A COMPARATIVE STUDY OF THE HABITATS OF THE UPPER IMBANG-CALIBAN WATERSHED, NORTH NEGROS FOREST RESERVE, NEGROS OCCIDENTAL, PHILIPPINES

TECHNICAL PUBLICATION OF THE NEGROS RAINFOREST CONSERVATION PROJECT: A COLLABORATIVE INITIATIVE BETWEEN THE NEGROS FORESTS AND ECOLOGICAL FOUNDATION, INC. AND CORAL CAY CONSERVATION

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Contents

List of Tables

List of Figures

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1. Introduction

1.1 The Negros Rainforest Conservation Project (NRCP)

The Negros Rainforest Conservation Project (NRCP) is a joint programme of co-operative research, education and training between the Negros Forests and Ecological Foundation Inc. (NFEFI) and Coral Cay Conservation (CCC). The NRCP is based in the Tropical Montane Cloud Forests of the North Negros Forest Reserve (NNFR), in Negros Occidental, Negros, Philippines (See Turner *et al.*, 2001).

1.2 Background

The Philippines is one of 17 megadiversity countries, with more than 52,177 described species. Over 57% of the major faunal and floral groups occur nowhere else in the world (Oliver & Heaney 1996). Only 6% of the countries remaining forest and 704 species are listed on the 2004 IUCN Redlist (an increase of 286 species), making the country one of the 25 global biodiversity hotspots.

The Philippines is one of only a few countries that is both a megadiversity country and a biodiversity hotspot, and per hectare may harbour more biological diversity than any other country in the world (PBCPP 2002). This biodiversity is continually under threat through habitat destruction, alteration and fragmentation.

Due to the nature of the Philippine Archipelago, which consists of over 7,000 islands, high levels of endemism and restricted range species have evolved. Such endemicity is shown across major taxonomic groups with 64% of land mammals, 44% of breeding land birds, 65% of reptiles and 77% of amphibians being endemic to the Philippines (PBCPP 2002). Thus conservation has to be comprehensive enough to ensure all species are represented across all the islands and across all biogeographical regions.

The Philippine Biodiversity Conservation Priority-setting Programme (PBCPP 2002) recently conducted detailed assessments of the data from five taxon based themes (plants, arthropods, amphibians and reptiles, birds and mammals) two ecosystem-based groups (inland and coastal waters); and one socio-economic group resulting in the identification of priority areas within the Philippines. These results in relation to the project site and the North Negros Forest Reserve (NNFR) are discussed.

1.3 The North Negros Forest Reserve

The NNFR on Negros Island falls within the Greater Negros – Panay region (location of NNFR see figure 1.1). Under the PBCPP (2002) the NNFR is designated at importance level ‘very high’ for terrestrial and inland water areas of biological importance; ‘extremely high critical’ for terrestrial and inland waters conservation priority areas; a priority area for conservation and research of arthropods; ‘extremely high’ conservation priority area for amphibians and reptiles; ‘extremely high’ conservation priority for birds; ‘extremely high’ priority area for terrestrial mammals; ‘very high’ area of socio-economic pressures and is identified as an area that should be developed as a terrestrial biodiversity corridor.

The results of the PBCPP further support the need for research within the NNFR in all major taxonomic groups. It is this research that will underpin the successful management of the forest resources and the watershed area.

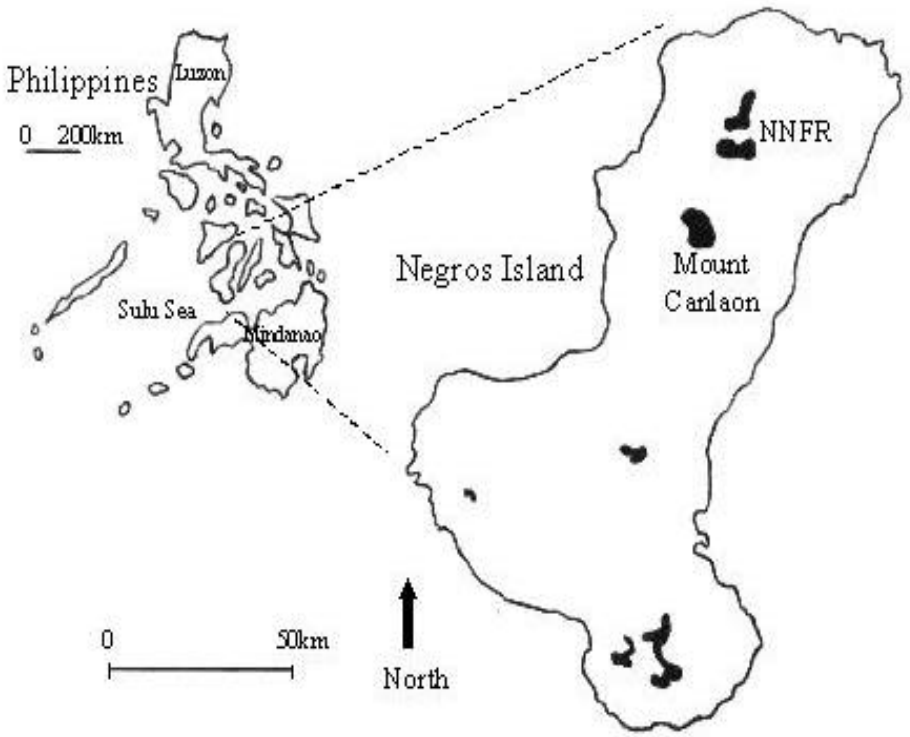

Figure 1.1. The remaining forest patches of Negros Island and the location of the North Negros Forest Reserve (NNFR) within Negros Island, Philippines.

Negros Island only has 4% of its original forest cover (Turner *et al.*, 2001), of which the major component of this remaining forest is the NNFR. Many endemic vertebrate species such as threatened hornbills (*Penelopides panini* and *Aceros waldeni*), the endangered (WCSP 1997) Philippine spotted deer (*Cervus alfredi*), and the Philippine warty pig (*Sus cebifrons*) inhabit these forested areas and records of these species in the NNFR have been made. The latter two species have been extirpated from 95% of their former range (Cox 1987) having once been common throughout the West Visayas but are now extinct on the islands of Cebu, Guimaras and Masbate. Their status and distribution on Negros is very poorly known and information is urgently needed for effective conservation and management.

In addition to harbouring immense biological diversity, the NNFR is also a source of vital ecosystem goods and services. For example, it provides many non-timber forest products (NTFPs) such as Rattan and Bamboo, and also protects six vital watersheds for the north Negros area, providing a clean and controlled supply of water to the provincial capital and other areas. Large scale flooding as a result of deforestation is becoming more common, and consequently has huge social and economic costs. The case to preserve the remaining forested watersheds for environmental and socio-economic reasons is clear. The Foundation for the Philippine Environment (FPE) has

therefore stressed the need to develop strategies to preserve and sustain the NNFR and its stakeholder communities.

1.4 Survey Locations

Survey locations were identified in six different habitat types, within each of the habitat types two survey sites were identified for conducting faunal surveys. All NNFR survey sites are situated in montane and sub-montane regions within the Upper Imbang - Caliban watershed. Surveys were conducted from May 2003 to May 2004.

Detailed inventory work on the species in lowland dipterocarp forests have been conducted throughout the Philippines, however, less has been completed on the sub montane and montane regions and forest fragments, including the NNFR. The forest fragment of the NNFR has been included in the IUCN category of the highest conservation priority (Dinerstein *et al.*, 1995) and has also been identified as a centre of plant biodiversity (Davis 1995).

Table 1.1 Survey locations by habitat type

Survey Location	Habitat Type
Mawa	Old Growth
Bagiawanan	Old Growth
Aeroplano	Disturbed Old Growth
Ginhawanan	Disturbed Old Growth
Palahawayan I	Secondary
Dam	Secondary
Crater I	Mossy
Crater II	Mossy
Caliban	Riparian
Palahawayan II	Riparian
Staff House	Edge
James's farm	Edge

The Old Growth region is characterised by containing canopy families such as Dipterocarpaceae, Burseraceae, Lauraceae and Sapotaceae. Additional understorey families include Euphorbiaceae, Melastomaceae, Moraceae, Myriceae, Symplocaceae and Tiliaceae. These regions are dominated by the Dipterocarpaceae family followed by the Lauraceae family. The disturbed old growth sites are similar in species composition, however these areas have been selectively logged for the dipterocarp species and other hard woods an estimated 15-20 years ago. Secondary sites were illegally logged for dipterocarps, softwoods, palms and tree ferns and almost totally exploited. It has been regenerating for 16 years. The mossy forest regions are at a higher altitude and are found at the crater of an extinct volcano. The vegetation in this area is more oak-laurel forest, with mosses and lichens thriving in the cloud level.

Riparian sites show more lowland forest species. These areas have been selectively logged in some areas, but still show characteristic large species from the Dipterocarpaceae family. The final habitat type surveyed is classified as forest edge.

These areas have been deforested and either left as disused farmland, or as working farms with fragments of forest between resident farmland areas.

1.5 Collection Permit

The NRCP operates under a Wildlife Gratuitous Permit (GP) as issued by the DENR to NFEFI, authorising the same to collect certain biological specimens for research/scientific purposes. All collection activities undertaken by the NRCP adhere strictly to the terms and conditions of the above mentioned GP, and the NRCP only collects specimens for preservation when strictly necessary for taxonomic identification and conservation purposes.

The current permit allows the NRCP to make collections from the major faunal and floral groups (as detailed below):

Most major faunal groups include: Avians, Mammals, Reptiles, Amphibians, & Invertebrates.

Most major floral groups include: Angiosperms, Gymnosperms, Filicinophyta & Bryophyta.

1.6 Aims and objectives of the NRCP

The current aims and objectives of the NRCP are outlined as follows:

- To obtain base-line quantitative data on the biodiversity of the fauna and flora of the NNFR, to create resource maps and an environmental database for the region.
- To conduct complimentary field based research into the habitat requirements and ecology of the species currently included in the NFEFI captive breeding programme, the objective of which is to produce guidelines for effective forest management to aid in-situ conservation of specific species.
- To provide suitable education materials and programmes to improve environmental awareness amongst local communities, to offer training opportunities to host country counterparts in biodiversity assessment & management and to provide non-destructive alternative livelihood opportunities through the development of eco-tourism and sustainable forestry practices.
- To produce integrated community-driven management plans for the conservation, restoration and sustainable use of biodiversity in the region.

The results of the baseline survey work will contribute vital information to the development of sustainable management recommendations for this area of the NNFR, with the potential to combine the work of the NRCP with other data sources and develop a management plan for the whole NNFR. All results and reports produced by the NRCP will be submitted to NFEFI who will facilitate their dissemination and outputs therein to the local municipalities and will include the findings in its community education projects.

1.7 Report Outline

This report aims to address the diversity and distribution of species within six forest habitats (riparian, secondary forest, disturbed old growth, old growth, mossy and edge) across the Imbang – Caliban watershed over a 12-month period. All ecological survey work has concentrated within these forest habitat types.

The report focuses on birds, volant mammals, non-volant mammals and butterflies throughout the forest, allowing an assessment of species composition and diversity to be made between forest habitats. Each faunal group is addressed in separate chapters, where the data is statistically analysed to distinguish differences between survey locations. In the final chapter (discussion and conclusions), all the results are analysed together to suggest future research and recommendations as well as conservation priorities.

2. Birds

2.1 Introduction

Asia is home to over 323 threatened bird species, of which 80% are forest dependent (Birdlife 2005). These species face increasing threats to their survival due to logging and forest clearance (BirdLife 2002). The Philippines is seen as a hotspot within this region (ranking second in Asia with the second largest number of threatened species) with a disproportionate number of species becoming increasingly threatened with extinction.

The Philippine archipelago has a high degree of endemism. This is especially true of the bird species with an estimated 44% (estimated 395) of breeding bird species being endemic to the islands, and 54 of the 58 threatened forest species unique to the Philippines (PBCPP 2002). There are also high levels of localised endemism within the archipelago. The Philippines have been subdivided into seven Endemic Bird Areas (Birdlife), of which the Negros-Panay floral region is included (EBA 152). In this area, species that are threatened include both lowland and montane forest specialists, some of which are highly localised.

The Philippines currently has the highest proportion of restricted range and threatened species worldwide (Stattersfield *et al.*, 1998). It is estimated that 80% of bird species are forest dependent (Collar *et al.*, 1999) and nearly half of the endemic bird species are threatened by deforestation (Brooks *et al.*, 1997). Other causes of decline are attributable to hunting and growing pet trade (WCSP 1997). Such problems are prevalent across most of the major islands in the Philippines, including Negros Island.

Negros supports more than 190 species of avifauna of which approximately 100 are thought to be forest dependent. Restricted range species are consequently under serious threat by further loss and fragmentation of the forests. Due to excessive hunting in the NNFR, larger birds are scarce, including hornbills and fruit pigeons (Haribon 2002). Many of these species are endangered and endemic with a staggering 59 species found on Negros endemic to the Philippines and 9 are further restricted to the Negros-Panay faunal region (Brooks *et al.*, 1992).

2.2 Aims

The avifaunal research work had two major aims:

- Update the ongoing bird species inventory for the study watershed;
- Compare and contrast the community composition of the six major forest habitat types studied.

2.3 Methods

MacKinnon Lists

The bird fauna of the NNFR was surveyed by observation using MacKinnon lists (MacKinnon & Phillips 1993). The observer makes a list of species sighted by recording each new species until a predetermined number of species is reached. Based on preliminary surveys, the list length was set at the advised minimum of 10 species (Bibby *et al.*, 1998). A species can only be recorded once on each list but may be

recorded on subsequent lists. Such data then permits the calculation of species discovery curves and an index of relative abundance or detectability (Bibby *et al.*, 1998; Turner *et al.*, 2002b).

Lists were compiled at 12 survey locations within the NNFR and focussed on the six major habitat types (Table 1.1) that were surveyed throughout the duration of the study period. Occasionally 10 species could not be recorded in a single visit; in such cases the site was revisited later in the day or the following day to complete the list.

Mist Netting
Standard mist netting techniques were employed (Bibby *et al.*, 1998) to survey the less conspicuous species that may not have been detected using the MacKinnon list method. Nets were established using bamboo poles and ropes tied vertically from tree branches. Mist nets (38mm mesh, Avinet, USA) were attached in different combinations (each 6m in length), at 6 locations within the study area (Table 3.1. & 3.5.). These locations were selected for their accessibility, areas of high bird activity and where species that could not be identified had been sighted.

Nets were opened between 0530 hours and 0630 hours and closed at approximately 1000 hours. Afternoon opening times were 1600 hours to 1830 hours. Occasionally nets were kept open throughout the day. These times were dependent upon weather conditions i.e. recording in heavy rain was avoided. Nets were checked between every 30 minutes to every 2 hours dependent upon previous bird activity. Net records were kept, recording species caught, time, date, location and basic morphology data, following the approach of Turner *et al.* (2002b).

Species identification was achieved through the use of the field guide 'A guide to the Birds of the Philippines' by Kennedy *et al.* 2000 and the taxonomic order of this publication is followed.

2.4 Results

Species discovery curves were calculated for each survey location by replacing surveyor effort with the number of lists and plotting this against the cumulative total number of species.

Species discovery curves (Figure 2.1) indicate similar rates of discovery at each location with plateaus forming in more than one site location. Plateaus indicate that new species discovery is unlikely, to a certain degree, in survey sites Mawa, the Dam and James's Farm. Survey sites that still show that the species discoveries are still increasing include Palahawayan I and II, the Caliban and Bagiawanan sites.

