. JakTim, operates in the vicinity of Gurua from where timber is removed by ship. P.T. Nusa Padma is currently operating in the region between S. Ifis and S. Iga. Timber is transported by road to the harbour at Foli. The fourth company is P.T. Tunggal Agathis Indah Wood Industry (TAIWI) which is owned by the Barito Pacific group. The original concession holders P.T. Wijaya Indah Raya and P.T. Tria Esko have merged with TAIWI thereby creating a large concession which runs from Labilabi to Buli, following the coast and including most of the land which is not already *Hutan Lindung* (Protection Forest). TAIWI is currently operating in the region between S. Akelamo and S.Lili. All four concessions overlap to some degree with proposed reserve boundaries.

The most important timber trees in the lowland forests are Mersawa (*Anisoptera* sp.), Nyatoh (*Palaquium* sp.), Bintangor (*Calophyllum* spp.) and *Canarium* spp. Other saleable species include *Hopea* sp., *Vatica papuana*, Matoa (*Pometia pinnata*), Ebony (*Diospyros* spp.) and *Vitex gofassus*. At higher altitudes *Agathis* sp. is also removed; it is the most valuable timber species, providing high quality veneers for plywood. A study in the P.T. Green Delta concession on neighbouring Morotai (with similar species compositions) quotes an average saleable timber volume of 51.9m^3 per hectare. The Halmaheran logs are supplied mainly to the plywood factory at Sidangoli.

Concessionaires are obliged to remove timber on a selective basis according to the Temband Pilih Indonesia (TPI) system. Only trees of greater than 20cm diameter at breast height may be removed and replanting must be done on at least a one-for-one basis. At the P.T. Nusa Padma concession the most commonly replanted species were fast-growing *Albizia falcataria*, *Acacia* sp. and *Gamalina* sp.; slower growing forest species of the genera *Calophyllum*, *Canarium*, *Palaquium* and *Anisoptera* were also being collected from the forest as seedlings and then replanted in logged areas.

5.2 Minor forest products

Animals

As already mentioned pigs and deer are hunted for meat. Parrots are also collected to keep as pets or for sale to traders in Tobelo. Five species are targeted: white cockatoos (*Cacatua alba*), chattering lories (*Lorius garrulus*), violet-necked lories (*Eos squamata*), eclectus parrots (*Eclectus roratus*) and king parrots (*Alisterus amboinensis*). The latter is apparently uncommon and considered a good catch. Wild birds are captured by luring them to branches which have been covered in sticky sap. The luring can be done either by imitating calls or, more usually, by tying a captive bird to the tree too and let its calls attract more parrots. The parrot trade in the North Moluccas has been described by Lambert (1993). Megapode eggs are eaten by forest people and some are sold at coastal markets. Edible frogs, prawns, eels and freshwater fish are eaten by hunters on their trips.

Plant products

A number of rattan species occur in Halmahera's forests. Some of these, such as *Daemomorops robustus* and *Calamus* spp. are suitable for use in furniture manufacture and basketry. We found no evidence of large scale collection of these. *Agathis* are still tapped for their resins (damar). Prior to WWII this resin was shipped to Europe to supply the Copal trade. Now the resins are used locally in varnishes.

Groups of hunters also search for *'batu gaharu'* (eagleswood or aloeswood), the resin-stained heartwood of the *Aquilaria* spp. (Thymelaeceae) which occurs after the tree has been infected with a specific fungus. This *gaharu* yields an oil which is used for incense and as a traditional cure for asthma. The collection is very destructive since it involves cutting down the tree. Local hunters suggested as few as one in ten trees destroyed would actually yield saleable *batu gaharu.* The trunks of young trees are also purposefully cut half way through to facilitate infection by the fungus. The value of *gaharu* varies according to its colour, ranging from yellow to black, with black being the most precious.Traders arrive at the villages once or twice a year to buy gaharu. *Gonystlus bancanus* (Thymelaeceae) is a common substitute for *Aquilaria* spp. in Java's markets (Whitmore, 1973).

Other forest trees are locally important: *Myrstica fragrans* provides nutmeg and mace (the forest variety is larger and considered more valuable than the cultivated variety) whilst *Canarium indicum* produces the Kenari nut which is used in cookery and traditional medicines. The clove, *Syzgium aromaticum,* was first cultivated in the North Moluccas and may still occur wild in Halmahera. The leaves and fruit of *Gnetum gnemon* are an important local vegetable source for the island. The forest-dwelling 'Tugutil' still use sago from the sago palm (*Metroxylan sagu*) as their main carbohydrate source. The Tobelo people still use many trees and plants for traditional medicines and their particular properties. In the Tobelo language many species are named according ti their uses (Taylor, 1990). For instance certain timbers are used in boat building, another tree provides a waterproofing resin and some vines are classified according to their usefulness as lashings on boats. Only two or three species are used for spear shafts; similarly other woods are favoured for parang (machete) handles. Amongst the indigenous Tobelo people the forest folklore is still well known and used.

5.3 Conservation value of genetic resources

The preservation of genetic resources is globally considered essential for the maintenance of natural variation. This variation is important since it can be used for the improvement of cultivated plants and domesticated animals. Additionally it can be used in the development of industrial and medicinal products. In the U.S. approximately 40% of all drug prescriptions are compounds with plant origins (Whitten *et al.*, 1988) of which many are from the tropics. Many plant species are used in traditional medicines in cultures throughout the tropics; however the benefits of these plants are in many cases not known. The potential for ethnobotanical research is therefore immense. Unfortunately such a project was outside the scope of this expedition, but we were able to confirm that the Tobelo people and especially the forest-dwelling 'Tugutil' do continue to use such medicines. In his study of folk classification amongst the Tobelo, Taylor (1990) mentions some of the species which are used.

6 LAND USE

The information presented in this section has been collected opportunistically from a variety of sources. It is intended to describe current, planned and potential land-use which could have a bearing on the proposed reserve's establishment and management.

6.1 Economy

The local economy is based on the production of copra for oil. All villages have extensive coconut plantations, generally with each man owning between 1 and five hectares. The crop can be harvested 4 times each year and yields vary primarily depending upon soil type and age of the trees. Copra is transported by boat to either Kao or directly to Tobelo (for a slightly better price) for subsequent shipment to Surabaya where coconut oil is extracted and sold for cooking or margarine production.

Rice is becoming increasingly important and is exported from the transmigration site on the Subaim plains. Traditionally the local diet was based on a carbohydrate source from sago but this has now been replaced by rice. There is a large irrigation project in the area helping to promote conditions for wet rice agriculture. The project appears to be successful although prolonged dry spells during the last few years have caused some crop failures.

Other crops and fruit such as sugar cane, *Cacao*, bananas, breadfruit, cassava and peanuts are grown for private consumption. The palm *Arenga pinnata* has a variety of uses, providing leaves for roofing material and sap which can be made into red palm sugar or alcoholic beverages of varying strength.