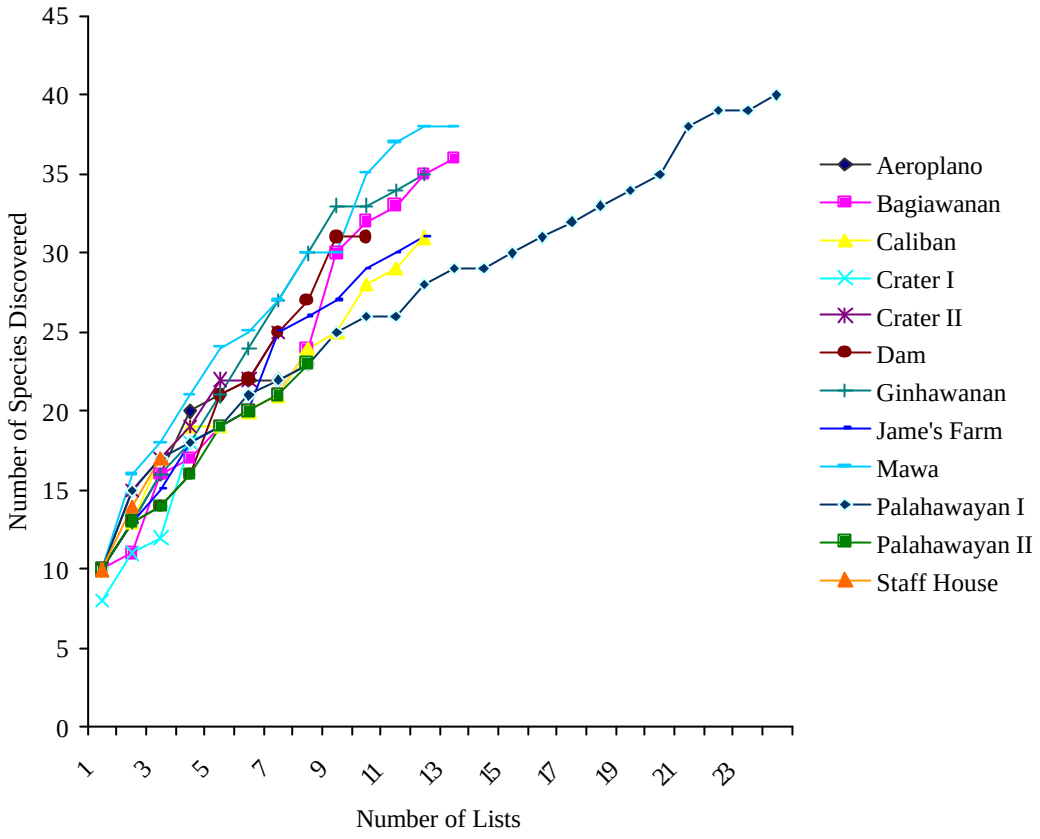

Figure 2.1 Species Discovery Curves for each survey location

An Index of Relative Detectability (IRD), rather than abundance, was calculated for each species calculating the proportion of lists on which it appears at each location, and thus the index can vary between 0 (species not recorded) and 1 (species recorded on every list). The term “index of relative detectability” has been used here, rather than the standard “index of relative abundance”, as the frequency of a species occurring on a list is dependent on several factors, of which abundance is only one.

Table 2.2 IRD Values for each survey site

Species	Dam	Aeroplano	Mawa	Crater I	Caliban	James's Farm	Palahawayan II	Palahawayan I	Crater II	Ginhawanan	Bagiawanan	Staff House
Oriental Honey Buzzard	0.00	0.00	0.08	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brahminy Kite	0.00	0.00	0.15	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Crested Serpent-Eagle	0.20	0.00	0.08	0.00	0.00	0.25	0.00	0.16	0.00	0.00	0.23	0.50
Red Junglefowl	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.12	0.00	0.08	0.08	0.00
Pompadour Green Pigeon	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00
White-eared Brown-Dove	0.20	0.56	0.15	0.00	0.25	0.50	0.33	0.28	0.00	0.42	0.31	0.50
Black-chinned Fruit Dove	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.32	0.00	0.33	0.31	0.00
Pink Bellied Imperial Pigeon	0.20	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.08	0.15	0.00
Green Imperial Pigeon	0.00	0.22	0.38	0.00	0.00	0.17	0.00	0.32	0.43	0.25	0.31	0.00
Metallic Pigeon	0.00	0.33	0.00	1.00	0.08	0.00	0.00	0.04	0.00	0.00	0.69	0.25
Reddish Cuckoo-Dove	0.00	0.22	0.15	0.75	0.00	0.50	0.00	0.04	0.57	0.08	0.31	0.00
Zebra Dove	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
Common Emerald Dove	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.04	0.00	0.08	0.08	0.00
Blue crowned racquet tail	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00
Hodgson's Hawk-cuckoo	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brush cuckoo	0.00	0.00	0.38	0.00	0.08	0.17	0.00	0.08	0.00	0.08	0.23	0.00
Philippine Coucal	0.20	0.67	0.31	0.00	0.17	0.75	0.33	0.28	0.14	0.67	0.69	0.75
Grass Owl	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.08	0.00	0.00	0.00	0.00
Philippine Scops Owl	0.00	0.33	0.00	0.75	0.00	0.08	0.00	0.08	0.00	0.17	0.00	0.00
Brown Hawk Owl	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00
Philippine Hawk-Owl	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.16	0.00	0.25	0.08	0.25
Philippine Frogmouth	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Philippine Swiftlet	0.00	0.00	0.00	0.00	0.00	0.42	0.33	0.04	0.00	0.00	0.00	0.00
Glossy Swiftlet	0.50	0.67	0.00	0.50	0.50	0.50	0.78	0.28	0.57	0.50	0.31	0.75
Pygmy Swiftlet	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.15	0.00
Philippine Needletail	0.00	0.00	0.00	0.25	0.00	0.08	0.00	0.00	0.29	0.00	0.15	0.00
Common Kingfisher	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.04	0.00	0.08	0.00	0.00

Species	Dam	Aeroplano	Mawa	Crater I	Caliban	James's Farm	Palahawayan II	Palahawayan I	Crater II	Ginhawanan	Bagiawanan	Staff House
White-collared Kingfisher	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spotted Wood Kingfisher	0.00	0.00	0.00	0.00	0.08	0.00	0.11	0.00	0.00	0.00	0.00	0.00
Tarictic Hornbill	0.20	0.00	0.08	0.25	0.00	0.00	0.00	0.08	0.14	0.08	0.00	0.00
Philippine Pygmy Woodpecker	0.10	0.11	0.15	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White-bellied Woodpecker	0.10	0.11	0.31	0.00	0.00	0.00	0.00	0.20	0.14	0.00	0.15	0.00
Pacific Swallow	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellow-vented Bulbul	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Philippine Bulbul	0.80	0.78	0.69	0.50	0.92	0.83	0.78	0.76	0.14	1.00	0.77	0.75
Yellowish Bulbul	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balicassiao	0.20	0.22	0.54	0.00	0.33	0.33	0.44	0.24	0.14	0.08	0.15	0.25
Black-naped Oriole	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
Elegant Tit	0.60	0.11	0.46	0.25	0.83	0.17	0.56	0.32	0.29	0.42	0.54	0.00
Velvet-fronted Nuthatch	0.20	0.22	0.46	0.00	0.08	0.00	0.44	0.04	0.14	0.00	0.08	0.00
White-browed Shortwing	0.10	0.00	0.08	0.00	0.17	0.00	0.22	0.04	0.29	0.33	0.08	0.00
Oriental Magpie Robin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
Pied Bushchat	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00
Sunda Ground Thrush	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Island Thrush	0.00	0.11	0.23	0.50	0.00	0.17	0.00	0.04	0.71	0.08	0.23	0.00
Arctic Warbler	0.20	0.00	0.23	0.25	0.17	0.00	0.00	0.00	0.00	0.00	0.15	0.00
Lemon-throated Leaf-Warbler	0.50	0.11	0.00	0.00	0.00	0.00	0.22	0.00	0.29	0.25	0.00	0.25
Philippine Leaf Warbler	0.00	0.11	0.15	0.00	0.25	0.00	0.00	0.20	0.00	0.00	0.15	0.00
Mountain Leaf-Warbler	0.20	0.33	0.08	0.00	0.58	0.17	0.33	0.04	0.71	0.08	0.15	0.00
Tawny Grassbird	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00
Philippine Tailorbird	0.70	0.78	0.62	0.00	0.33	0.67	0.89	0.48	0.14	0.67	0.54	0.75
Mountain Tailorbird	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.17	0.00	0.00
Ashy Breasted Flycatcher	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grey-streaked Flycatcher	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Species	Dam	Aeroplano	Mawa	Crater I	Caliban	James's Farm	Palahawayan II	Palahawayan I	Crater II	Ginhawanan	Bagiawanan	Staff House
Mountain Verditer Flycatcher	0.60	0.11	0.46	0.50	0.58	0.00	0.56	0.52	0.57	0.42	0.08	0.00
Little Pied Flycatcher	0.10	0.00	0.08	0.00	0.00	0.00	0.11	0.00	0.14	0.25	0.08	0.00
Blue and white flycatcher	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
Citrine Canary-Flycatcher	0.40	0.00	0.31	0.00	0.58	0.00	0.22	0.32	0.29	0.08	0.08	0.00
Pied Fantail	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blue-headed Fantail	0.80	0.56	0.85	0.00	0.92	0.33	0.78	0.52	0.71	0.75	0.62	0.25
White-vented Whistler	0.20	0.00	0.08	0.00	0.25	0.00	0.11	0.08	0.00	0.00	0.08	0.00
Yellow wagtail	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grey Wagtail	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00
Brown Shrike	0.10	0.00	0.15	0.00	0.08	0.33	0.00	0.04	0.00	0.00	0.15	0.25
Coleto	0.10	0.56	0.38	0.25	0.58	0.33	0.56	0.28	0.29	0.08	0.15	0.75
Olive-backed Sunbird	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00
Lovely sunbird	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bicolored Flowerpecker	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.29	0.00	0.00	0.00
Red-keeled Flowerpecker	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orange-bellied Flowerpecker	0.70	0.00	0.46	0.75	0.67	0.08	0.67	0.44	1.00	0.67	0.62	0.00
Pygmy flowerpecker	0.10	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellowish White-eye	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.14	0.17	0.00	0.00
Mountain White-eye	1.00	0.89	0.77	1.00	0.92	0.67	1.11	0.60	1.00	0.92	0.92	0.75
Eurasian Tree Sparrow	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00
White-bellied Munia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
Scaly-breasted Munia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
Chestnut Munia	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.25

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

Table 2.3 Diversity indices for each survey location

Survey Locations	Total Species[1]	Total Individuals[2]	Species Richness[3]	Pielou's Evenness[4]	Shannon-Wiener Index[5]
Aeroplano	23	74	5.1	0.9	2.9
Bagiawanan	36	129	7.2	0.9	3.3
Caliban	30	120	6.1	0.9	3.0
Crater I	18	36	4.7	1.0	2.8
Crater II	25	67	5.7	0.9	3.0
Dam	30	97	6.3	0.9	3.1
Ginhawanan	34	118	6.9	0.9	3.2
James's farm	31	117	6.3	0.9	3.2
Mawa	38	130	7.6	0.9	3.3
Palahawayan I	41	199	7.6	0.9	3.3
Palahawayan II	24	92	5.1	0.9	3.0
Staff House	16	30	4.4	1.0	2.7

[1]Number of Species: the number of species present in a community is a crucial aspect of that community's biodiversity. The number of species varies between locations and can be a useful biodiversity indicator.

[2] Total Number of individuals identified during the survey period.

[3]Species Richness: Species Richness is defined by Margalef's Index ((d=(S-1)/Log (N)). This incorporates the total number of individuals and is the measure of the number of species present for a given number of individuals. Species richness of the communities sampled in this study are based on same sample sizes and surveying effort.

[4]Pielou's Evenness: this is an expression of equitability and expressed as $J'=H'/H'_{max}=H'/\log S$ where H'_{max} is the maximum possible value of Shannon diversity, if all species were equally abundant.

[5]Shannon-Wiener: represented as $H' = -\sum_{i\,pi} \text{Log}\,(p_i)$ where p_i is the proportion of the total count arising from the ith species. The higher the figure obtained the higher the diversity of the area.

The highest number of species discovered includes the survey locations of Mawa, Palahawayan I, Ginhawanan, Bagiawanan and James's Farm with over 30 different species found at each of these locations.

Species evenness is used as communities which are dominated by one or two species are considered to be less diverse than ones in which several different species have a similar abundance, i.e. communities which are shown to be more even. Thus a higher value for evenness suggests a more diverse area. The analysis shows that across all survey sites the species composition is even, with few species dominating one particular habitat type.

Species richness is high across all sites with highest values shown in Mawa (old growth), Bagiawanan (old growth) and Palahawayan I (secondary) with lowest values for edge habitats of the Staff House and the mossy regions of Crater I.

Diversity (measured by Shannon-Wiener Index) is shown to be high across all of the sites, the highest measure of diversity is found within the Bagiawanan, Ginhawanan, Palahawayan I, James's Farm, the Dam and Mawa.

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

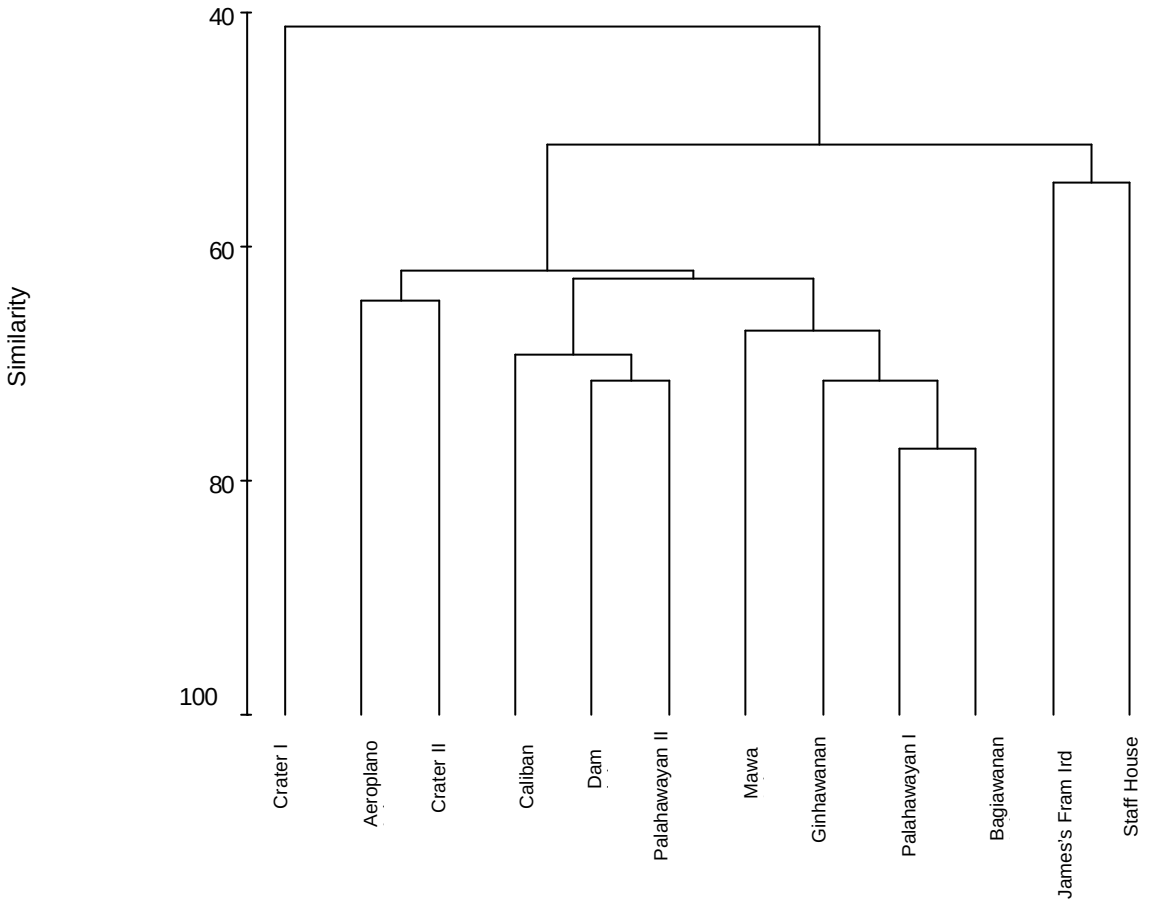

Figure 2.2 Dendrogram of Bird Community Composition
(Calculated using group average linking of Bay-Curtis similarities (4th root transformation) and labelled according to survey location name).

This dendrogram can be converted into an additional dendrogram expressing similarities between habitat types rather than by site location names.