The main source of protein is from small-scale fishing by villagers. However during our study period there was a shortage of fresh fish. Whether this signals over-fishing or a seasonal variation was unclear. During the expedition the only constant protein source was from ngafe (Clupeid), small fry which are dried in the sun and therefore keep for a few weeks. Traditionally Pulau Bobale on the northern side of Kao bay provided pearls and mother of pearl for export but overexploitation has caused this fishery to collapse, leaving just one remaining team of pearl divers.

Although forestry is the most lucrative industry it provides few jobs for the local people. Most of the skilled workers (chainsaw operators, drivers, mechanics) come from elsewhere, particularly Sulawesi. Forestry is discussed in **section 5.1.**

6.2 Regional development

Development in Indonesia is based on a system of 5 year plans (REPELITA) which work towards predefined goals. The country is currently in REPELITA VI, an aim of which is to increase the infrastructure to stimulate industrial development in eastern Indonesia. In Halmahera most development has traditionally occurred on the north peninsula, in particular around Tobelo and Galela. For approximately five years there has been a road link between Ternate and Tobelo. In the late 1980s local government control of central Halmahera was transferred from Ternate to the capital of Tidore, Soasio, and the new Kabupaten Halmahera (HALTENG) was formed.

HALTENG is little developed: there are few roads, no airport and most transportation is by boat. The local government plans to develop infrastructure for the region are outlined by PKDTII HALTENG (1993) and a brief summary is given here.

Essentially there will be two levels of development: Macro and Micro. At the macro level they plan to open the North Moluccas as a 'door to the north', hoping to initiate international trade with the Philippines and Japan. Also Buli, in Kec. Maba, is recognised as a major potential port which could be used to strengthen trade with Sorong in Irian Jaya.

At the micro level the aims can be summarised as follows:

1. Documentation of natural resources potential of the region.
2. Creation of central infrastructure to support development.
3. Documentation of economic output and potential for different areas.
4. Continuation of the resettlement of indigenous forest people.
5. Develop a clearer understanding of demographic patterns within the Kabupaten.

Map 6.1 shows the existing and planned infrastructure for the regions adjacent to the proposed reserve. **Map 6.2** shows the existing land-use designations for the peninsula.

Roads will be built around the coast. For some areas there are already existing forestry roads, many of which are no longer used. Where these are present they will be used.

Most villages have at least one privately owned boat capable of crossing Kao bay. The development of harbours at Subaim and Buli is planned. Subaim harbour already receives relatively large passenger boats from both Bobaneigo and Tobelo. During W.W.II the Japanese constructed two airfields near Lolobata. At present both of these are unusable but the local government hopes to re-open one of them.

The provision of clean water supplies, telecommunication facilities and electricity to each Kecamatan capital is a priority. Cemara Jaya (SP2), the capital of Kec. Wasile already has electricity.

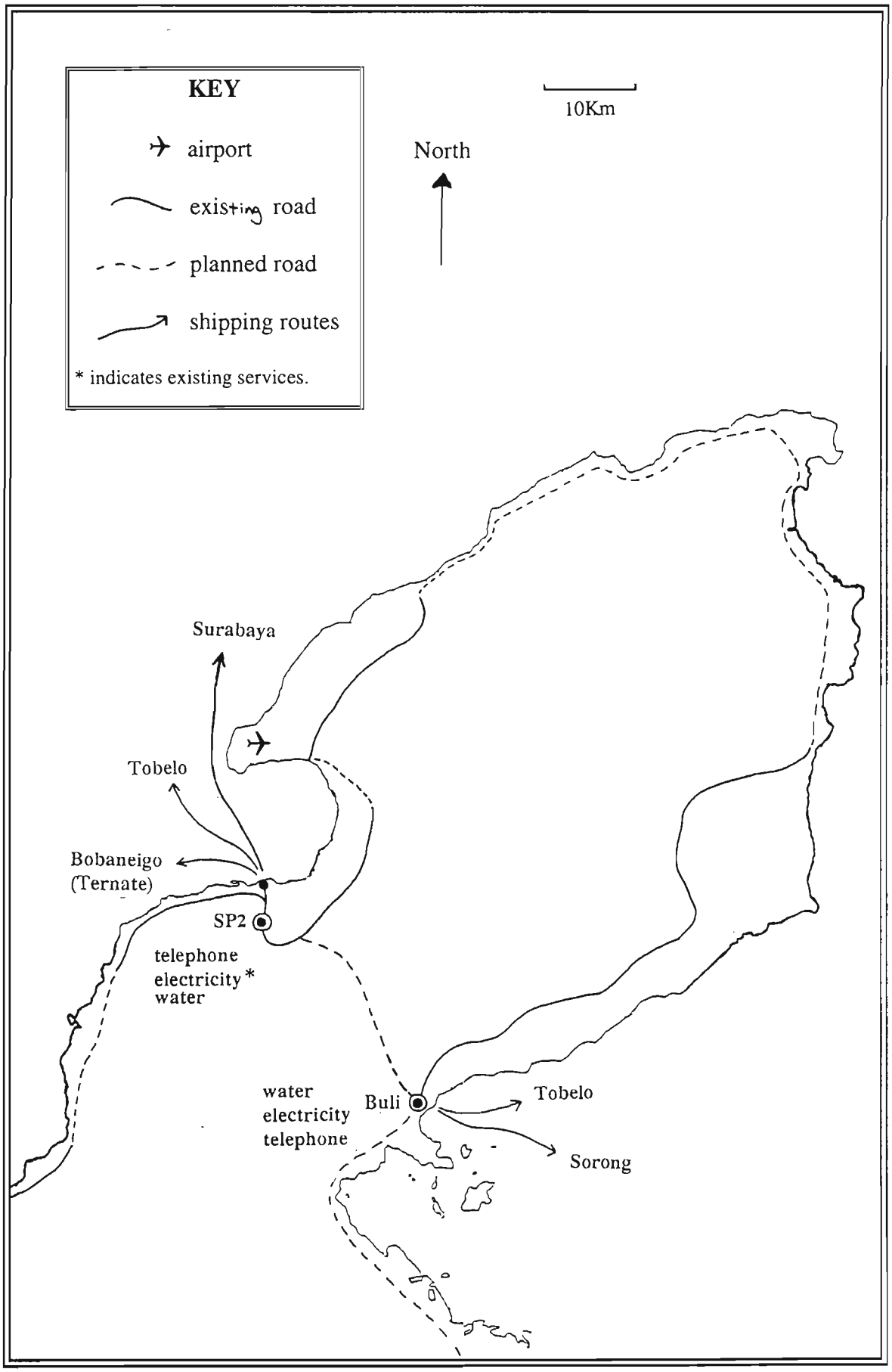
There are already two transmigration sites present on the peninsula: one at Subaim, the other at Nusajaya (formerly Ekor). There are also two more planned sites: one near Tatam, the other inland from Miaf (see **map 6.3**).

6.3 Mining

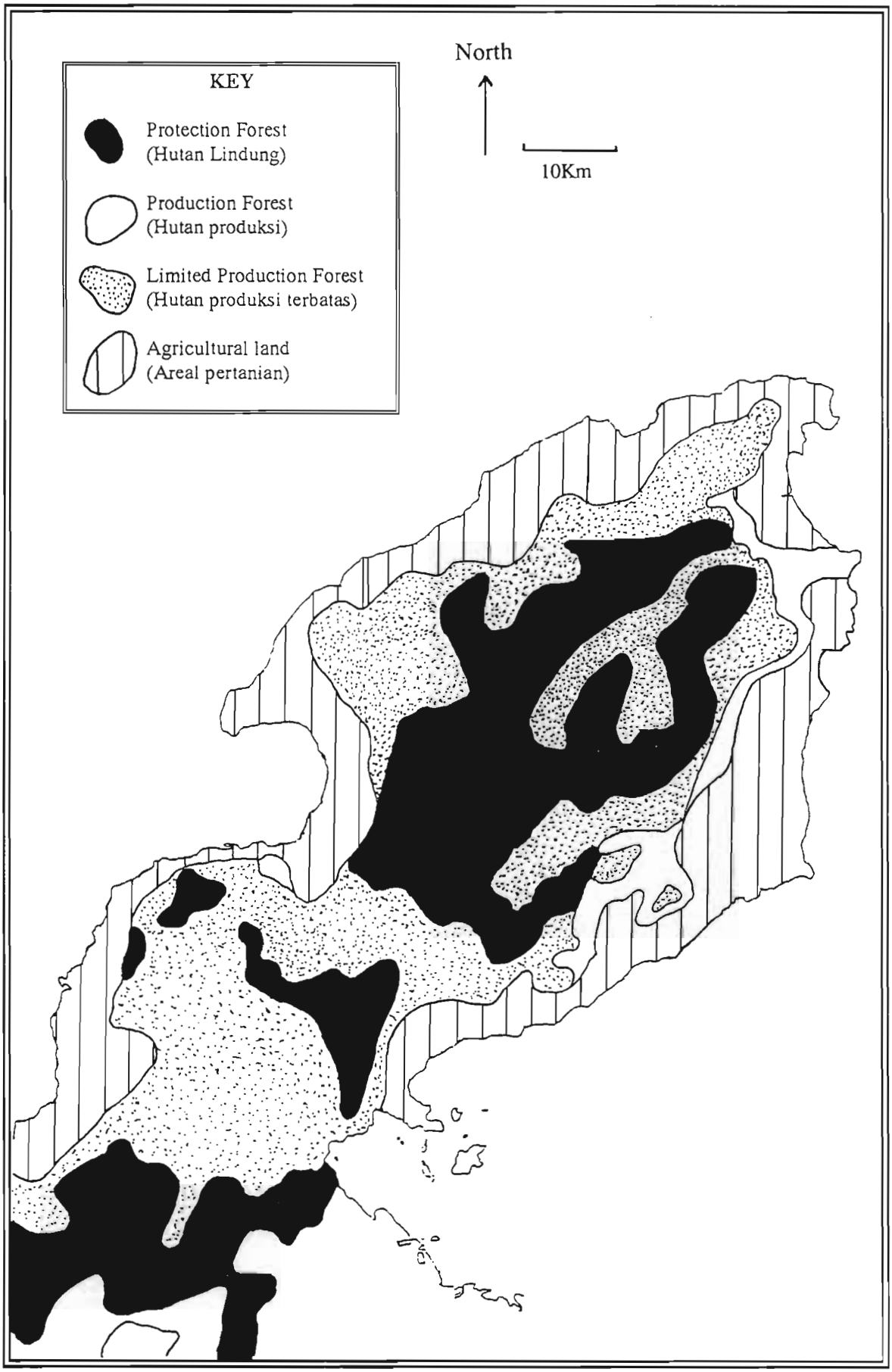
To our knowledge there are currently no large-scale organised mining activities on Halmahera's north-east peninsula. However a number of pilot surveys have been conducted and some mineral deposits have been identified. The deposit locations which have been reported to the BAPPEDA (Development planning) office in Soasio (Tidore) are reported on **map 6.3**.

Shortly before our arrival on Halmahera gold was discovered on a tributary of Sungai Onat, near Miaf. This caused a 'gold rush' with gold panners travelling from local areas, from Tobelo and even arriving on large ships from Sulawesi. When the police evicted these immigrants in early September there were approximately 4000 living along the river bank.

Map 6.1 Existing and planned infrastructure on the north-east peninsula



Map 6.2 Existing land-use designations for the north-east peninsula



The excitement caused by this discovery led to widespread searches on other rivers and at our last study site, on S. Ifis, near Hilaitetor, another gold source has been found. Approximately 200 people, mostly local, from Iga, Hilaitetor and Foli were panning in this region. Yields were variable but experienced panners claimed to be obtaining a gram of gold after about 4 days work.

There is a large scale copper mining operation on Pulau Gebe. Shortly before our departure it was rumoured that this company would be granted the mining rights for the gold deposits on S. Onat.

The local government's plan (PKDTII HALTENG, 1993) refers to plans for oil and gas extraction near Lolobata but gives no details. It also mentions Cromite mining sites near Buli and on Pulau Pakal but we have no confirmation of these.