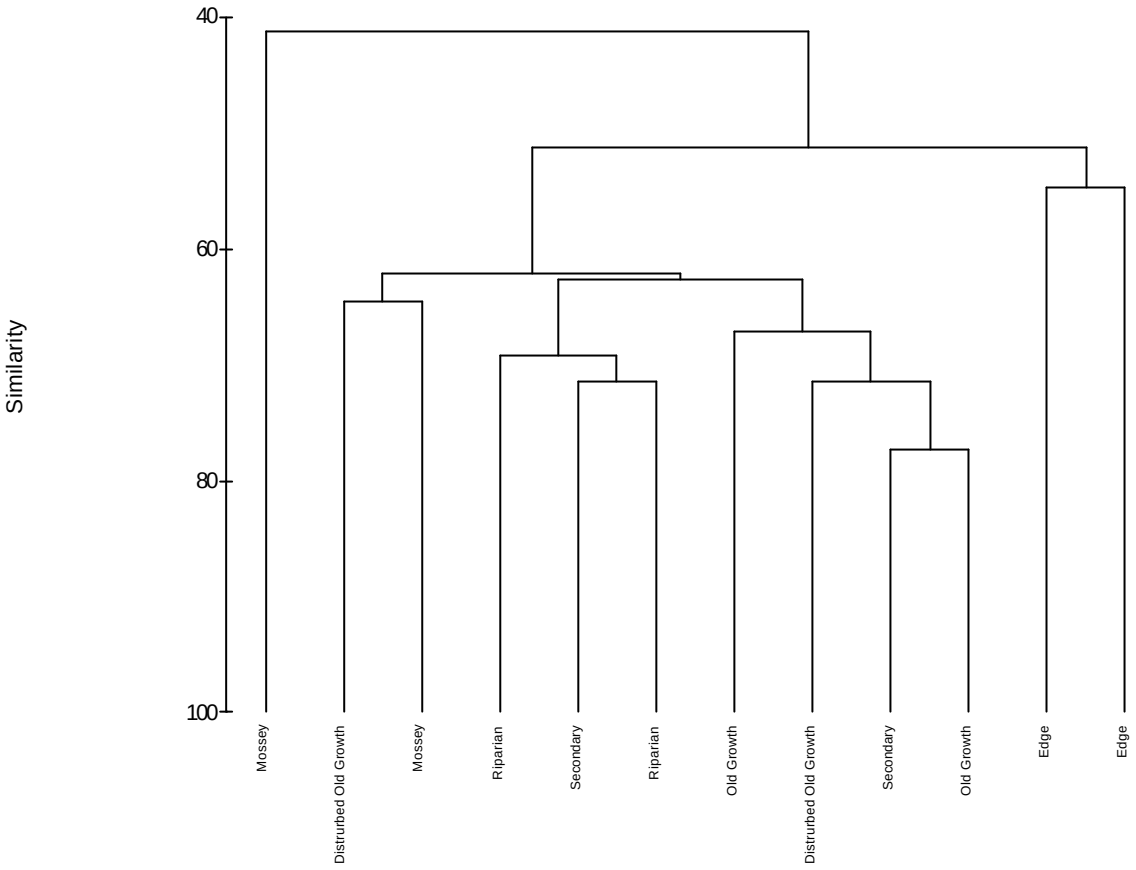

Figure 2.3 Dendrogram of Bird Community Composition by habitat types
(Calculated using group average linking of Bay-Curtis similarities (4^{th} root transformation) and labelled according to survey location name).

The clusters within the dendrogram highlight areas that are similar in species composition and areas that are more dissimilar. By creating the dendrogram by habitat type (simply through renaming the original plots) it can be seen that there are certain areas that stand out. The 'edge' habitat types appear more similar to each other than to any other habitat; showing only an estimated 50% similarity with other sites surveyed within the forest habitats. Habitats such as 'old growth' and 'disturbed old growth' and 'secondary' show similar levels of species composition. In fact, it can be seen that the majority of the sites show similar community composition with the largest cluster over 60% identical which includes all sites except the 'edge' and one 'mossy' site.

NMDS analyses these clusters further by creating a 'map' or configuration of the sample sets and placing the sample sets (here these are locations) in 'space'. Physically the nearer the samples are to each other the more similar they are in terms of species composition.

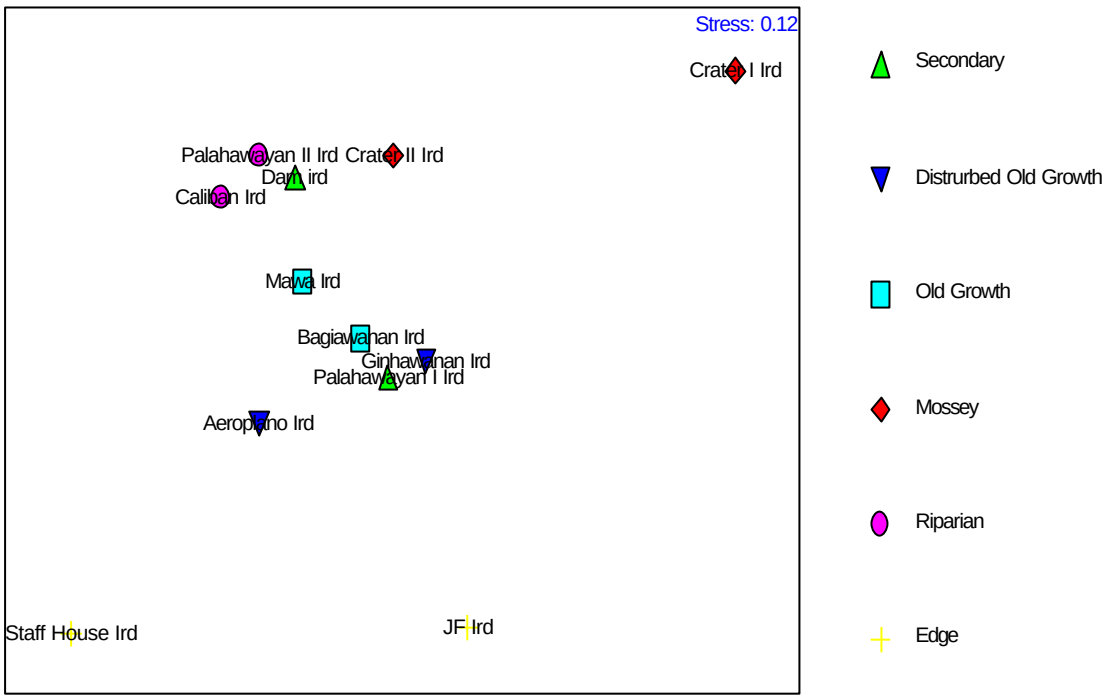

Figure 2.4 NMDS ordination of IRD values for each survey location showing habitat type per location.

Through the NMDS the clusters are transformed in space to illustrate areas of similarity of species composition. It can be seen that the 'edge' habitat of Staff House and James's Farm are clearly separate from the forested regions. The 'Old Growth', 'Disturbed Old Growth' and the 'Secondary' forest habitat seem to be most similar. Habitat types 'mossy' and 'riparian' also show high similarities of species composition.

Further analysis to find which species are responsible for the observed clustering was achieved. By looking at the overall percentage contribution each species makes to the average similarity within groups, a species list can be formed showing species in decreasing order of their importance in discriminating the sample sets. This gives species that are typical to the group, in the sense that they are found at constant (high) abundances/detectabilty in most samples. These species can then be used as

discriminators between groups. This can be achieved through SIMPER (Clarke & Warwick, 2001).

Table 2.4 SIMPER Results for 'Secondary' forest group. Average similarity 63.42%

Species	Av.Abund[1]	Av.Sim[2]	Contrib%[3]	Cum.%[4]
Philippine Bulbul	0.78	8.61	13.57	13.57
Mountain White-eye	0.80	6.80	10.71	24.29
Blue-headed Fantail	0.66	5.89	9.29	33.57
Mountain Verditer Flycatcher	0.56	5.89	9.29	42.86
Philippine Tailorbird	0.59	5.44	8.57	51.43
Orange-bellied Flowerpecker	0.57	4.98	7.86	59.29
Citrine Canary-Flycatcher	0.36	3.62	5.71	65.00
Elegant Tit	0.46	3.62	5.71	70.71
Glossy Swiftlet	0.39	3.17	5.00	75.71
Philippine Coucal	0.24	2.27	3.57	79.29
Balicassiao	0.22	2.27	3.57	82.86
White-eared Brown-Dove	0.24	2.27	3.57	86.43
Crested Serpent-Eagle	0.18	1.81	2.86	89.29
Coleto	0.19	1.13	1.79	91.07

[1]Average abundance
[2]Average similarity
[3]Percentage contribution of individual species to the overall similarity between groups
[4]Cumualtive contribution of species to overall similarity between groups

The majority of these species are generalists, known to inhabit areas from forest edges, disturbed forests and secondary growth. The White-eared Brown-dove is slightly more specialist, only being recorded below 1600m and in primary or less disturbed secondary forest regions.

Table 2.5 SIMPER results for 'Disturbed Old Growth' habitat. Average similarity 62.15%

Species	Av.Abund[1]	Av.Sim[2]	Contrib%[3]	Cum.%[4]
Mountain White-eye	0.90	9.85	15.84	15.84
Philippine Bulbul	0.89	8.62	13.86	29.70
Philippine Tailorbird	0.72	7.38	11.88	41.58
Philippine Coucal	0.67	7.38	11.88	53.47
Blue-headed Fantail	0.65	6.15	9.90	63.37
Glossy Swiftlet	0.58	5.54	8.91	72.28
White-eared Brown-Dove	0.49	4.62	7.43	79.70
Green Imperial Pigeon	0.24	4.46	3.96	83.66
Philippine Scops Owl	0.25	1.85	2.97	86.63
Elegant Tit	0.26	1.23	1.98	88.61
Lemon-throated Leaf-Warbler	0.13	1.23	1.98	90.59

The major contributing species include species found in the 'secondary' growth habitats. However additional species of the Green Imperial Pigeon, the Philippine Scops Owl and the Lemon-throated Leaf Warbler indicate that there is a variety of species present within this habitat type. The Green Imperial Pigeon is a lowland specialist, found in relatively undisturbed sites and the Lemon-throated Leaf-warbler also falls within this category. The Philippine Scops-owl is more of a generalist.

Table 2.6 SIMPER result for 'Old Growth' habitat. Average similarity 66.41%

Species	Av.Abund[1]	Av.Sim[2]	Contrib%[3]	Cum.%[4]
Mountain White-eye	0.85	7.72	11.63	11.63
Philippine Bulbul	0.73	6.95	10.47	22.09
Blue-headed Fantail	0.73	6.18	9.30	31.40
Philippine Tailorbird	0.58	5.41	8.14	39.53
Orange-bellied Flowerpecker	0.54	4.63	6.98	46.51
Elegant Tit	0.50	4.63	6.98	53.49
Philippine Coucal	0.50	3.09	4.65	58.14
Green Imperial Pigeon	0.35	3.09	4.95	62.79
Island Thrush	0.23	2.32	3.49	66.28
Brush cuckoo	0.31	2.32	3.49	69.77
Brown Shrike	0.15	1.54	2.33	72.09
Coleto	0.27	1.54	2.33	74.42
Arctic Warbler	0.19	1.54	2.33	76.74
Philippine Leaf Warbler	0.15	1.54	2.33	79.07
White-bellied Woodpecker	0.23	1.54	2.33	81.40
Balicassiao	0.35	1.54	2.33	83.72
White-eared Brown-Dove	0.23	1.54	2.33	86.05
Reddish Cuckoo-Dove	0.23	1.54	2.33	88.37
Citrine Canary-Flycatcher	0.19	0.77	1.16	89.53
White-vented Whistler	0.08	0.77	1.16	90.70

Although generalist species are found in this location additional species that are more specialist have been recorded at these survey locations. The endemic Philippine Leaf-warbler, the near endemic White-vented Whistler and the White-bellied Woodpecker are all species that require forest that is undisturbed. The Island Thrush specialises in montane forest habitats and the Brush Cuckoo also requires less disturbed locations, including montane forest regions. These species contribute to the differences in species composition between the old growth forest habitats and other slightly more disturbed sites.

Table 2.7 SIMPER result for 'Mossy' Habitat. Average similarity 52.31%.

Species	Av.Abund[1]	Av.Sim[2]	Contrib%[3]	Cum.%[4]
Mountain White-eye	1.00	10.77	20.59	20.59
Orange-bellied Flowerpecker	0.88	8.08	15.44	36.03
Reddish Cuckoo-Dove	0.66	6.15	11.76	47.79
Island Thrush	0.61	5.38	10.29	58.09
Mountain Verditer Flycatcher	0.54	5.38	10.29	68.38
Glossy Swiftlet	0.54	5.38	10.29	78.68
Coleto	0.27	2.69	5.15	83.82
Elegant Tit	0.27	2.69	5.15	88.97
Philippine Needletail	0.27	2.69	5.15	94.12

The Reddish Cuckoo-dove and the Island Thrush are species, which are regularly found in montane mossy forest habitats, and are good indicator species that the region can support such species. The endemic and near threatened Philippine Needletail has also been recorded at this site.

Table 2.8 SIMPER results for 'Riparian' habitat. Average similarity 73.08

Species	Av.Abund[1]	Av.Sim[2]	Contrib%[3]	Cum.%[4]
Mountain White-eye	1.01	9.07	12.41	12.41
Blue-headed Fantail	0.85	7.69	10.53	22.93
Philippine Bulbul	0.85	7.69	10.53	33.36
Orange-bellied Flowerpecker	0.67	6.59	9.02	42.48
Coleto	0.57	5.49	7.52	50.00
Elegant Tit	0.69	5.49	7.52	57.52
Mountain Verditer Flycatcher	0.57	5.49	7.52	65.04
Glossy Swiftlet	0.64	4.95	6.77	71.80
Mountain Leaf-Warbler	0.46	3.30	4.51	76.32
Philippine Tailorbird	0.61	3.30	4.51	80.83
Balicassiao	0.39	3.30	4.51	85.34
White-eared Brown-Dove	0.29	2.47	3.38	88.72
Citrine Canary-Flycatcher	0.40	2.20	3.01	91.73

The majority of these species are generalist forest and forest edge species. However, the Mountain leaf-warbler is a more specialist species that requires submontane (and montane) undisturbed forests for its habitat.

Table 2.9 SIMPER result for 'Edge' habitat. Average similarity 61.84%

Species	Av.Abund[1]	Av.Sim[2]	Contrib%[3]	Cum.%[4]
Philippine Coucal	0.75	8.70	14.06	14.06
Philippine Bulbul	0.79	8.70	14.06	28.13
Mountain White-eye	0.71	7.73	12.50	40.63
Philippine Tailorbird	0.71	7.73	12.50	53.13
Glossy Swiftlet	0.63	5.80	9.38	62.50
White-eared Brown-Dove	0.50	5.80	9.38	71.88
Coleto	0.54	3.86	6.25	78.13
Blue-headed Fantail	0.29	2.90	4.69	82.81
Brown Shrike	0.29	2.90	4.69	87.50
Balicassiao	0.29	2.90	4.96	92.19

All the species recorded at the forest edge habitats are known to be generalist forest and forest edge species.

These SIMPER results illustrate the distinctions between the groups through species compositions. There is a high degree of similarity between the groups, however individual species percentage contribution changes within the groups and individuals unique to groups have also been highlighted.

2.5 Discussion

Surveys of the last 12 months have resulted in the recording of 32 bird families, representing 76 species. Of these species, 26 are endemic to the Philippines. These include; Philippine frogmouth, Philippines Scops-owl (the Negros-Panay race which may represent a new species due to DNA analysis), White-eared Brown-dove (race *nigrorum*), Pink-bellied Imperial Pigeon, Blue-crowned Racquet-tail (race *whitehedi*), Philippines Hawk Owl (race *centralis*), Spotted wood-kingfisher (race *moseleyi*), Philippine Swiflet, Pygmy Swiftlet, Philippine Needletail, Visayan Tartictic Hornbill (race *panini*), Philippine Pygmy Woodpecker (race *maculates*), Philippine Bulbul (race *guimarasensis*), Yellowish Bulbul, Balicassiao (race *mirabilis*), Elegant Tit (race *albescens*), Philippine Leaf-warbler, Lemon-throated Leaf-warbler (race *cebuensis*), Philippine Tailorbird (race *rabori*), Ashy-breasted Flycatcher, Blue-headed Fantail (race *albiventris*), Yellowish White-eye (race *nigrorum*), Bicoloured Flowerpecker (race *viridissimum*), Red-striped Flowerpecker (race *haematostictu),* Pygmy Flowerpecker (race *pygmaeum)* and the Lovely Sunbird (race *bonita*).