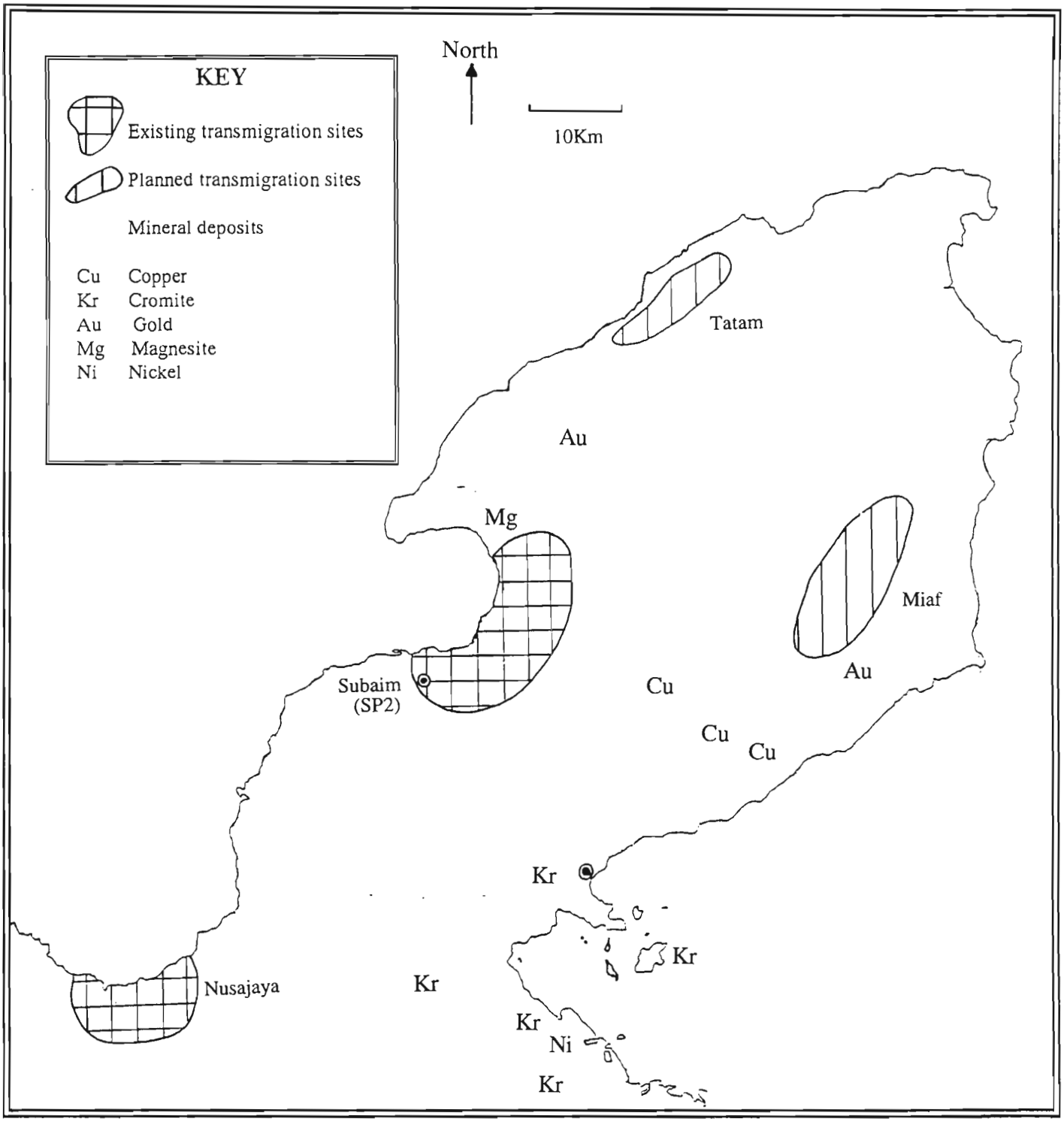
6.4 Tourism potential

The generation of income from tourism can be an important contribution of nature reserves to the regional economy. Indeed we found that local government officials and villagers felt that a reserve would be beneficial for that reason. However we think there is little tourist potential for the North Moluccas. It is difficult and expensive to visit from other areas of the archipelago. There are a small number of tourists who visit Ternate and some venture up the northern arm of Halmahera, particularly attracted to the diving off Pulau Bobale. Most of Halmahera's foreign visitors are birdwatchers who visit the area around Sidangoli in the hope of seeing some of the endemics. A very small number of people (perhaps five every year, and according to the visitor's book they are usually anthropology students) visit Dodaga to trek up the Dodaga river in search of the 'Tugutil'.

The existence of a reserve would probably be an incentive for some birdwatchers and those wanting 'jungle trekking'. In fact the area is already mentioned in at least one travel guide book (Muller, 1990) as a region for 'extremely arduous trekking'. There are also some war memorabilia such as old tanks, aircraft guns and possibly aircraft in the vicinity of Lolobata. However these are mostly in poor condition, resembling little more than rusty heaps of metal. Aesthetically the area is quite impressive with mountains rising up almost straight from the sea behind Fayaul and from the plains near Subaim. There are some topographical features such as waterfalls near Fayaul and underground river systems on S.Tutuling and Hilaitetor which may also be of interest. Caves in the area are important roost sites for many bat species which are easily disturbed and should therefore not be exploited for tourism. Even the underground river systems are unlikely to be of interest to foreign cavers who are more likely to head for the more impressive and famous systems on S. Sangea, Kec. Weda (Brouquisse, 1989).

In summary, the region has more potential for local tourism from Ternate and Tobelo than it does for foreigners. Even those tourists that do venture to north-east Halmahera are likely to be young 'travellers' unwilling to part with large sums of money. Divers, who have higher spending potential, are more likely to be attracted to Kao where there is already equipment, wrecked warships and coral reefs around Pulau Bobale.

Map 6.3 Potential land-use conflicts: Transmigration sites and known mineral deposits



Appendices

Appendix I

CURRENT BUDGET

The expedition's income was £16,990 of which £15,394 has been spent (as of 21st January 1996). The difference will pay for the production and distribution of this report and any remainder will contribute towards the cost of producing educational material (including a bat conservation poster) aimed at increasing the awareness of Halmahera's conservation needs within the region.

Table 6.1 Total expedition expenditure arranged by category.

Category	Expense in Indonesia (£)	Expense paid in U.K. (£)
International flights	400.00	2,188.00
Domestic flights		3,023.00
Local transport	922.92	
Freight	312.58	
Food	1,735.10	
Accommodation	468.41	
Communications	98.94	104.32
Visas and tax	84.50	157.50
Photocopying	85.40	
Insurance	170.67	480.00
Camping equipment	467.08	405.86
Scientific equipment	315.78	694.87
Medical	538.83	514.00
Photography	67.40	635.51
Counterparts	950.00	
Guides	378.00	
Miscellaneous	89.78	105.84
TOTAL	7,085.39	8,308.90

The medical expenditure in Indonesia was considerably higher than had been anticipated, due to three serious illness/injuries which required immediate medical attention. However the expenses incurred for each individual incident was insufficient to warrant us pursuing a claim with our insurers. The miscellaneous category consists primarily of expenses incurred during currency transfer and other bank charges.

The funding for this project was obtained from a variety of sources. We would like to thank the institutions listed in **table 6.2** for their generous financial contributions which made this project possible.

Table 6.2 Sources of funding

Source	Amount received (£)
Team member contributions	3,500
BP Conservation Expedition Awards	3,000
People's Trust for Endangered Species	3,000
Royal Geographical Society (with contribution from Rio Tinto Zinc Ltd.)	1,500
British Ecological Society	1,100
University of Bristol	1,010
Gilchrist Educational Trust	650
Vogelfreunde Achern	580
British Ornithologists' Union	500
Institute of Biology	330
Bird Exploration Fund	300
Lindeth Charitable Trust	250
A.S. Butler Trust	100
Harry Crook Foundation	100
T-shirt sales	500
Personal contributions	570
TOTAL RAISED	16,990

We are particularly grateful for the personal contributions from Ms. J. Cochrane, Commander R.M. Favell, Mr. N.S. Kok, Dr. A.U. MacKinnon, Dr. K. MacKinnon and Sir J. Morse.