Of the species that are found to be endemic to the Philippines, several species are red listed by the IUCN, including; the Philippine Needletail (IUCN near threatened), Pink-bellied Imperial Pigeon (IUCN near threatened), the Visayan Tarictic (IUCN endangered and CITES Appendix II) and the Ashy-breasted Flycatcher (IUCN vulnerable). These species have been affected by increase destruction of their preferred habitat of lowland forest cover and hunting. It is positive to see these species in the NNFR, however these species are at the limits of their habitat requirements.

These species have been found at several locations across the NNFR. The Tarictic Hornbill has been recorded in 'disturbed old growth', 'old growth', 'secondary growth' and 'mossy' forest; the Pink-bellied Imperial Pigeon has been recorded in 'secondary', 'mossy', 'disturbed old growth' and 'old growth' forests; the Philippine Needletail has been recorded in 'mossy', 'edge' and 'old growth' habitats. The Ashy-breasted Flycatcher has only been recorded in 'old growth' forest.

The bird species recorded are listed in the annotated list that includes their scientific name, distribution and conservation status (see table 2.10).

The analysis suggests that species composition within old growth forest habitats and habitats that have been previously disturbed are now becoming increasingly similar. This may demonstrate successful recruitment of species back into disturbed habitats, or that previously disturbed habitats are becoming increasingly suitable to species that require less disturbed forest types. The results also show that there are significant species that are being recorded in the NNFR. Both endemics and IUCN species have been recorded within many of the forest types. These results suggest that the disturbed sites may now be regenerating and species that are normally found in old growth areas are now being recorded in disturbed or secondary forest types. This suggests a positive regeneration of some of the forest regions in the NNFR.

Table 2.10 Annotated bird species list

Scientific Name	Common Name	IUCN Category/ CITES	Additional Notes
CUCULIDAE			
Cuculus fugax	Hodgson's Hawk-cuckoo	Least Concern	1 race that is a Philippine endemic, *pectoralis*.
Cacomantis variolosus	Brush Cuckoo	Least Concern	There is evidence of population fluctuations.
PODARGIDAE			
Batrachostomus septimus	Philippine Frogmouth	Least Concern	3 races are found in the Philippines, the race *menagei* is endemic to Negros and Panay only. There is evidence of population decline.
STRIGIDAE			
Otus megalotis	Philippine Scops-owl	Least Concern	There are 3 races found within the Philippines the race *nigrorum* is found in Negros and Panay only.
ACCIPITRIDAE			
Haliastur Indus	Brahminy Kite	Least Concern	There is evidence of a population decline.
Pernis ptilorhynchus	Oriental Honeybuzzard	N/a	3 races of which 2 are endemic in the Philippines. Negros race *philippensis*.
Spilornis cheela	Crested Serpent-eagle	Least Concern	There are 2 endemic races found within the Philippines, *holospilus*, is found on Negros.
PHASIANIDAE			
Gallus gallus	Red Junglefowl	Least Concern	There is 1 race that is endemic to the Philippines – *philippensis*.
COLUMBIDAE			
Treron pompadora	Pompadour Green-pigeon	Least Concern	The Philippines has 4 endemic races, of which *canescens* is found in Negros.
Phapitreron leucotis	White-eared Brown-dove	Least Concern	Endemic to the Philippines and consists of 4 races, *nigrorum*, is found on the island of Negros.
Ptilinopus leclancheri	Black-chinned Fruit-dove	Least Concern	Near endemic to the Philippines, *leclancheri* race, is endemic and found on Negros.
Ducula poliocephala	Pink-bellied Imperial-pigeon	Near Threatened	Endemic to the Philippines where it occurs on at least 16 islands, including Negros. It is uncommon and declining owing to the combination of over hunting and the extensive clearance of its preferred lowland forest habitat.
Ducula aenea	Green Imperial-pigeon	Least Concern	There are four races, 3 of which are endemic to the Philippines, *aenae*, is found on Negros.
Columba vitiensis	Metallic Pigeon	Least Concern	There are 2 near endemic races found in the Philippines, *griseogularis*, is found in Negros.
Macropygia phasianella	Reddish Cuckoo-dove	Least Concern	3 endemic races, *tenuirostris* found on Negros
Geopelia striata	Zebra Dove	Least Concern	1 Philippines race, *striata*.

Scientific Name	Common Name	IUCN Category/ CITES	Additional Notes
Chalcophaps indica	Emerald Dove	Least Concern	1 race in the Philippines, *indica*.
PSITTACIDAE			
Prioniturus discurus	Blue-crowned Racquet-tail	Least Concern	This species is endemic to the Philippines and consists of 3 races, *whiteheadi* race is found in Negros.
CUCULIDAE			
Centropus viridis	Philippine Coucal	Least Concern	Endemic to the Philippines, with 4 races. *Viridis* found on Negros
TYTONIDAE			
Tyto capensis	Grass-owl	Least Concern	Endemic race *amauronota* found in Philippines.
STRIGIDAE			
Ninox scutulata	Brown Hawk-owl	Least Concern	Endemic races are found in the Philippines, the *randi* race is found on Negros.
Ninox philippensis	Philippine Hawk-owl	Least Concern	This species is endemic to the Philippines with 8 races throughout its range.
APODIDAE			
Collocalia mearnsi	Philippine Swiftlet	Least Concern	This species is endemic to the Philippines.
Collocalia esculenta	Glossy Swiftlet	Least Concern	There are 5 races in the Philippines that are endemic, *marginata* is found on Negros.
Collocalia troglodytes	Pygmy Swiftlet	Least Concern	Endemic to the Philippines.
Mearnsia picina	Philippine Needletail	Near Threatened	Endemic to the Philippines where it has been described as fairly common on Mindanao, Samar, Leyte, Biliran, Cebu and Negros. Populations declining due to lowland forest destruction.
ALCEDINIDAE			
Alcedo atthis	Common Kingfisher	Least Concern	A common migrant with 1 race within the Philippines
Actenoides lindsayi	Spotted Kingfisher	Least Concern	Endemic to the Philippines, race *moseleyi* found on Negros.
BUCEROTIDAE			
Penelopides panini	Visayan Tarictic	Endangered, CITES Appendix II	Endemic to the Philippines This species has a very small, severely fragmented and rapidly declining population as a result of lowland deforestation and hunting. It is estimated that it has a very small occupied range on the two main islands where it survives, with perhaps just 10% of remaining forest (c.144 km^2) below 1,000 m.
PICIDAE			
Dendrocopos maculates	Philippine Pygmy Woodpecker	Least Concern	Endemic to the Philippines.
Dryocopus javensis	White-bellied Woodpecker	Least Concern	9 endemic races in the Philippines, *philippinensis* found on Negros.
HIRUNDINIDAE			
Hirundo tahitica	Pacific Swallow	Least Concern	

Scientific Name	Common Name	IUCN Category/ CITES	*Additional Notes*
PYCNONOTIDAE			
Pycnonotus goiavier	Yellow-vented Bulbul	Least Concern	3 endemic races to the Philippines, *goiavier* found on Negros.
Ixos philippinus	Philippine Bulbul	Least Concern	Endemic to the Philippines, *guimarasensis* race found on Negros.
Ixos everetti	Yellowish Bulbul	Least Concern	Endemic to the Philippines.
DICRURIDAE			
Dicrurus balicassius	Balicassiao	Least Concern	Endemic to the Philippines, *mirabilis* race found on Negros.
ORIOLIDAE			
Oriolus chinensis	Black-naped Oriole	Least Concern	3 endemic races in the Philippines, *yamamurae* found on Negros.
PARIDAE			
Parus elegans	Elegant Tit	Least Concern	Endemic to the Philippines, *albescens* race found on Negros.
SITTIDAE			
Sitta frontalis	Velvet-fronted Nuthatch	Least Concern	7 endemic races in the Philippines, *oenochlamys* found on Negros.
TURDINAE			
Brachypteryx Montana	White-browed Shortwing	Least Concern	7 races in the Philippines, race *brunneiceps* endemic to Negros.
Saxicola caprata	Pied Bushchat	Least Concern	3 endemic races in Philppines, *randi* found on Negros.
Zoothera andromedae	Sunda Thrush	Least Concern	Resident but rare, found in mossy forests above 1000m.
Turdus poliocephalus	Island Thrush	Least Concern	7+races in Philippines, *nigrorum* is endemic to Negros.
Copsychus saularis	Oriental Magpie-robin	Least Concern	Two races found within the Philippines, both of which are endemic.
SYLVIINAE			
Phylloscopus borealis	Arctic Warbler	Least Concern	5 + races found in the Philippines.
Phylloscopus cebuensis	Lemon-throated Leaf-warbler	Least Concern	Endemic to the Philippines, race *cebuensis* found on Negros.
Phylloscopus olivaceus	Philippine Leaf-warbler	Least Concern	Endemic to the Philippines.
Phylloscopus trivirgatus	Mountain Leaf-warbler	Least Concern	7 endemic races to the Philippines, *nigrorum* found on Negros.
Megalurus timoriensis	Tawny Grassbird	Least Concern	4 endemic races to the Philippines, *tweeddalei* found on Negros.
Orthotomus castaneiceps	Philippine Tailorbird	Least Concern	Endemic to the Philippines, *rabori* race found on Negros.
Orthotomus cucullatus	Mountain Tailorbird	N/A	3 endemic races in Philippines.
MUSCICAPINAE			
Muscicapa randi	Ashy-breasted Flycatcher	Vulnerable	Endemic to the Philippines where it is known from Luzon, Negros and Samar. Extensive and continuing lowland deforestation is the main threat.
Muscicapa griseisticta	Grey-streaked Flycatcher	Least Concern	Common migrant in the Philippines.
Eumyias panayensis	Mountain verditer Flycatcher	Least Concern	3 endemic races found in the Philippines, *panayensis* found on Negros.
Ficedula westermanni	Little Pied Flycatcher	Least Concern	2 endemic races found in the Philippines, *rabori* found on Negros.
Cyanoptila cyanomelana	Blue-and-white Flycatcher	Least Concern	2 races found in the Philippines, *cyanomelana* found on Negros.

Scientific Name	Common Name	IUCN Category/ CITES	Additional Notes
Culicicapa helianthea	Citrine Canary-flycatcher	Least Concern	3 endemic races found in the Philippines, *panayensis* found on Negros.
Rhipidura javanica	Pied Fantail	Least Concern	Common resident in the Philippines (monotypic).
Rhipidura cyaniceps	Blue-headed Fantail	Least Concern	Endemic to the Philippines, *albiventris* found on Negros.
PACHYCEPHALINAE			
Pachycephala homeyeri	White-vented Whistler	Least Concern	Near endemic, *winchelli* found on Negros.
MOTACILLIDAE			
Motacilla cinerea	Grey Wagtail	Least Concern	1 race found in the Philippines.
Motacilla flava	Yellow Wagtail	Least Concern	2 races found in the Philippines, *simillima* found on Negros.
LANIIDAE			
Lanius cristatus	Brown Shrike	Least Concern	2+ races in the Philippines, *leucionensis* found on Negros.
STURNIDAE			
Sarcops calvus	Coleto	Least Concern	Near endemic to the Philippines, race *melanonotus* found on Negros.
NECTARINIIDAE			
Nectarinia jugularis	Olive-backed Sunbird	Least Concern	4 endemic races found in the Philippines, *jugyularis* found on Negros.
Aethopyga shelleyi	Lovely Sunbird	Least Concern	Endemic to the Philippines. Several races found within the Philippines. Race *bonita* in Cebu, Masbate, Negros, Panay and Ticao.
DICAEIDAE			
Dicaeum bicolour	Bicoloured Flowerpecker	Least Concern	Endemic to the Philippines, race *viridissimum* found on Negros
Dicaeum australe	Red-striped Flowerpecker	Least Concern	Endemic to the Philippines, *haematostictum* found on Negros.
Dicaeum trigonostigma	Orange-bellied Flowerpecker	Least Concern	11 endemic races found in the Philippines, *dorsale* found on Negros.
Dicaeum pygmaeum	Pygmy Flowerpecker	Least Concern	Endemic to the Philippines, *pygmaeum* found on Negros.
ZOSTEROPIDAE			
Zosterops nigrorum	Yellowish White-eye	Least Concern	Endemic to the Philippines, race *nigrorum* found on Negros.
Zosterops montanus	Mountain White-eye	Least Concern	7 endemic races found in the Philippines, *pectoralis* found on Negros,
PASSERINAE			
Passer montanus	Eurasian Tree Sparrow	Least Concern	Monotypic common resident in the Philippines.
ESTRILDIDAE			
Lonchura leucogastra	White-bellied Munia	Least Concern	3 races in the Philippines, *manueli* found on Negros.
Lonchura punctulata	Scaly-breasted Munia	Least Concern	1 race in the Philippines, *cabanisi*.
Lonchura malacca	Chestnut Munia	Least Concern	2 races in the Philippines, *jagori* found on Negros.

3. Non-volant Mammals

3.1 Introduction

A highly diverse and unique mammalian fauna characterises the Philippines. The region is home to more than 165 native species (Heaney *et al.*, 2002) of which, over 100 are endemic (Conservation International 2005). Unfortunately the mammalian fauna of the Philippines is also one of the most endangered groups in the world (Heaney *et al.*, 2000).

An index of faunal endangerment developed by Heaney (1993), calculated the ranking of the degree of threat to specific species. The Greater Negros–Panay faunal region was recognised as the most critical region, with 8 native species threatened to a significant degree.

Negros Island harbours 54 mammalian species from 6 families. Non-volant species represent 5 of the families consisting of Insectivora, Primates, Rodentia, Carniviora and Artiodactyla. Negros is an oceanic island that is geologically young and therefore it's mammalian fauna is as diverse relative to other areas of the Philippines (Heaney *et al.*, 2000). The 5 families found include 13 species consisting of 18% of the total Philippine non-volant faunal species. Many of these species are mainly forest dependent and due to the islands geological history are consequently both unique and highly endangered.

Nevertheless traces of the extremely rare Visayan warty pig (*Sus cebifrons*) and the Philippine spotted deer (*Cervus alfredi*), the most endangered deer in the world, have been discovered in the NNFR. Long tailed macaques (*Macaca fascicularis*), the only primate found on the island, are common however as with many species of frugivore, populations are becoming severely bottlenecked. The rare and endemic Negros shrew (*Crocidura negrina)* is heavily restricted due to habitat destruction, however, due to lack of survey work its presence and distribution in the NNFR is unknown (Turner *et al.*, 2002a).

Little data has been published on the habitat selection, relative abundance, or life histories of small mammals. The number of threatened species is proportional to the degree of deforestation in the region. Most species require primary forest for survival (Heaney 1993). The remarkable depauperate level of information available on these species in conjunction with the pressures on their habitat and populations, presents an extreme threat to the mammalian species of the Negros-Panay faunal region. However as research continues, information on new species emerge. A previously unrecorded new species of mouse was recently found on Luzon. The species appears separate from any other mouse species found on the island and may prove to be a member of an entirely new genus (Heaney *et al.*, 2005).

Whilst deforestation and loss of habitat are considered to be major threats to species, the introduction of invasive alien species is an increasingly significant driver of species extinctions in island ecosystems (Convention on Biological Diversity 2003). *Rattus rattus* and *Rattus norvegius* have eliminated local bird populations on some small islands and out-competed other rodent species on islands in Southeast Asia

(IUCN 2001). However, the threat posed by many non-native species on the Philippines has yet to be quantified.

3.2 Aims

The non-volant mammal research work had two major aims:

- To complete an inventory of the non-volant species present within the study area
- To assess their relative abundance and distribution between the different survey locations (habitat types)

3.3 Methods

Small mammals were trapped using Sherman live traps (2x2.5x6.5"), and medium-sized mammals were trapped using cage traps. Traps were set up in 'trap lines' following the approaches of Heideman *et al.* (1987) and Heaney *et al.* (1989). Traps were stationed in lines of 10 Sherman and 3 cages along a 60m transect with at least 5m spacing between each trap. Three trap lines were established (with at least 10m separation between lines) at each survey site. It was ensured that the traps were wholly within the habitat type being surveyed. Each trap location was marked with a small piece of ribbon/raffia (or similar) tied to a branch above (1m) the trap.