A number of companies were also supportive of the project and we thank the following for the provision of equipment and services that allowed us to reduce expedition costs: Aquascribe, Bayer, BASF, Becton-Dickson, British Airways Assisting Nature Conservation, Cox Pharmaceuticals, Garuda Indonesia, Grangers, Kendall, Kodak UK, Konica UK, London Camera Exchange, Lonely Planet, Lwellyn Wynne, MASTA, Napp Lab, Nomads, NRA (National Rivers Authority), One World Tours, Pakistan International Airways, Quinoderm, Robinsons, Roche, Searle, Senton Healthcare, Swiss Cutlery UK, TDK, Thorntons travel, W.A. Ingrams and Zeneca.

Appendix II

BIRDS ENDEMIC TO THE MOLUCCAS AND FOUND ON HALMAHERA

English Name	Scientific Name	Present on Other Islands
Moluccan Sparrowhawk	*Accipiter henicogrammus*	Ba, Mo
Rufous-necked Sparrowhawk	*A. erythrauchen*	Ba, Mo, Ob, Bu, Am, Se
Dusky Scrubfowl	*Megapodius freycinet*	EX
Moluccan Scrubfowl	*M. wallacei*	Bu, Se, Am, Ba, Te, Misool
Invisible Rail	*Habroptila wallacii*	
Scarlet-breasted Fruit-Dove	*Ptilinopus bernsteinii*	Ba, Te, Ob
Blue-capped Fruit-Dove	*P. monacha*	Mo, Ti, Te, Mot, Da, Ka, Ba, Ob
Grey-headed Fruit-Dove	*P. hyogaster*	Ti, Te, Ba
White-eyed Imperial Pigeon	*Ducula perspicillata*	Mo, Da, Wi, Ka, Mot, Ti, Te, Ba, Ob, Bu, Se, Bo, Am, Sa
Cinammon-bellied Imperial Pigeon	*D. basilica*	Mo, Te, Ba, Ob
White-Cockatoo	*Cacatua alba*	Te, Ti, Ba, Ob
Chattering Lory	*Lorius garrulus*	Mo, Ra, Wi, Ba, Ob
Moluccan Cuckoo	*Cuculus heinrichi*	Ba
Giant Coucal	*Centropus goliath*	Ba, Ob, Ti, Mo
Halmahera Owlet-Nightjar	*Aegotheles crinifrons*	Ba
Blue-and-White Kingfisher	*Halycon diops*	Mo, Da, Te, Ti, Ba, Mot, Ob
Sombre Kingfisher	*H. funebris*	
Azure Roller	*Eurystomus azureus*	Ba, Te, Ti
Ivory-breasted Pitta	*Pitta maxima*	Mo, Ba
Moluccan Cuckoo-Shrike	*Coracina atriceps*	Se, Te, Ba
Halmahera Cuckoo-Shrike	*C. parvula*	
Rufous-bellied Triller	*Lalage aurea*	Mo, Te, Ka, Ba, Ob
Dusky-Brown Oriole	*Oriolus phaeochromus*	
Long-billed Crow	*Corvus validus*	Mo, Ka, Ba, Ob
Paradise Crow	*Lycocorax pyrrhopterus*	Mo, Ra, Ba, Ob
Standard-wing Bird Of Paradise	*Semioptera wallacii*	Ba
Slaty Monarch	*Myiagra galatea*	Mo, Ba, Te, Ob, SeL, Ka, Am, Bu
White-naped Monarch	*Monarcha pileatus*	Bu, Ta, Tan
White-streaked Friarbird	*Melitograis gilolensis*	Mo, Ba
Dusky Friarbird	*Philemon fuscicapillus*	Mo, Ba
Flame-breasted Flowerpecker	*Dicaeum erythothorax*	Bu, Mo, Ba, Ob
Moluccan White-eye	*Zosterops atriceps*	Mo, Ba

Key:

Am Ambon	Ra Rau
Ba Bacan	Sa Saparua
Bo Boano	Se Seram
Bu Buru	SeL Seram Laut
Da Damar	Ta Tayandu
Ka Kayoa	Tan Tanimbar
Mo Morotai	Te Ternate
Mot Moti	Ti Tidore
Ob Obi	Wi Widi

EX occurs outside Maluku.

After White and Bruce (1986)

Appendix III

CHECKLIST OF THE BIRDS OF HALMAHERA

English Name	Scientific Name	Halmahera '94
1.Red-throated Little Grebe	*Tachybaptus ruficollis tricolor*	
2.Streaked Shearwater	*Calonectris leucomelas*	
3.Wedge-tailed Shearwater	*Puffinus pacificus*	
4.Wilson's Storm Petrel	*Oceanites oceanicus oceanicus*	
5.Matsudaira's Storm Petrel	*Oceanodroma matsudairae*	
6.Great Frigatebird	*Fregata minor*	✓
7.Lesser Frigatebird	*F. ariel ariel*	✓
8.Little Black Cormorant	*Phalacrocorax sulcirostris*	
9.Little Pied Cormorant	*P. melanoleucos melanoleucos*	✓
10.Masked Booby	*Sula dactylatra personata*	✓*
11.Brown Booby	*S. leucogaster plotus*	✓
12.Australian Pelican	*Pelecanus conspicillatus*	
13.Great-billed Heron	*Ardea sumatrana*	✓
14.Great White Egret	*Egretta alba modesta*	✓
15.Intermediate Egret	*E. intermedia*	✓
16.Little Egret	*E. garzetta nigripes*	✓
17.Pacific Reef Egret	*E. sacra sacra*	✓
18.Cattle Egret	*Bubulcus ibis coromandus*	✓
19.Striated Heron	*Butorides striatus moluccarum*	✓
20.Rufous Night Heron	*Nycticorax caledonicus hilli*	
21.Japanese Night Heron	*Gorsachius goisagi*	
22.Chinese Little Bittern	*Ixobrychus sinensis*	✓
23.Black Bittern	*I. flavicollis*	✓
24.Glossy Ibis	*Plegadis falcinellus*	
25.Osprey	*Pandion haliaetus cristatus*	✓V
26.Crested Baza	*Aviceda subcristata rufa*	
27.Brahminy Kite	*Haliastur indus girrenera*	✓V
28.White-bellied Sea Eagle	*Haliaeetus leucogaster*	✓
29.Chinese Goshawk	*Accipiter soloensis*	
30.Variable Goshawk	*A. novaehollandiae griseogularis*	✓
31.Moluccan Goshawk	*A. henicogrammus*	✓
32.Rufous-necked Sparrowhawk	*A. erythrauchen erythrauchen*	✓
33.Meyer's Goshawk	*A. meyerianus*	✓
34.Grey-faced Buzzard	*Butastur indicus*	
35.Indian Black Eagle	*Ictinaetus malayensis*	
36.Gurney's Eagle	*Aquila gurneyi*	✓V
37.Little Eagle	*Hieraaetus morphnoides weiskei*	✓V
38.Spotted Kestrel	*Falco moluccensis moluccensis*	✓V
39.Oriental Hobby	*F. severus*	
40.Spotted Whistling Duck	*Dendrocygna guttata*	