Traps were placed on the ground under suitable cover and alongside natural objects such as fallen trees, logs or branches or under low shrubs. Each trap was baited with peanut butter and oat mix (or similar) and dry bedding material (dry grass, cotton wool, shredded paper etc) was also placed in the nest box. Traps were covered with foliage in order to minimise rain penetration and reduce risk of hypothermia in capture animals. Traps were set for a minimum of 3 mornings and 3 nights, being left open during the intervening periods. Traps were checked at least twice a day, re-baited as needed, and damp bedding replaced. All trap lines were established in areas where no other surveys are being undertaken to minimise disturbance and enhance capture probability.

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

3.4 Results

Capture Data

Table 3.1 shows that a total of 301 individuals were captured over a 12-month survey period. Of this, *Rattus exulans* was the most abundant, representing 38% of all captures followed closely by *Rattus argentiventer*, 28% of captures.

Trap effort for cage and Sherman traps are provided in Tables 3.4 and 3.5. Morphological data for all species captured are also given.

Table 3.1 Mammal species by location

Sub-order	Family	Scientific Name	Common Name	Total	Aeroplano	Bagiawanan	Caliban	Crater 1	Crater 2	Dam	Ginhawanan	James's Farm	Mawa	Palahawayan I	Palahawayan II	Staff house
Insectivora (order)	Sorcidae	*Suncus murinus*	Asian house shrew	71	1	6	2	25	2	3	13	-	3	11	5	-
Sciurognathi	Muridae	*Mus muculus*	House mouse	7	-	-	2	-	-	3	1	-	-	-	-	1
Sciurognathi	Muridae	*Rattus tanezumi*	Oriental house rat	12	5	-	-	2	1	-	1	2	-	1	-	-
Sciurognathi	Muridae	*Rattus exulans*	Polynesian rat	123	11	18	10	21	16	2	19	-	3	14	3	6
Sciurognathi	Muridae	*Rattus argentiventer*	Rice field rat	79	12	15	7	3	4	4	4	1	6	12	5	6
Sciurognathi	Muridae	*Unknown Rattus spp.*	Unknown rat	6	1	-	-	-	4	-	-	-	1	-	-	-
Sciurognathi	Muridae	*Apomys sp. A*	Western Visayan forest mouse	3	-	-	-	-	-	1	-	1	1	-	-	-
			Total	301	30	39	21	51	27	13	38	4	14	38	13	13

Table 3.2 Female mammal morphological data

Species	Statistical Measures	Body Mass (g)	Ear (mm)	Hind foot (mm)	Tail (mm)	Body Length (mm)
Suncus Murinus	Mean	25.9	10.2	17.5	61.6	93.0
	St. dev	7.3	1.5	1.9	7.1	11.7
	Range	14-40	7.9-13.6	12.3-19.4	50.5-83.2	80.6-118.5
	N	15	17	17	17	16
Mus musculus	Mean	26.3	11.9	21.7	87.1	85.2
	St. dev	11.7	2.8	3.8	16.9	12.0
	Range	15-41	8.1-14.6	16.5-25.5	63.2-100	72.6-101.4
	N	4	4	4	4	4
Rattus tanezumi	Mean	64.3	15.4	27.4	107.1	120.8
	St. dev	25.7	2.3	6.8	51.4	19.1
	Range	48-94	13.6-18	22.6-35.2	48.2-142.7	103.2-141.1
	N	3	3	3	3	3
Rattus exulans	Mean	60.0	14.4	26.1	119.9	109.5
	St. dev	23.4	2.1	3.1	29.1	22.0
	Range	31-150	11-19.4	18-33.8	65.9-202.4	11.3-189.6
	N	64	66	66	66	66
Rattus argentiventer	Mean	117.7	16.4	31.8	167.8	149.3
	St. dev	37.9	2.0	3.0	34.7	18.3
	Range	45-170	13.4-23.9	23.4-36.5	95.6-235	112-185
	N	24	25	25	24	24
Unknown rattus spp.	Mean	44	15.2	19.2	103.1	93.45
	St. dev	11.3	1.0	8.2	4.8	0.9
	Range	36-52	14.5-15.9	13.4-25	99.7-106.5	92.8-94.1
	N	2	2	2	2	2

Table 3.3. Male mammal morphological data

Species	Statistical Measure	Body Mass (g)	Ear (mm)	Hind foot (mm)	Tail (mm)	Body Length (mm)
Suncus murinus	Mean	34.5	9.8	19.7	59.7	89.1
	St dev	2.2	0.4	1.3	7.1	7.1
	Range	32-36	9.4-10.1	18.8-21.1	51.8-65.45	81-93.9
	N	3	3	3	3	3
Mus musculus	Mean	103.8	15.5	30.5	172.9	135.2
	St dev	102.2	4.5	7.8	52.5	70.4
	Range	31.5-176	12.3-18.7	24.9-36	135.8-210	85.4-184.9
	N	2	2	2	2	2
Rattus tanezumi	Mean	84.8	15.1	27.6	130.1	126.1
	St. dev	38.5	3.0	6.6	56.9	22.4
	Range	50-140	12.7-20	18.8-35.8	61.3-199	110.4-165
	N	5	5	5	5	5
Rattus exulans	Mean	52.3	14.4	22	101.2	112.7
	St. dev	15.4	1.8	5.8	23.3	18.4
	Range	21-86	11.4-168	12.6-29.2	64.5-140.9	79.6-139.9
	N	16	17	18	18	18
Rattus argentiventer	Mean	107.2	16.7	30.2	158.9	142.0
	St. dev	39.6	2.5	5.3	31.4	25.3
	Range	21-160	11.1-20.3	20.7-37.8	83.3-215	73.6-198
	N	24	25	20	25	25
Unknown Spp.	Mean	38.3	13.7	23.4	95.2	84.6
	St. dev	14.6	1.3	2.3	4.4	8.6
	Range	22-50	12.4-14.9	20.8-24.2	91.4-100	74.8-90.8
	N	3	3	3	3	3
Apomys sp. A	Mean	29.7	13.6	23.9	102.9	83.6
	St. dev	14.4	1.5	3.8	13.1	29.2
	Range	19-46	12.3-15.2	19.6-25.4	88.9-114.8	54.7-113.1
	N	3	3	3	3	3

Table 3.4 Cage trap effort by location

Species	Aeroplano	Bagiawanan	Caliban	Crater 1	Crater 2	Dam	Ginhawanan	James's Farm	Mawa	Staff House	Palahawayan I	Palahawayan II
Effort Per Location*	432	2352	588	360	108	192	768	108	423	432	2158	300
Suncus murinus	-	-	-	0.08	-	0.08	-	-	-	-	0.08	-
Mus musculus	-	-	-	-	-	-	-	-	-	-	-	-
Rattus tazenumi	0.08	-	-	0.08	-	-	-	0.08	-	-	-	-
Rattus exulans	0.08	0.08	-	-	0.08	-	0.08	-	-	0.08	0.08	-
Rattus argentiventer	0.08	0.08	0.0833	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Unknown Rattus spp.	-	-	-	-	-	-	-	-	-	-	-	-
Apomys sp. A	-	-	-	-	-	-	-	-	-	-	-	-

*Number of cages x the number of hours cages are left open.

Table 3.5. Sherman trap effort by location

Species	Aeroplano	Bagiawanan	Caliban	Crater 1	Crater 2	Dam	Ginhawanan	James's Farm	Mawa	Staff House	Palahawayan I	Palahawayan II
Effort per Location*	8748	5808	2352	24300	6912	972	10800	12	768	4116	7500	768
Suncus Murinus	0.08	0.08	0.08	0.08	0.08	0.08	0.08	-	0.08	-	0.08	0.08
Mus musculus	-	-	0.08	-	-	0.08	0.08	-	-	0.08	-	-
Rattus tazenumi	0.08	-	-	0.08	0.08	-	0.08	-	-	-	0.08	-
Rattus exulans	0.08	0.08	0.08	0.08	0.08	0.08	0.08	-	0.08	0.08	0.08	0.08
Rattus argentiventer	0.08	0.08	-	-	-	0.08	0.08	-	-	0.08	0.08	-
Unknown Rattus spp.	0.08	-	-	-	0.08	-	-	-	0.08	-	-	-
Apomys sp. A	-	-	-	-	-	0.08	-	0.08	0.08	-	-	-

*Number of cages x the number of hours cages are left open.

3.5 Discussion

All but one of the mammal species identified are listed as IUCN (2004) Low Risk or Least Concern. *Mus musculus, Suncus murinus* and *Rattus exulans* are all widely distributed throughout most parts of Southeast Asia. Non-native species such as *Suncus murinus* and *Rattus tazenumi* also thrive in a wide range of habitats. All of these species are commensal (extend their ranges freely, into areas settled by humans). *R. exulans* is reported as 'alien' to the Philippines (Motokawa *et al.,* 2001) and is listed on the Global Invasive Species Database (www.issg.org/database).

There is evidence to suggest some island species are vulnerable to the presence of *R. exulans* and *S. murinus* especially those that descend to ground level for part of their life cycle (South Pacific Regional Environment Programme [SPREP] 2000). Lizard populations have been shown to increase following the removal of *R. exulans* and *S. murinus* is strongly implicated in the extirpation of several island lizard species (SPREP 2000).

Table 3.6. Conservation status and distribution of non-volant mammals

		Status		
Scientific Name	Common Name	IUCN (2004)	Heaney (1998)	Distribution
Suncus murinus	Asian house shrew	LR/Lc	Common*	Non-native*
Mus muculus	House mouse	LR/Lc	Common*	Non-native*
Rattus tanezumi	Oriental House rat	LR/Lc	Common*	Non-native*
Rattus exulans	Polynesian rat	LR/Lc	Common*	'Alien' to Philippines†
Rattus argentiventer	Rice field rat	LR/Lc	Common*	Non-native*
Unknown Rattus spp.	-	-	-	-
Apomys sp. (A)	Western Visayan Forest mouse	D/D	Threatened*	Endemic* to Greater Negros-Panay region

* Heaney (1998).
† SPREP (2000).

The recording of three individuals of *Apomys* species at the Dam, James's Farm and Mawa is promising. The *Apomys* genus is one of the most diverse of the muridae family, with at least 13 species represented across the Philippines (Steppan *et al.*, 2003). However, the genus includes relatively new species, of which, the Western Visayan Forest Mouse is one of the least known and as a result is regarded as Data Deficient (IUCN 2004). It is believed to only occur on the islands of Negros, Sibuyan and possibly Panay (Steppan *et al.,* 2003). However no biometric data has been published for this species hence further research, possibly including specimen removal for analysis, is required to assert positively the extent of occurrence of *Apomys* species as well as other members of the *muridae* family within the NNFR.

4. Butterflies

4.1 Introduction

Tropical butterfly assemblages are particularly diverse, with many sites having large numbers of endemic species, most of which are dependent to some extent on forest ecosystems (Sutton & Collins 1991). Butterflies are a suitable group for ecological studies; they are relatively large, mostly diurnal, their taxonomy is relatively well known, and there are some data on their geographic distributions and for some species on their life history (Hill *et al.*, 1992; Spitzer *et al.*, 1993; Beccaloni & Gaston, 1995). This is in contrast to other insect groups in the tropics, where the taxonomy is often poorly known, and morphospecies are often used instead.

Furthermore, butterflies have been suggested as potential bioindicators of disturbance in both tropical and temperate regions (Gilbert, 1984; Spitzer *et al.*, 1997). The dependence of the larval stages on a specific host plant, and the adults' roles as pollinators for other plants, link butterflies closely to the diversity and health of their habitats (Blau, 1980; Kato, 1996; Ghazoul, 1997). Hammond & Miller (1998) conclude that the biodiversity of butterflies is linked to the ecosystem by influencing nutrient cycling, plant population dynamics, and predator-prey population dynamics. Butterflies are also very sensitive to changes in temperature, humidity, and light levels, parameters often affected by habitat disturbance (Wood & Gillman, 1998).

Information on the insects of the Philippines is generally limited with a current species count of 20,940 with an overall endemicity of over 69% in 6,185 genera and 499 families. New species are being discovered each year and it is estimated that arthropod species reach approximately 50,000 to 100,000 species. However, no sampling has been conducted in forest canopies across the Philippines (PBCPP 2002).

Although there is more information available on butterfly species (see Treadaway 1995), abundance and species distributions are not readily known. Experts who have studied the butterflies within the Philippines have presumed that species considered to be ‘very rare’ are likely to be ‘endangered’, and those that are ‘rare’ are likely to be ‘vulnerable’. Areas that show high levels of butterfly endemism rank as priority areas set in the National Biodiversity Action Plan 2002. Priority areas are also set to areas that have received little amounts of research. The North Negros Forest Reserve falls in to priority areas for both research and conservation.

4.2 Aims

- Develop photographic guide or key
- Characterise distribution
- Assessment of species diversity within the survey areas
- Assessment of species abundance within the survey areas

4.3 Methods

Transect Walks
The transect walk method with non-random point counts are used to investigate butterfly spatial distribution, diversity and abundance at different survey sites. The

use of such transects also meant that a wide variety of habitats and microclimates (streams, canopy gaps, different aspects, etc.) can be surveyed (Hill 1999).

Line transects (500m) are marked out and observation stations are marked every 50m (10 stations in total) for the point counts. Butterflies are surveyed along the transects using methods similar to those described for butterflies in temperate regions by Pollard (1977), and used in previous studies of tropical forest butterflies (Hamer *et al.*, 1997; Hill 1998; Hill *et al.*, 1995; Spitzer *et al.*, 1993, Slade 2001), thus, allowing data to be compared with diversity studies from other areas. To ensure a constant duration of observation for each transect walk, a constant speed of 3 minutes per 50m has to be maintained. During the walk butterflies are observed within an imaginary box around the observer (5m each side, 5m ahead and 5m above). Similarly, at each observation station binoculars were used to record butterflies observed during a 10 minute period within a 10m radius, and at all heights from the ground, in an attempt to include higher flying butterflies. These distances are similar to those used in other tropical butterfly studies (Spitzer *et al.*, 1993; Hill *et al.*, 1995; Hamer *et al.*, 1997). Thus, any differences in butterfly diversity between sites was not due to differences in visibility, because recording is restricted to within 10m of the stations and within 5m of transects (Hamer *et al.*, 1997).

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

Peak butterfly density is noted to occur around the middle of the day (Hill *et al.*, 1995; Pollard, 1977; Pollard 1988; Walpole 1999). Transect counts are therefore advised to be conducted between 1000hrs and 1500hrs, and only when the weather is good (i.e. sunny, and no rain), as temperature/irradiance differences are known to affect butterfly flight (Pollard & Yates, 1993; Willott *et al.*, 2000). The direction in which transects are walked should be alternated for each transect to minimise any differences due to time of day in an attempt to ensure equivalent conditions. Each transect should be walked two times during each 4 day survey period.

Walpole (1999) noted low densities of butterflies beneath the canopy, and concluded that to obtain a sizeable sample, repeated counts would be needed along the transect. Hamer *et al.*, (1997) note that although the degree of movement by individuals should not alter the probability of encountering a species, in the absence of sufficient sampling the higher variance for non-sedentary species can lead to possible errors in estimates of relative abundance.

Feeding Traps

Within each transect 10 feeding traps should be baited with over-ripe bananas and hung from vegetation with the base of the trap at least 1m above ground level. The traps are tied to a branch so it is hanging freely and not touching vegetation. The netting is pulled down but a sufficiently large gap is left between the netting and the base to allow butterflies to fly into the trap. The bait is placed on to a large leaf and then placed on the centre of the baiting platform. Traps are spaced every 50m with 10 traps set at any survey location. Traps are set for a period of 48hrs, and checked every

12hrs. On checking traps, individuals are identified to species level, if unable to identify then photographic records are kept.

Different species can be attracted to various bates depending on their functional ecology. Baits can be divided into major groups: dung, carrion, rotting or fermenting plant material, pheromones and live animals.

4.4 Results

Species diversity metrics (Table 4.1) were calculated from the total number of species found at each location, gained from both transect walks and feeding trap methodologies. Three measures of local diversity were calculated for each survey location and these included: Total number of species (S), Shannon-Weiner diversity $H=\sum(P_i*\text{Log}_e(P_i))$ where P_i is the number of individuals of the *i*th species as a proportion of the total number of all *i*th species, and Pielou's evenness $J=H/\text{Log}_e S$ (Carr 1996).