41.White-headed Shelduck	*Tadorna radjah radjah*	✓
42.Dusky Scrubfowl	*Megapodius freycinet freycinet*	✓V
43.Moluccan Scrubfowl	*Eulipoa wallacei*	✓V
44.Blue-breasted Quail	*Coturnix chinensis lineata*	
45.Red-legged Crake	*Rallina fasciata*	
46.Buff-banded Rail	*Gallirallus philippensis yorki*	✓
47.Bare-eyed Rail	*Gymnocrex plumbeiventris*	
48.Bush Hen	*Amaurornis olivaceus moluccanus*	✓V
49.White-browed Crake	*Porzana cinerea leucophrys*	✓
50.Invisible Rail	*Habroptila wallacii*	
51.Pacific Golden Plover	*Pluvialis fulva*	✓
52.Grey Plover	*P. squatarola*	
53.Greater Sand Plover	*Charadrius leschenaultii leschenaultii*	
54.Lesser Sand Plover	*C. mongolus mongolus*	✓
55.Kentish Plover	*C. alexandrinus*	
56.Turnstone	*Arenaria interpres interpres*	
57.Great Knot	*Calidris tenuirostris*	✓
58.Sharp-tailed Sandpiper	*C. acuminata*	
59.Red-necked Stint	*C. ruficollis*	
60.Curlew Sandpiper	*C. ferruginea*	
61.Red-necked Phalarope	*Phalaropus lobatus*	✓
62.Greenshank	*Tringa nebularia*	
63.Marsh Sandpiper	*T. stagnatilis*	
64.Wood Sandpiper	*T. glareola*	✓
65.Terek Sandpiper	*Xenus cinereus*	
66.Grey-tailed Tattler	*Heteroscelus brevipes*	✓
67.Common Sandpiper	*Actitis hypoleucos*	✓
68.Little Whimbrel	*Numenius minutus*	✓*
69.Whimbrel	*N. phaeopus variegatus*	✓
70.Eurasian Curlew	*N. arquata orientalis*	
71.Far Eastern Curlew	*N. madagascariensis*	✓
72.Black-tailed Godwit	*Limosa limosa*	
73.Bar-tailed Godwit	*L. lapponica*	
74.Common Snipe	*Gallinago gallinago gallinago*	
75.Swinhoe's Snipe	*G. megala*	
76.White-headed Stilt	*Himantopus leucocephalus*	
77.Beach Thick-knee	*Burhinus magnirostris*	✓
78.Oriental Pratincole	*Glareola maldivarum*	
79.Pomarine Skua	*Stercorarius pomarinus*	✓
80.Whiskered Tern	*Chlidonias hybridus javanicus*	✓
81.White-winged Black Tern	*C. leucopterus*	
82.Gull-billed Tern	*Gelochelidon nilotica affinis*	
83.Common Tern	*Sterna hirundo longipennis*	✓
84.Roseate Tern	*S. dougallii gracilis*	✓
85.Black-naped Tern	*S. sumatrana*	✓*
86.Bridled Tern	*S. anaethetus anaethetus*	✓
87.Sooty Tern	*S. fuscata nubilosa*	✓
88.Spectacled Tern	*S. lunata*	✓
89.Little Tern	*S. albifrons sinensis*	✓

90.Chinese Crested Tern	*S. bernsteini*	
91.Crested Tern	*S. bergii cristata*	✓
92.Lesser Crested Tern	*S. bengalensis torresii*	✓
93.Brown Noddy	*Anous stolidus pileatus*	✓
94.Metallic Pigeon	*Columba vitiensis halmaheira*	✓
95.Spotted Dove	*Streptopelia chinensis tigrina*	✓V
96.Slender-billed Cuckoo Dove	*Macropygia amboinensis albiceps*	✓V
97.Great Cuckoo Dove	*Reinwardtoena reinwardtii reinwardtii*	✓V
98.Green-winged Pigeon	*Chalcophaps indica indica*	✓V
99.Nicobar Pigeon	*Caloenas nicobarica*	✓
100.Pink-necked Green Pigeon	*Treron vernans*	
101.Scarlet-breasted Fruit Dove	*Ptilinopus bernsteinii bernsteinii*	✓V
102.Superb Fruit Dove	*P. superbus superbus*	✓
103.Blue-capped Fruit Dove	*P. monacha*	✓V
104.White-breasted Fruit Dove	*P. rivoli prasinorrhous*	
105.Grey-headed Fruit Dove	*P. hyogaster*	✓V
106.White-eyed Imperial Pigeon	*Ducula perspicillata perspicillata*	✓V
107.Cinnamon-bellied Imperial Pigeon	*D. basilica*	✓V
108.Pink-headed Imperial Pigeon	*D. rosacea*	
109.Pied Imperial Pigeon	*D. bicolor*	✓V
110.White Cockatoo	*Cacatua alba*	✓V
111.Red-flanked Lorikeet	*Charmosyna placentis*	✓V
112.Chattering Lory	*Lorius garrulus garrulus*	✓V
113.Violet-necked Lory	*Eos squamata riciniata*	✓V
114.Moluccan Hanging Parrot	*Loriculus amabilis amabilis*	✓
115.Moluccan King Parrot	*Alisterus amboinensis hypophonius*	✓V
116.Red-cheeked Parrot	*Geoffroyus geoffroyi cyanicollis*	✓V
117.Eclectus Parrot	*Eclectus roratus vosmaeri*	✓V
118.Great-billed Parrot	*Tanygnathus megalorhynchus megalorhynchus*	✓V
119.Oriental Cuckoo	*Cuculus saturatus saturatus*	
120.Moluccan Cuckoo	*C. heinrichi*	
121.Brush Cuckoo	*C. variolosus infaustus/variolosus*	✓
122.Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*	✓*
123.Little Bronze Cuckoo	*C. minutillus minutillus*	
124.Pied Bronze Cuckoo	*C. crassirostris*	
125.Drongo Cuckoo	*Surniculus lugubris musschenbroeki*	
126.Common Koel	*Eudynamys scolopacea corvina*	
127.Channel-billed Cuckoo	*Scythrops novaehollandiae*	
128.Giant Coucal	*Centropus goliath*	✓V
129.Lesser Coucal	*C. bengalensis javanensis*	✓
130.Moluccan Scops Owl	*Otus magicus leucospilus*	✓
131.Moluccan Hawk Owl	*Ninox squamipila hypogramma*	✓
132.Barking Hawk Owl	*N. connivens rufostrigata*	✓
133.Brown Hawk Owl	*N. scutulata japonica*	✓*
134.Halmahera Owlet Nightjar	*Aegotheles crinifrons*	✓
135.Grey Nightjar	*Caprimulgus indicus*	
136.Large-tailed Nightjar	*C. macrurus schlegelii*	✓V
137.Moustached Tree Swift	*Hemiprocne mystacea confirmata*	✓V

138.White-bellied Swiftlet	*Collocalia esculenta spilura*	✓V
139.Moluccan Swiftlet	*Aerodramus infuscatus infuscatus*	✓V
140.Uniform Swiftlet	*A. vanikorensis waigeuensis*	✓V
141.Pacific Swift	*Apus pacificus pacificus*	
142.Common Paradise Kingfisher	*Tanysiptera galatea browningi*	✓V
143.Blue-and-white Kingfisher	*Halcyon diops*	✓V
144.Collared Kingfisher	*H. chloris chloris*	✓
145.Sombre Kingfisher	*H. funebris*	✓
146.Beach Kingfisher	*H. saurophaga saurophaga*	✓
147.Sacred Kingfisher	*H. sancta sancta*	✓
148.Variable Kingfisher	*Ceyx lepidus uropygialis*	✓
149.Little Kingfisher	*Alcedo pusilla pusilla*	
150.Azure Kingfisher	*A. azurea affinis*	✓V
151.Common Kingfisher	*A. atthis bengalensis/hispidoides*	
152.Rainbow Bee-eater	*Merops ornatus*	✓V
153.Broad-billed Roller	*Eurystomus orientalis orientalis/pacificus*	✓
154.Azure Roller	*E. azureus*	✓V
155.Blyth's Hornbill	*Rhyticeros plicatus ruficollis*	✓V
156.Blue-breasted Pitta	*Pitta erythrogaster rufiventris*	✓V
157.Ivory-breasted Pitta	*P. maxima*	✓V
158.Barn Swallow	*Hirundo rustica gutturalis*	✓
159.Pacific Swallow	*H. tahitica javanica*	✓V
160.Tree Martin	*H. nigricans*	✓
161.Black-faced Cuckoo Shrike	*Coracina novaehollandiae melanops*	✓*
162.Moluccan Cuckoo Shrike	*C. atriceps magnirostris*	✓V
163.White-bellied Cuckoo Shrike	*C. papuensis papuensis*	✓
164.Halmahera Cuckoo Shrike	*C. parvula*	✓V
165.Common Cicadabird	*C. tenuirostris grayi*	✓V
166.Rufous-bellied Triller	*Lalage aurea*	✓V
167.Golden Bulbul	*Ixos affinis chloris*	✓V
168.Spangled Drongo	*Dicrurus bracteatus atrocaeruleus*	✓V
169.Dusky-brown Oriole	*Oriolus phaeochromus*	✓
170.Long-billed Crow	*Corvus validus*	✓V
171.Australian Crow	*C. orru*	✓V
172.Paradise Crow	*Lycocorax pyrrhopterus pyrrhopterus*	✓V
173.Wallace's Standard Wing	*Semioptera wallacii halmaherae*	✓V
174.Blue Rock Thrush	*Monticola solitarius philippensis*	
175.Gray's Grasshopper Warbler	*Locustella fasciolata*	✓
176.Lanceolated Warbler	*L. lanceolata*	
177.Eastern Great Reed Warbler	*Acrocephalus orientalis*	
178.Arctic Warbler	*Phylloscopus borealis*	
179.Island Leaf Warbler	*P. poliocephala henrietta*	✓V
180.Grey-streaked Flycatcher	*Muscicapa griseisticta*	
181.Slaty Monarch	*Myiagra galatea galatea*	✓V
182.Shining Monarch	*M. alecto alecto*	✓V
183.Spectacled Monarch	*Monarch trivirgatus bimaculatus*	✓V
184.White-naped Monarch	*M. pileatus pileatus*	✓V
185.Island Monarch	*M. cinerascens cinerascens*	
186.Rufous Fantail	*Rhipidura rufifrons torrida*	

187.Willie Wagtail	*R. leucophrys melaleuca*	✓V
188.Golden Whistler	*Pachycephala pectoralis mentalis*	✓V
189.Drab Whistler	*P. griseonota cinerascens*	
190.Yellow Wagtail	*Motacilla flava simillima*	
191.Grey Wagtail	*M. cinerea cinerea*	
192.White-breasted Wood Swallow	*Artamus leucorhynchus leucopygialis*	✓V
193.Brown Shrike	*Lanius cristatus lucionensis*	
194.Island Starling	*Aplonis mysolensis mysolensis*	✓V
195.Shining Starling	*A. metallica metallica*	✓V
196.White-streaked Friarbird	*Melitograis gilolensis*	✓V
197.Dusky Friarbird	*Philemon fuscicapillus*	✓V
198.Olive Honeyeater	*Lichmera argentauris*	
199.Dusky Honeyeater	*Myzomela obscura simplex*	✓
200.Black Sunbird	*Nectarinia aspasia auriceps*	✓V
201.Olive-backed Sunbird	*N. jugularis frenata*	✓V
202.Flame-breasted Flowerpecker	*Dicaeum erythrothorax schistaceiceps*	✓V
203.Creamy-throated White-eye	*Zosterops atriceps fuscifrons*	✓V
204.Eurasian Tree Sparrow	*Passer montanus malaccensis*	✓*
205.Blue-faced Parrot-Finch	*Erythrura trichroa modesta*	✓V
206.Black-faced Munia	*Lonchura molucca*	✓V
207.Chestnut Munia	*L. malacca jagori*	✓

✓-denotes species recorded during the expedition
V- denotes species recorded during VCP fieldwork
*-denotes new record for Halmahera

141 species recorded during the expedition
7 new species for Halmahera
69 species recorded from VCP stations

Appendix IV

AMPHIBIANS AND REPTILES OF NORTH MOLUCCAS

Amphibia

Hyla ruappelli
H. infrafrenata
Oreophryne senckenbergia
Hylophorbus montanus
H. boetgeri
Hylophorbus dubius
Rana modesta
R. rugata
R. papua
Rana arfarki
Rhacophorus leucomystax