Table 4.1 Diversity Indices by location

Survey Locations	Total Species[1]	Total Individuals[2]	Species Richness[3]	Pielou's Evenness[4]	Shannon-Wiener Index[5]
Aeroplano	11	73	2.3	0.9	2.1
Bagiawanan	11	27	3.0	0.9	2.2
Caliban	16	226	2.8	0.6	1.8
Crater I	5	9	1.8	0.8	1.3
Crater II	7	19	2.0	0.9	1.7
Dam	18	118	3.6	0.7	2.1
Ginhawanan	22	146	4.2	0.7	2.4
James's farm	28	256	4.9	0.9	2.9
Mawa	23	83	5.0	0.9	2.7
Palahawayan I	18	81	3.9	0.8	2.4
Palahawayan II	25	481	3.9	0.8	2.5
Staff House	24	146	4.6	0.9	2.8

[1]Number of Species: the number of species present in a community is a crucial aspect of that community's biodiversity. The number of species varies between locations and can be a useful biodiversity indicator.

[2] Total Number of individuals identified during the survey period.

[3]Species Richness: Species Richness is defined by Margalef's Index **(**d=(S-1)/Log (N)). This incorporates the total number of individuals and is the measure of the number of species present for a given number of individuals. Species richness of the communities sampled in this study are based on same sample sizes and surveying effort.

[4]Pielou's Evenness: this is an expression of equitability and expressed as $J'=H'/H'_{max}=H'/\log S$ where H'_{max} is the maximum possible value of Shannon diversity, if all species were equally abundant.

[5]Shannon-Wiener: represented as $H' = -\sum_{i\ pi}\ \text{Log}\ (p_i)$ where p_i is the proportion of the total count arising from the ith species. The higher the figure obtained the higher the diversity of the area.

The highest numbers of species were found in the survey sites Ginhawanan, James's Farm, Mawa, Palahawayan II and at the Staff House site. At these sites over 20 different species of butterflies were collected.

Species evenness is used as a measure of diversity, as communities which are dominated by one or two species are considered to be less diverse than one in which

several different species have a similar abundance, i.e. communities which are shown to be more even. Thus a higher value for evenness suggests a more diverse area. The analysis shows that across all survey sites the species composition is even, with few species dominating one particular habitat type.

The Shannon-Wiener diversity index takes in to account both species richness and relative abundances and the index depends on both the species richness and the evenness (equitability) with which individuals are distributed among the species. Thus the higher the value of the index the greater the diversity of the area that has been surveyed. The results indicate that the locations that are most diverse include James's Farm, Mawa, Palahawayan I and II and the Staff House site. These locations therefore include 'old growth', 'edge', 'secondary' and 'riparian' survey locations.

Further analysis of the results using Non Metric Multi-Dimensional Scaling (NMDS) shows visible clusters by creating a 'map' or configuration of the sample sets and placing the sample sets (here these are locations) in 'space'. Physically the nearer the samples are to each other the more similar they are in terms of species composition.

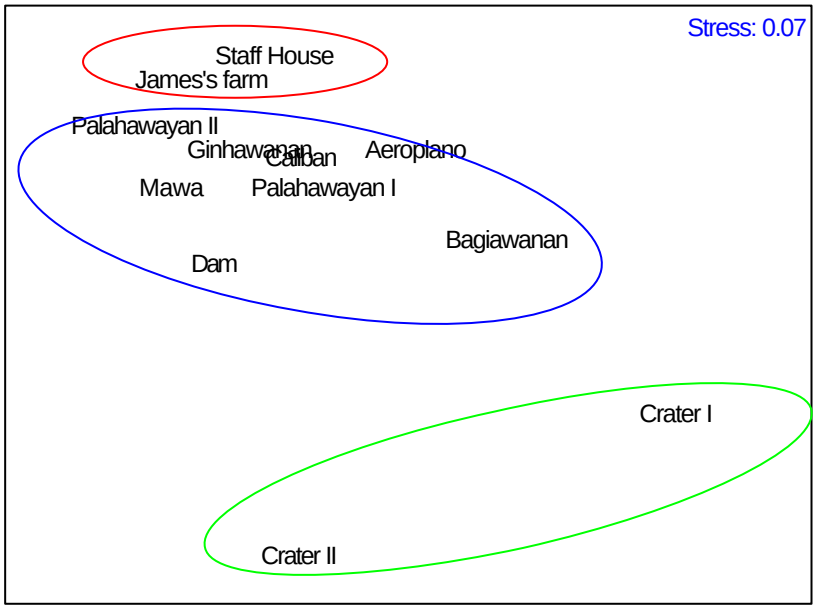

Figure 4.1 NMDS ordination of species by survey location.

The NMDS highlights three main groups within the survey locations. These groups show more similarity within them than they do between the other groups. The 'green' group highlights the two survey sites in the Crater area, which are both mossy forest regions. Both these sites are at relatively high altitude (up to 1800m) and show the lowest number of species found on location site. The diversity of these sites is therefore the poorest found within the NNFR. The 'blue' group consists of 'riparian', 'secondary', 'old growth' and 'disturbed old growth' sites within the NNFR. This

suggests that the differences seen in these habitats are becoming increasingly less, perhaps suggesting that the forest is regenerating effectively. The final group is the 'red' group, which represent the 'edge' habitat types. Species found here are similar to the 'blue' group, however species composition differed to a significant degree.

Species which were found at each location site using both the transect walks and the feeding traps are listed in Tables 4.2 and 4.3. Table 4.4 details species distributions and status of the butterfly species that have been recorded in the forest habitats of the NNFR.

Table 4.4 shows that 6 of the 37 species captured are identified by Treadway (1995) as endemic to the Negros-Panay faunal region and that there are 9 sub-species which are also only in the Negros-Panay faunal region. *Ideopsis gaura canlaoni, Charaxes amycus negrosensis, Cyrestis maenalis negros, Tanaecia howarthii and Ragadia luzonia negrosensis* are all sub species identified as endemic to Negros. According to Treadway (1995) these endemics are found to be 'uncommon' with the exception of *Cyrestis maenalis negros.*

Table 4.2 Species captures on transects by location

Species	Aeroplano	Bagiawanan	Caliban	Crater I	Crater II	Dam	Ginhawanan	James's farm	Mawa	Palahawayan I	Palahawayan II	Staff House
Acrophtalmia yamashitai	15	0	60	0	7	42	25	19	2	3	126	31
Catopsilia pomona pomona	3	2	6	1	0	0	2	6	0	2	13	3
Cepora boisduvalia	0	0	0	0	0	0	0	0	2	0	1	0
Cyrestis maenalis negros	0	0	0	0	0	2	0	0	0	0	0	0
Delias henningia henningia	0	0	1	0	0	0	1	11	1	0	0	1
Delias hyparete panayensis	0	0	1	0	0	0	2	0	1	3	0	0
Discophora dodong	0	0	0	0	0	0	0	0	0	0	0	1
Elymnias sansoni	0	0	0	0	0	1	1	2	1	1	3	2
Euploea mulciber kochi	0	0	0	0	0	0	0	0	0	0	2	0
Eurema hecabe hecabe	0	0	0	0	0	0	0	30	0	0	4	12
Faunis phaon carfinia	12	0	5	0	1	10	21	18	15	5	52	9
Hypolimnas anomala anomala	0	0	0	0	0	0	0	0	0	0	2	0
Hypolimnas bolina philippensis	0	0	2	1	0	1	1	2	1	0	20	2
Ideopsis gaura canlaoni	0	0	0	0	0	16	5	5	9	0	8	3
Jamides alecto	0	0	0	0	0	2	2	2	0	0	0	1
Lampides boeticus	12	4	11	0	0	0	3	12	2	5	16	10
Lethe chandica byzaccus	0	0	0	0	0	0	1	0	1	0	0	0

Table 4.2 Continued

Species	Aeroplano	Bagiawanan	Caliban	Crater I	Crater II	Dam	Ginhawanan	James's farm	Mawa	Palahawayan I	Palahawayan II	Staff House
Lexias satrapes amlana	5	3	91	5	4	15	22	11	12	20	54	6
Melanitis atrax cajetana	0	0	0	0	1	0	0	0	2	0	0	0
Melanitis leda leda	0	2	0	0	0	0	0	1	0	0	0	0
Mycalesis georgi canlaon	6	0	6	0	0	1	1	6	3	1	12	3
Mycalesis ita teatus	2	0	0	0	0	1	1	25	0	2	2	11
Mycalesis perseus caesonia	0	0	0	0	0	0	0	2	0	0	0	2
Odontoptilum spp.	0	0	0	0	0	0	0	0	0	0	1	0
Papilio hystapes	2	0	2	0	0	0	10	8	8	1	56	11
Papilio rumanzoviz	0	0	0	0	0	0	0	2	6	0	12	0
Parantica luzonensis luzonensis	0	0	0	0	0	0	0	2	2	0	1	0
Parantica vitrina oenone	0	1	24	0	2	4	17	22	4	6	25	10
Ptychandra leucogyne	0	0	0	0	1	0	0	0	2	0	2	1
Ragadia luzonia negrosensis	0	0	0	0	0	0	2	3	1	0	4	0
Rhinopalpa polynice panayana	0	0	0	0	0	0	0	0	0	0	0	1
Tanaecia howarthii	0	0	2	0	0	0	5	0	2	2	2	0
Unknown	3	0	5	1	2	6	1	9	3	1	18	0
Ypthima stellera stellera	1	0	0	0	0	0	1	1	0	0	0	2
Zethera musides	0	0	0	0	0	0	0	3	0	0	0	0
Zizina otis oriens	11	0	1	0	0	1	4	1	1	4	19	0

Table 4.3 Species captures by feeding traps

Species	Bagiawanan	Caliban	Crater I	Crater II	Dam	Ginhawanan	James's farm	Mawa	Palahawayan I	Palahawayan II	Staff House
Acrophtalmia yamashitai	0	0	0	0	0	0	0	0	0	1	0
Amathusia phidippus pollicanis	0	1	0	0	0	0	0	0	0	0	2
Charaxes amycus negrosensis	0	0	0	0	0	0	2	0	0	0	0
Faunis phaon carfinia	1	2	0	0	0	7	2	0	4	3	0
Ideopsis gaura canlaoni	0	0	0	0	0	0	0	0	0	1	0
Lethe chandica byzaccus	1	0	0	0	1	0	1	0	0	0	0
Lexias satrapes amlana	1	2	0	1	2	6	1	0	8	6	0
Melanitis atrax cajetana	0	0	0	0	2	0	2	0	0	1	0
Melanitis boisduvalia boisduvalia	0	1	0	0	0	0	0	0	1	0	2
Melanitis leda leda	2	0	0	0	1	1	9	0	1	0	3
Mycalesis georgi canlaon	7	3	1	0	5	3	25	1	5	7	4
Mycalesis ita teatus	1	0	0	0	0	0	4	1	0	0	2
Mycalesis perseus caesonia	0	0	0	0	0	0	2	0	0	0	3
Papilio hystapes	0	0	0	0	0	0	0	0	1	1	0
Parantica luzonensis luzonensis	0	0	0	0	1	0	0	0	0	0	0
Parantica vitrina oenone	0	0	0	0	0	0	0	0	0	1	0
Ptychandra leucogyne	0	0	0	0	0	0	0	0	0	0	1
Ragadia luzonia negrosensis	0	0	0	0	0	0	0	0	1	0	0
Rhinopalpa polynice panayana	1	0	0	0	0	0	0	0	0	0	0
Tanaecia howarthii	0	0	0	0	1	0	2	0	1	2	0
Unknown	1	0	0	0	2	1	1	0	0	1	2
Ypthima stellera stellera	0	0	0	0	0	0	2	0	0	0	4
Zethera musides	0	0	0	0	0	0	0	0	3	0	0
Zizina otis oriens	0	0	0	0	0	0	0	0	0	2	0

Table 4.4. Distribution and status of butterfly species

Family	Species	Habitat (Captures and Feeding traps)	Distribution (sp.)	Distribution (ssp.)	Occurrence
Danaidae	*Euploea mulciber kochi*	R	SE Asia	Negros-Panay	2
	Ideopsis gaura canlaoni	S, OG, R, E, DOG	SE Asia	Negros	1
	Parantica luzonensis luzonensis	E, OG, R	SE Asia	Philippines	2
	Parantica vitrina oenone	R, E, S, DOG, OG, M	Philippines	Negros-Panay & Mindanao	2
Hesperiidae	*Odontoptilum spp.*	R	Asia	-	-
Lycaenidae	*Jamides alecto (manilana?)*	E, S, DOG	SE Asia	Philippines	1
	Lampides boeticus	E, R, DOG, OG, S	Philippines	-	2
	Zizina otis oriens	R, DOG, S, E, OG	Asia	Philippines	1
Papilionidae	*Papilio hystapes*	R, E, DOG, OG, S,	Philippines	-	2
	Papilio rumanzovia	R, OG, E	Philippines	-	2
Pieridae	*Catopsilia pomona pomona*	R, E, DOG, S, M	Asia	Asia	2
	Cepora boisduvalia	OG, R	Negros-Panay	-	1
	Delias henningia henningia	E, R, OG	SE Asia	Philippines	2
	Delias hyparete panayensis	S, OG, R	Philippines	Panay*	-
	Eurema hecabe hecabe	E, R	SE Asia	Philippines	2
	Charaxes amycus negrosensis	E	Philippines	Negros	-
Nymphalidae	*Cyrestis maenalis negros*	S	SE Asia	Negros	2
	Hypolimnas anomala anomala	R	SE Asia	SE Asia	2
	Hypolimnas bolina philippensis	R, E, DOG, M, S	Asia	Philippines	2
	Lexias satrapes amlana	R, S, DOG, E, OG, M	Philippines	Negros-Panay	1
	Rhinopalpa polynice panayana	E,	SE Asia	Negros-Panay	2
	Tanaecia howarthii	DOG, R, S	Negros-Panay	Negros	1
Satyridae	*Discophora dodong?*	E	Negros-Panay	-	1
	Acrophtalmia yamashitai	R, E, DOG, S, M, OG	Negros-Panay	-	1
	Amathusia phidippus pollicanis	R, E	SE Asia	Negros-Panay	2
	Elymnias sansoni	E, S, R, OG	Negros-Panay	Negros-Panay	2
	Faunis phaon carfinia	R, DOG, E, S, OG, M	Negros-Panay	Negros-Panay	2

Table 4. 4 Continued

Family	Species	Habitat (Captures and Feeding traps)	Distribution (sp.)	Distribution (ssp.)	Occurrence
Satyridae	*Lethe chandica byzaccus*	DOG, OG	SE Asia	Philippines	1
	Melanitis atrax cajetana	M, OG	SE Asia	Philippines*	2
	Melanitis leda leda	OG, E	Asia	Asia	2
	Mycalesis georgi canlaon	R, E, DOG, OG, S,	Philippines	-	-
	Mycalesis ita teatus	E, DOG, S, R	Philippines	Negros-Panay	-
	Mycalesis perseus caesonia	E	Asia	Philippines	1
	Ptychandra leucogyne	OG, R, E, M	Philippines	Philippines	1
	Ragadia luzonia negrosensis	R, E, DOG, S	Philippines	Negros	1
	Ypthima stellera stellera	E, DOG	Philippines	Philippines	2
	Zethera musides	E	Philippines	Negros-Panay	2

Keys

Habitat
DOG – Disturbed Old Growth
E – Edge
M – Mossy
OG – Old Growth
R- Riparian
S – Secondary

Distribution and Occurrence
1 Uncommon or local
2 Common
- Unknown
*Based on D'Arbrea (1986), otherwise Treadway (1995)

4.5 Discussion

A total of 12 of the species surveyed have been identified as endemic to the Philippines, with 16 species and subspecies found to be endemic to the Negros-Panay region.

However, there is little evidence available as to the state of endemic butterfly species populations on Negros and as such, none of the species are recorded on the IUCN Lepidopteron Specialist Group Redlist. Further research is needed to fully identify species such as *Odontoptilum spp.* and to document the distribution of sub-species such as *Mycalesis spp.* Additional research using differing foods in the feeding traps could further yield more species found within the NNFR.

Analysis of butterfly species distribution throughout the regions of the NNFR suggests that similar species occur in the 'old growth', 'disturbed old growth', 'secondary growth' and 'riparian growth'. This suggests that the forests habitats are increasingly becoming more similar, showing perhaps, regeneration of habitats and re-colonisation by butterfly species. Species distributions are different on the 'edge' and 'mossy' forest habitats, differing significantly from the main clustered group. These areas are considerably different from the forest habitats and the differing species results were anticipated.

Further work is required to analyse specifically which species are associated with which type of forest habitat to give further insight to the proposed regeneration of some of the forest habitats within the NNFR. Additional work should include changing the bait for the feeding traps as recent research has only involved the use of fermented fruit. Carrion and dung should also be included in the research.

5. Bats

5.1 Introduction

Bats (Chiropterans) often make up a large proportion of the mammalian diversity of forest habitats and this is particularly the case for the Philippines, which has one of the richest mammal faunas in the world. The Chiropterans are the most diverse order of mammals in the Philippines, with 25 Megachiropteran and 48 Microchiropteran species (Heaney & Regalado 1998) and approximately 40% of these are endemic (Heaney 1986). However, it is also recognised that the Philippines Megachiropteran fauna contains a high percentage of threatened taxa as a result of large-scale deforestation and hunting (Mickleburgh *et al.*, 1992). The status of the Microchiropteran fauna is still poorly known (Heaney 1993) despite the identification of many endemic species (Ingle & Heaney 1992).

Negros Island is the most threatened of the Philippines' five faunal regions (Heaney & Regalado 1998). There are at least 42 species of bat thought to be present within this area, of which approximately 25% are known to be endemic to the Philippines (Heaney *et al.*, 1998). Mickleburgh *et al.* (1992) stressed (as one of twenty priority global projects) the urgent need to survey Negros Island area which is ranked eighth highest in the world for Megachiropteran diversity and is listed sixteenth globally for requiring the establishment of protected areas for world fruit bat conservation.

The major threats to bats are the continual destruction and fragmentation of their habitats. Almost all the lowland forest has been lost in the Philippines. This is especially true of Negros. Additionally, the restricted areas of forested habitat are still susceptible to local hunting pressure.

5.2 Aims

- To compile an inventory of species within a defined area
- To assess relative abundance and distribution of each species
- To assess species biometrics

5.3 Methods

Mist-net surveys
Mist-nets (38mm mesh, 6m x 2.6m) were used within 12 locations, representing both forested and non-forested habitats within the study area of the NNFR.

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

Bats captured are identified using Ingle and Heaney (1992) and Francis (2001), sexed by observation of genitalia and nipples, and aged (to adult or juvenile) by assessment

of the ossification of the joints of the digits of the wing. Measurements taken are obtained by dial calipers. All measurements taken are important for identification purposes.

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

5.4 Results

During the research period over 600 individual bats in the 12 different survey locations were captured and their biometrics taken. Table 5.1 lists all species that were identified, their family and their sub-order.

Table 5.1 Bat Species documented in 12 location sites

Sub Order	Family	Species
Megachirpoteran	Pteropodidae	*Cynopterus brachyotis*
Megachirpoteran	Pteropodidae	*Eonycteris spelaea*
Megachirpoteran	Pteropodidae	*Haplonycteris fischeri*
Megachirpoteran	Pteropodidae	*Haplonycteris whiteheadi*
Megachirpoteran	Pteropodidae	*Macroglossus minimus*
Megachirpoteran	Pteropodidae	*Nyctimene rabori*
Megachirpoteran	Pteropodidae	*Ptenochirus jagori*
Megachirpoteran	Pteropodidae	*Pteropus hypomelanus*
Megachirpoteran	Pteropodidae	*Pteropus pumilus*
Microchirpoteran	Vespertilionidae	*Miniopterus australis*
Microchirpoteran	Vespertilionidae	*Myotis macrotarsus*
Microchirpoteran	Vespertilionidae	*Myotis horsfieldii*
Microchirpoteran	Vespertilionidae	*Myotis murcola*
Microchirpoteran	Vespertilionidae	*Pipistrellus javanicus*
Microchirpoteran	Rhinolophidae	*Rhinolophus arcuatus*
Microchirpoteran	Rhinolophidae	*Rhinolophus arcuatus-L*
Microchirpoteran	Rhinolophidae	*Rhinolophus arcuatus-S*
Microchirpoteran	Rhinolophidae	*Rhinolophus philippinensis*
Microchirpoteran	Rhinolophidae	*Rhinolophus virgo*

There are 9 species of fruit bat (megachiropteran) reported from this survey period. An estimated 14 fruit bat species are thought to be found in Negros. Additionally, 9 microchiropteran species have been recorded (as *Rhinolophus arcuatus* has not been identified as either L or S). An estimation of 27 species of microchirpoteran are thought to be found on Negros (Heaney *et al.*, 2000).

Species captured are recorded by survey location and are shown in Table 5.2.

Biometric measurements of these species are taken where possible. These are shown in Tables 5.3, 5.4, 5.5 and 5.6. These tables are broken down in to male, female and adult and juvenile biometric data tables. Each data has been analysed from a sample set (N) with the mean, the range (minimum to maximum data point) and the standard deviation (St.Dev) (variance of results) calculated.

Table 5.2 Species by location

Species	Crater II	Ginhawanan	Palahawayan I	Caliban	Bagiawanan	Dam	Aeroplano	Mawa	Staff house	Crater I	James' farm	Palahawayan II
Cynopterus brachyotis	2	4	12	3	0	14	25	10	17	1	82	25
Eonycteris spelaea	0	0	0	0	0	0	0	0	0	0	0	3
Haplonycteris fischeri	18	25	20	6	8	18	26	26	0	2	3	22
Harpyionycteris whiteheadi	0	0	0	0	1	0	0	0	0	3	2	0
Macroglossus minimus	5	2	1	1	3	9	3	17	30	0	87	1
Nyctimene rabori	0	0	0	0	0	1	0	0	0	0	1	0
Ptenochirus jagori	0	1	2	0	2	0	7	5	0	1	8	0
Pteropus hypomelanus	0	1	0	0	0	0	0	0	0	0	0	0
Pteropus pumilus	0	0	0	0	0	0	0	0	0	0	3	0
Rhinolophus arcuatus	0	0	0	0	0	0	1	4	0	0	0	0
Rhinolophus arcuatus-L	0	0	0	0	0	0	0	4	0	0	0	0
Rhinolophus arcuatus-S	0	0	0	0	0	0	0	5	0	0	0	0
Rhinolophus philippinensis	0	0	0	0	0	0	0	0	0	0	0	1
Rhinolophus virgo	0	0	2	0	1	0	0	1	0	0	0	0
Miniopterus australis	0	1	0	0	0	0	0	1	0	1	0	0
Myotis macrotarsus	0	0	0	0	0	0	0	0	0	0	2	0
Myotis horsfieldii	0	0	0	0	0	0	0	0	0	1	0	0
Myotis murcola	1	0	1	0	0	0	0	0	0	1	0	0
Pipistrellus javanicus	0	0	0	1	0	1	0	1	0	1	0	4

Table 5.2 Adult female morphological data

Species	Statistics	Body Mass (g)	Fore arm (mm)	Ear (mm)	Hind foot (mm)	Tail (mm)	Total Body Length (mm)
Rhinolophus virgo	Mean	6.1	42.8	17.3	7	20.4	44.7
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Pteropus pumilus	Mean	87	94.8	17.4	16.7	-	122.1
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	-	1
Ptenochirus jagori	Mean	92.4	85.3	15.7	13	7.6	117.7
	St.Dev	6.5	5.0	3.7	5.6	3.73	12.5
	Range	87-103	76.7-88.9	12.5-21.4	3.9-18.8	2.2-12.4	103.4-131
	N	5	5	5	5	5	5
Pipistrellus javanicus	Mean	8.3	35.8	9.9	8.5	26.6	42.6
	St.Dev	1.5	0.9	1.8	1.0	3.4	9.4
	Range	7-10	35-36.8	8.8-12	7.5-9.4	23.2-30	31.9-49.1
	N	3	3	3	3	3	3
Myotis horsfieldii	Mean	6	35.4	9.8	9.8	25.8	50.3
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Myotis macrotarsus	Mean	16	44.7	9.6	8.1	-	68.3
	St.Dev	8.5	1.2	3.1	1.3	-	4.6
	Range	10-22	43.8-45.5	7.4-11.8	7.2-9	-	65-71.5
	N	2	2	2	2	-	2

Table 5.2 Continued

Species	Statistics	Body Mass (g)	Fore arm (mm)	Ear (mm)	Hind foot (mm)	Tail (mm)	Total Body Length (mm)
Macroglossus minimus	Mean	19.6	44.2	11.5	10.3	-	66.4
	St.Dev	5.8	2.2	1.7	1.3	-	4.9
	Range	10-31	39.5-50.6	8.6-16.7	8-12.5	-	57-76.4
	N	36	38	38	38	-	38
Harpyionycteris whiteheadi	Mean	130	90	19.3	21.1	-	133.8
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	-	1
Haplonycteris fischeri	Mean	21.5	49	8.6	10.4	-	67.6
	St.Dev	3.6	2.9	1.7	1.4	-	6.2
	Range	15-34	41-56.2	5.5-11.6	7.9-13.4	-	58.1-78.2
	N	48	48	47	47	-	44
Eonycteris spelaea	Mean	80	61.9	13.3	12.1	10.5	77.2
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Cynopterus brachyotis	Mean	34.2	62.4	12.5	12.6	5.9	88.1
	St.Dev	7.7	4.7	2.3	1.8	2.5	7.3
	Range	15-55	45.5-69.2	3-17.3	10.2-19.9	2.4-11.4	70.6-101.4
	N	47	47	46	46	42	45

Table 5.3 Juvenile female morphological data

Species	Statistics	Body Mass (g)	Fore arm (mm)	Ear (mm)	Hind foot (mm)	Tail (mm)	Total Body Length (mm)
Rhinolophus arcuatus-L	Mean	8.7	49.5	13.6	6.4	21.4	51.1
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Ptenochirus jagori	Mean	101	92	20.5	16.2	11.4	136.8
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Macroglossus minimus	Mean	16.3	44.7	12.5	10.1	-	64.2
	St.Dev	3.1	1.2	1.1	1.2	-	4.8
	Range	10-20	42.7-60	9.1-13.5	8.2-11.9	-	51.5-70.6
	N	19	19	19	19	-	18
Harpyionycteris whiteheadi	Mean	115	90.8	18.6	20.7	-	133.8
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	-	1
Haplonycteris fischeri	Mean	19.8	45.7	8.5	9.8	-	65.2
	St.Dev	4.7	6.4	0.9	1.7	-	3.9
	Range	13-30	42-51.5	8-10.8	7.1-12.9	-	56.4-72
	N	14	14	14	14	-	13

Table 5.3 Continued

Species	Statistics	Body Mass (g)	Fore arm (mm)	Ear (mm)	Hind foot (mm)	Tail (mm)	Total Body Length (mm)
Cynopterus brachyotis	Mean	28.6	59.6	11.5	11.1	3.9	81.4
	St.Dev	6.0	6	1.2	1.2	3	9.1
	Range	18-33	45.3-63.7	9.5-13.5	8.9-12.6	1.5-9.6	62.3-89.8
	N	8	8	8	8	8	8

Table 5.4 Adult male morphological data

Species	Statistics	Body Mass (g)	Fore arm (mm)	Ear (mm)	Hind foot (mm)	Tail (mm)	Total Body Length (mm)
Rhinolophus virgo	Mean	11	36.7	13.3	7.3	19.6	42.6
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Rhinolophus philippinensis	Mean	5	43.3	18.1	9.1	24.9	41
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Rhinolophus arcuatus-S	Mean	8.9	46.3	13.5	8.7	18.2	49.1
	St.Dev	1.3	0.8	0.2	0.6	0.4	0.2
	Range	7-9.8	45.7-47.5	13.2-13.8	8.3-9.6	17.6-18.5	48.8-49.2
	N	3	3	3	3	3	3
Rhinolophus arcuatus-L	Mean	8.8	49.7	13	7.4	19.8	53.6
	St.Dev	0.1	1.4	1.6	0.3	1.4	3.3
	Range	8.65-8.9	48-50.5	12.1-14.9	7.2-7.7	19-21.5	49.8-55.5
	N	3	3	3	3	3	3
Pteropus pumilus	Mean	98.5	84.1	16.9	19.9	-	126.3
	St.Dev	41.7	4.7	2.1	2.3	-	1.8
	Range	69-128	80.7-87.4	15.4-18.4	18.2-21.5	-	125-127.6
	N	2	2	2	2	-	2
Pteropus hypomelanus	Mean	112	88.8	17.6	21.9	-	130.1
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	-	1

Table 5.4 Continued

Species	Statistics	Body Mass (g)	Fore arm (mm)	Ear (mm)	Hind foot (mm)	Tail (mm)	Total Body Length (mm)
Pteropus hypomelanus	N	1	1	1	1	-	1
Ptenochirus jagori	Mean	88.9	85.5	15.9	17.9	10.6	116.1
	St.Dev	11.8	3.2	2.1	2.3	3.1	9.6
	Range	64-110.5	78.1-90.7	12-19.5	14.1-22.6	3.8-14.5	98.1-139.9
	N	19	19	19	19	19	19
Pipistrellus javanicus	Mean	10.7	35.8	7.5	6.8	26.7	50
	St.Dev	9.8	2.4	0.8	2.4	3.8	2.1
	Range	5-22	33-37.5	6.7-8.2	4.8-9.4	23.3-30.8	47.6-51.5
	N	3	3	3	3	3	3
Nyctimene rabori	Mean	79	79.1	13.7	16.7	19.9	125.2
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Myotis murcola	Mean	8	34	7.1	7.1	29.8	47.2
	St.Dev	5.3	1.7	1.7	2.2	9.1	1.7
	Range	4-14	32.3-35.7	5.4-8.8	5.6-9.7	23.5-40.3	45.3-48.5
	N	3	3	3	3	3	3
Miniopterus australis	Mean	6.8	33.5	7.8	23.1	27.6	45.5
	St.Dev	2.5	1.4	-	-	-	-
	Range	5-8.5	32.5-34.5	-	-	-	-
	N	2	2	1	1	1	1
Macroglossus minimus	Mean	17.9	42.1	11.7	10.1	-	65
	St.Dev	3.7	6.6	1.5	1.5	-	9
	Range	10-28	10.6-51.1	8.8-14.5	6.4-13.7	-	12.5-74.8
	N	49	51	51	51	-	51

Table 5.4 Continued

Species	Statistics	Body Mass (g)	Fore arm (mm)	Ear (mm)	Hind foot (mm)	Tail (mm)	Total Body Length (mm)
Harpyionycteris whiteheadi	Mean	118	85.9	15	20.2	-	141.1
	St.Dev	1.4	0.2	0.4	4.2	-	6.5
	Range	117-119	85.7-86	14.7-15.2	17.2-23.1	-	136.5-145.7
	N	2	2	2	2	-	2
Haplonycteris fischeri	Mean	23.4	49.5	8.6	10.2	-	66.5
	St.Dev	9.4	3.9	1.5	1.8	-	5.1
	Range	8-47	34.7-63.2	5.8-12.6	4.8-14.1	-	56.5-79
	N	63	65	64	64	-	62
Cynopterus brachyotis	Mean	32.3	62.6	12.4	12.3	5.1	84.6
	St.Dev	5.7	5.2	2	1.7	2	7.6
	Range	17-47	42-84.4	5.5-17.1	7.9-17.2	1-13.2	65-102.3
	N	90	91	92	92	87	91

Table 5.5 Juvenile male morphological data

Species	Statistics	Body Mass (g)	Fore arm (mm)	Ear (mm)	Hind foot (mm)	Tail (mm)	Total Body Length (mm)
Rhinolophus virgo	Mean	6	39	12.3	5.9	19.5	38.3
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Rhinolophus arcuatus-S	Mean	9	45.2	18.9	5.5	14.2	39.6
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Ptenochirus jagori	Mean	79	87.8	17.3	18.7	9.6	122.1
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Pipistrellus javanicus	Mean	82	85.7	17.6	15.8	126	117.9
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Nyctimene rabori	Mean	80	76	8.6	18.3	16.9	101.4
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1
Miniopterus australis	Mean	5	32.1	4.3	5.4	23.1	40.8
	St.Dev	-	-	-	-	-	-
	Range	-	-	-	-	-	-
	N	1	1	1	1	1	1