Reptilia

Snakes

Acanthophis antarsticus
Cylindrophis rufus
Calamorhabdium kukenthali
Chyrysopelea rhodopleuron
Chersydrus granulatus
Dendropis pictus
Tropidonotus trianguligerus
T. subminiatus
T. chrysargus
Calamaria vermiformis
Dryophis prasinus
Hydrus platurus
Hydrophis nigrocinctus
Typhlops braminus
T. flaviventer
T. ater
Python reticulatus
P. amethystinus
Enygrus carinatus
Dendrophis calligaster
Dendrelaphis caudolineatusmodestus
Tropidonotus truncatus
T. punctiventris
T. halmahericus
Zamenis dipsas
Stegonotus modestus
S. batjanensis
Brachyorrhus albus
1Cerberus rhynchops
Dipsadomorphus irregularis
Platurus laticaudatus
P. colubrinus

Lizards, Turtles and Crocodiles

Gymnodactylus marmoratus
G. fumosus
Hemidactylus frenatus
H. platyurus
Gehyra mutlata
G. oceanica
G. marginata
Lepidodactylus lugubris
Gecko vittatus
Calotes cristatellus
Lophura amboinensis
L. weberi
Varaus salvator
V. idicus
Tiliqua gigas
Lygosoma mentovarium
Dibanus novae-guineae
Cuora amboinensis
Indotestudo forsteni
Mabuia multifasciata
Lygosoma baudini
L. rufescens
L consobrinum
L. variegatum
L. smaragdinum
L. brevipes
L. noctua
L. fuscum
L. novae-guineae
L. cyanogaster
L. sorex
L. kuekenthali
L. cyanurum
L. atrocostatum
Crocodillus porosus
Chelonia mydas
Eretmochelys imbricata
Dermochelys coriaceae

After de Rooij (1915), van Kampen (1923), UNDP/FAO (1981b) and Taylor (1990).

Appendix V

TREE SPECIES RECORDED FROM HALMAHERA

Alangiaceae

Alangium javanicum
A. hassicum
A.villosum

Anacardiaceae

Buchanania amboinensis
B. arborescens
Dracontomelon mangiferum
Koordersiodendron pinnatum
Mangifera indica

Annonaceae

Cananga odorata
Polyalthia glauca
Saccopetalum horsfieldii

Apocynaceae

Altsonia scholaris
Cerbera floribunda
Lepiniopsis ternatensis
Ochrosia glomerata

Araliaceae

Boerlagiodendron palmatum

Araucaiaceae

Agathis sp. (*philippinensis* ?)

Burseraceae

Canarium asperum
C. commune
C. mehenbethne
Haplolobus celebicus
H. moluccanus

Caesalpiniaceae

Intsia bijuga
I. plurijuga
Kingiodendron sp.
Manilota sp.

Casurinaceae

Casuarina sumatrana

Celastraceae

Euonymus javanicus
Lophopetalum sp.

Combretaceae

Terminalia sp.
T. rubiginosa

Cunoniaceae

Weinmannia fraxinea

Dilleniaceae

Wormia sp.

Dipterocarpaceae

Anisoptera costat
Hopea sp.
Vatica papuana

Ebenaceae

Diospyros cauliflora
D. ebenum
D. lolin
D. rumphii
D. ulo

Elaeocarpaceae

Sloanea sp.

Erythroxylaceae

Erythroxylon sp.

Euphorbiaceae

Bischoffia javanica
Blumeodendron tokbrai
Cleistanthus myrianthus
Macaranga tanaria
Endospermum moluccanum
Pimeleodendron ambionicum

Flacourtiaceae

Homalium foetidum

Gnetaceae

Gnetum gnemon

Guttiferae

Calophyllum inophyllum
C. soulattri
Garcinia dulcis

Hernandiaceae

Hernandia ovigera

Icacinaceae

Stemonurus javanicus

Lauraceae

Cinnamomum xanthoneurum
Cryptocarya costata
Dehaasia microcarpa
Litsea cubeba
Nothaphoeba sp.

Lecythidaceae

Crateriphytum moluccanum
Strychnos sp.

Meliaceae

Aglaia ap.
Chisocheton sp.
Dysoxylum arborescens

Mimosaceae

Paraserianthes falcataria
P. saponaria

Moraceae

Artocarpus dasyphyllus
A. incisus
Ficus gibbosa
F. variegata
Paratrophis phillippinensis
Pseudotrophis sp.

Myristicaceae

Decaspermum fruticosum
Eugenia aromatica
Tristania sp.

Nyctaginaceae

Pisonia longirostris

Palmae

Calamus sp.

Papilionaceae

Pterocarpus indicus

Podocarpaceae

Dacrydium elatum
Podocarpus rumphii

Rhizophoraceae

Carallia brachiata

Rosaceae

Pygeum sp.

Rubiaceae

Mastixodendron pachyclad
Nauclea mitragyna
Neonauclea schlechteri

Sapindaceae

Euphoria sp.
Paranephelium sp.
Pometia pinnata
Tristiropsis canaroides

Sapotaceae

Burckella sp.
Mimusops elengi
Palaquium javanse
P. lobbianum
Planchonella firma

Simarubaceae

Ailanthus malabarica

Sonneratiaceae

Duabanga moluccana

Sterculiaceae

Heritiera sylvatica
Sterculia macrophylla

Theaceae

Ternstroemia sp.

Ulmaceae

Celtis sp.
C. wightii

Urticaceae

Laportea amplissima
Pipturus sp.

Verbenaceae

Avicennia officinalis
Vitex cofassus

Source: Hildebrand (1951)

Appendix VI

THREATENED SPECIES OCCURRING ON HALMAHERA

Class	Species	English name	RDB status	Other status
Mammalia	*Emballonura raffrayana*	Raffray's Sheath-tailed bat	K	
	Hipposideros papua	Geelvink Bay Leaf-nosed bat	R	
Aves	*Megapodius wallacei*	Moluccan Scrubfowl	R	
	Habroptila wallacei	Invisible Rail	I	
	Cacatua alba	White Cockatoo	E	
	Philemon fuscicapillus	Dusky Friarbird	R	
	Lorius garrulus	Chattering Lory		N[1]
	Todirhampus funebris	Sombre Kingfisher		N
	Lycocorax pyrrhopterus	Paradise Crow		N
	Semioptera wallacei	Standard-wing Bird of Paradise		N
Reptilia	*Indotestudo forstenii*	Travancore Tortoise	R	
	Crocodilus porosus	Estuarine crocodile	V	
	Chelonia mydas	Green Turtle	E	
	Eretochelys imbricata	Hawksbill Turtle	E	
	Dermochelys coriaceae	Leatherback Turtle	E	
Insecta	*Ornithoptera croseus*		V	
	Chalicodoma pluto	Wallace's giant bee	E	

Notes: 1. N: considered near-threatened by Collar N.J. and Andrew P. 1988.

The codes for RDB status are:

- E: Endangered
- V: Vulnerable
- R: Rare
- I: One of the above but insufficient data
- K: Suspected to be threatened

RDB Source: IUCN (1990).

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James MacKinnon (Leader):	Graduate zoology student from the University of Bristol. Responsible for the mammal project.
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