Table 5.5 Juvenile male morphological data

Species	Statistics	Body Mass (g)	Fore arm (mm)	Ear (mm)	Hind foot (mm)	Tail (mm)	Total Body Length (mm)
Macroglossus minimus	Mean	15.8	42.8	11.3	10.1	-	71.7
	St.Dev	3.9	2.3	1.6	1.4	-	5.6
	Range	8-25	36.2-48.8	8.2-15.8	7.2-12.6	-	52.6-73.3
	N	48	48	48	48	-	47
Harpyionycteris whiteheadi	Mean	120.5	86.4	16.1	19.4	-	126.6
	St.Dev	10.6	0.9	1.6	2.8	-	6.5
	Range	113-128	85.7-87	14.9-17.2	17.4-21.3	-	122-131.2
	N	2	2	2	2	-	2
Haplonycteris fischeri	Mean	20.4	49	8.7	10	-	64.5
	St.Dev	4.8	3.6	1.6	1.4	-	5.9
	Range	12-35	41.1-60.6	7.2-14.9	7-12.4	-	53.9-79.9
	N	44	44	44	43	-	42
Eonycteris spelaea	Mean	61	53	11.2	10.7	7.4	68.5
	St.Dev	41	6.4	1.4	0.9	-	3.2
	Range	32-90	48.5-57.5	10.2-12.2	10-11.3	-	66.2-70.7
	N	2	2	2	2	1	2
Cynopterus brachyotis	Mean	27.5	58.4	11.6	11.5	5.3	78.8
	St.Dev	6	5.9	2.3	2.2	1.8	10.5
	Range	18-44	43-66.5	7.2-19.6	6.5-15.6	1.9-10.1	55.2-98.2
	N	34	35	35	35	32	35

Table 5.6 Bat captures by location by mist net effort

Species	Aeroplano	Bagiawanan	Caliban	Crater I	Crater II	Dam	Ginhawanan James Farm	Mawa	Palahawayan I	Palahawayan II	Staff House
Effort per location (no. of hours x no. of nets)	1608	600	555	846	889.2	1161.3	1530	3549.6	1426.56	869.4	3399	234
Cynopterus brachyotis	0.0091	-	0.00173	0.0005	0.0087	0.0054	0.0013	0.017	0.0036	0.0053	0.0052	0.014
Eonycteris spelaea	-	-	-	-	-	-	-	-	-	-	0.0006	-
Haplonycteris fischeri	0.0095	0.0043	0.00347	0.0009	0.0078	0.00696	0.0079	0.0007	0.0094	0.0088	0.0046	-
Harpyionycteris whiteheadi	-	0.0005	-	0.0014	-	-	-	0.0004	-	-	-	-
Macroglossus minimus	0.0011	0.0016	0.00058	-	0.0022	0.00348	0.024	0.019	0.0061	0.0004	0.0002	0.025
Nyctimene rabori	-	-	-	-	-	0.00039	-	0.0002	-	-	-	-
Ptenochirus jagori	0.0026	0.0011	-	0.0005	-	-	0.0003	0.0017	0.0018	0.0009	-	-
Pteropus hypomelanus	-	-	-	-	-	-	0.0003	-	-	-	-	-
Pteropus pumilus	-	-	-	-	-	-	-	0.0007	-	-	-	-
Rhinolophus arcuatus	0.0004	-	-	-	-	-	-	-	0.0014	-	-	-
Rhinolophus arcuatus-L	-	-	-	-	-	-	-	-	0.0014	-	-	-
Rhinolophus arcuatus-S	-	-	-	-	-	-	-	-	0.0018	-	-	-
Rhinolophus philippinensis	-	-	-	-	-	-	-	-	-	-	0.0002	-
Rhinolophus virgo	-	0.0005	-	-	-	-	-	-	0.0004	0.0009	-	-
Miniopterus australis	-	-	-	0.0005	-	-	0.0003	-	0.0004	-	-	-
Myotis macrotarsus	-	-	-	-	-	-	-	0.0004	-	-	-	-
Myotis horsfieldii	-	-	-	0.0005	-	-	-	-	-	-	-	-
Myotis murcola	-	-	-	0.0005	0.0004	-	-	-	-	0.0004	-	-
Pipistrellus javanicus	-	-	0.0006	0.0005	-	0.0004	-	-	0.0004	-	0.0008	-

Diversity indices were calculated for each of the survey locations. The results of the analysis are shown in Table 5.6 below.

Table 5.7 Diversity Indices by Location

Survey Locations	Total Species[1]	Total Individuals[2]	Species Richness[3]	Pielou's Evenness[4]	Shannon-Wiener Index[5]
Crater II	4	26	0.92	0.65	0.89
Ginhawanan	6	34	1.42	0.53	0.96
Palahawayan I	6	38	1.38	0.67	1.20
Caliban	4	11	1.25	0.81	1.12
Bagiawanan	5	15	1.48	0.80	1.29
Dam	5	43	1.06	0.77	1.23
Aeroplano	5	62	0.97	0.74	1.19
Mawa	10	74	2.10	0.79	1.83
Staff House	2	47	0.26	0.94	0.65
Crater I	8	11	2.91	0.95	1.97
James' Farm	8	188	1.34	0.53	1.11
Palahawayan II	6	56	1.24	0.68	1.22

[1]Number of Species: the number of species present in a community is a crucial aspect of that community's biodiversity. The number of species varies between locations and can be a useful biodiversity indicator.

[2] Total Number of individuals identified during the survey period.

[3]Species Richness: Species Richness is defined by Margalef's Index ((d=(S-1)/Log (N)). This incorporates the total number of individuals and is the measure of the number of species present for a given number of individuals.

[4]Pielou's Evenness: this is an expression of equitability and expressed as $J'=H'/H'_{max}=H'/\log S$ where H'_{max} is the maximum possible value of Shannon diversity, if all species were equally abundant.

[5]Shannon-Wiener: represented as $H' = -\sum_{i\,pi} \text{Log}\,(p_i)$ where p_i is the proportion of the total count arising from the ith species. The higher the figure obtained the higher the diversity of the area.

The results suggest the locations that have the highest levels of species richness include Cater I, Mawa, Bagiawanan and Palahawayan I. Peilou's evenness documents each location's species equitability. The analysis shows that location sites Crater I, the Staff House, the Caliban and Bagiawanan have the highest values, suggesting more diverse areas.

Shannon-Wiener diversity index also suggests that Crater I, Mawa, the Dam and Palahawayan II show high levels of diversity.

Further analysis of the distribution of the species and patterns in community composition of bats found within the NNFR forest types can be assessed using PRIMER (Clarke & Warwick, 1994a). The Bray-Curtis similarity measure was then calculated between every permutation of sample pairs (Clarke & Warwick 1994b). The relationship between survey sites was analysed using a Non-metric MultiDimensional Scaling (NMDS) ordination and a hierarchical agglomerate clustering technique (Clarke & Green 1988).

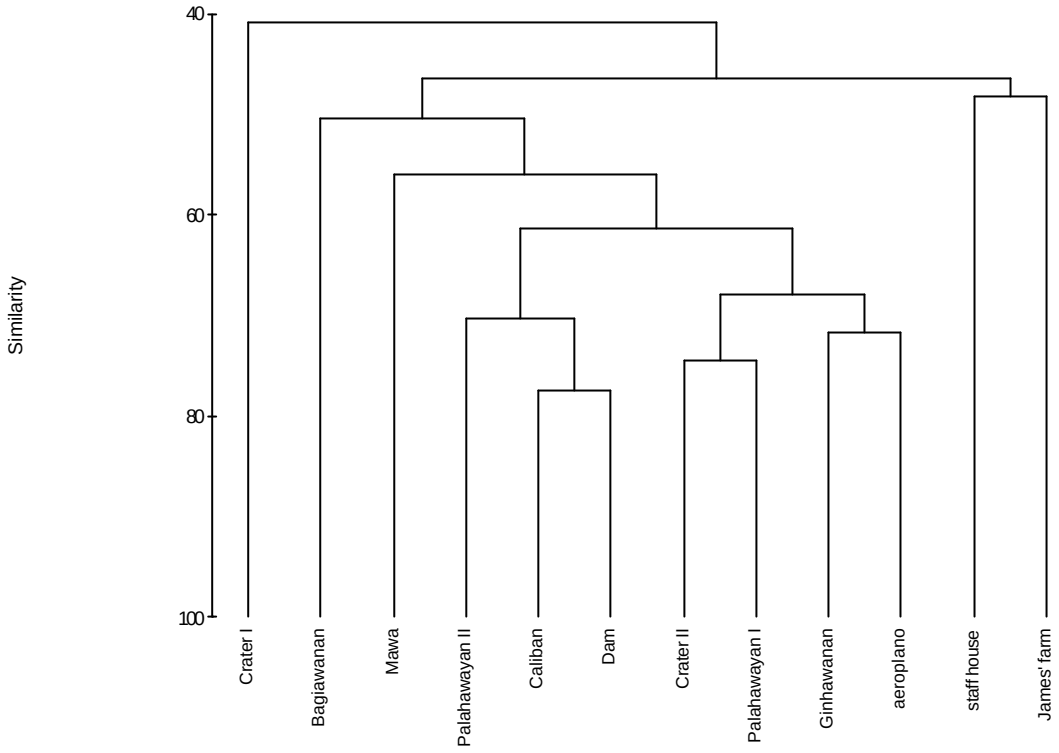

Figure 5.1 Dendrogram of Bat Species Composition.
(Calculated using group average linking of Bay-Curtis similarities (4th root transformation) and labelled according to survey location name).

This analysis shows that the majority of all the sites surveyed are 50% similar in species composition. However, there seem to be groups within this analysis. The Staff House and James' Farm are more similar in species composition to each other than other sites in the NNFR. Both these sites are situated on the forest edge. Bagiawanan and Mawa also show to be slightly less similar in species composition then other forested sites. Crater I is found to be just 40% similar to the other surveyed sites.

To clarify patterns found in the community composition an additional dendrogram is created by replacing survey location names with habitat type. This is shown in Figure 5.2.

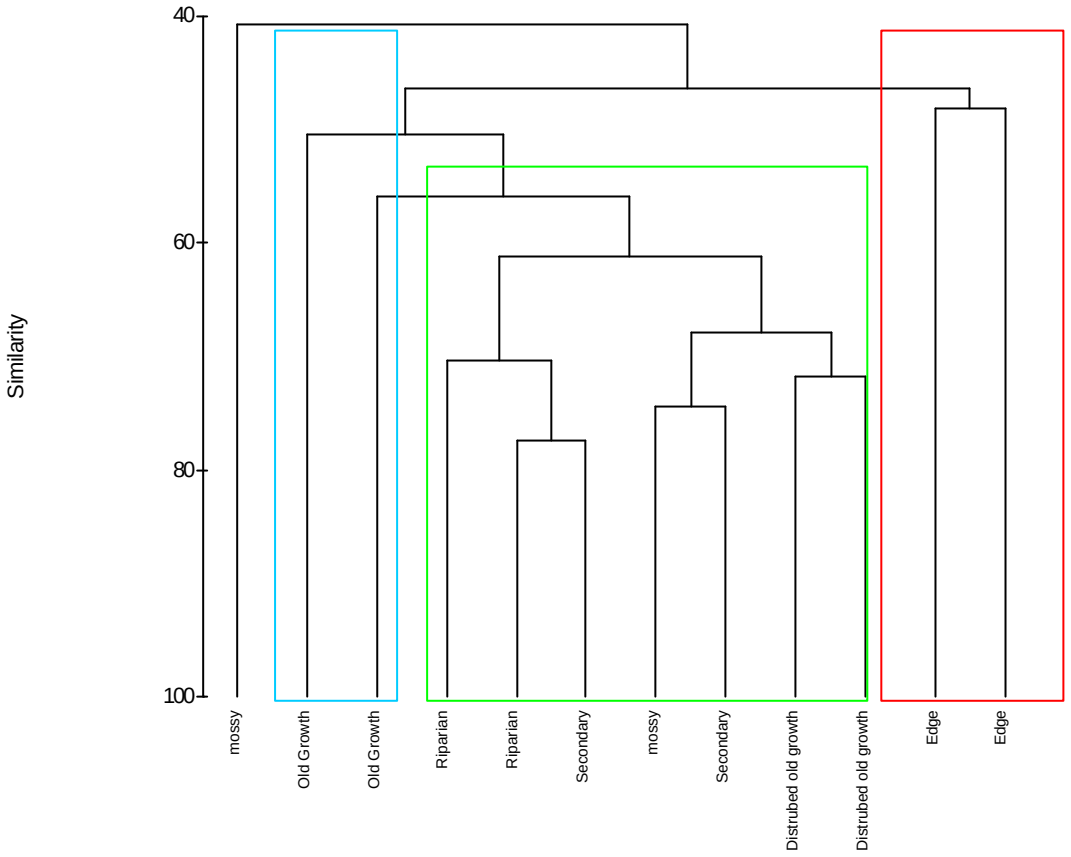

Figure 5.2 Dendrogram showing similarity in species composition by habitat type.

The dendrogram highlights three main clustered groups. The red box highlights the forest 'edge' habitat, showing that these habitats are more similar to each other than to the other forest habitat types. The green box contains the majority of the forest habitats, excluding the 'old growth'. These habitats have very similar species composition with over 60% similarity. Finally, the blue box highlights the 'old growth' forest habitat. These locations are slightly different from the majority of the other habitats, showing only 50% similarity in species composition with the other forest locations.

The use of NMDS can further illustrate the similarities of these habitat types by plotting locations in 'space'. The closer the locations are to each other, the more similar they are in species composition.

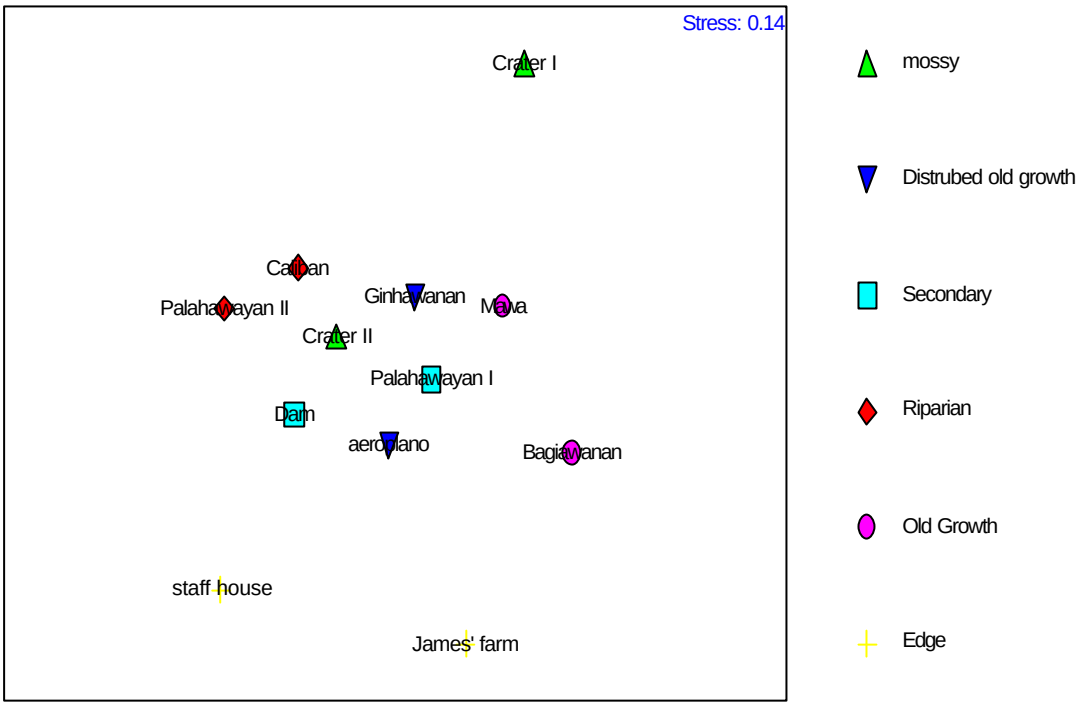

Figure 5.3 NMDS plot of location/habitat type

NMDS further supports the dendrogram analysis. It can be seen that there is a general cluster centrally with all the forest habitat types. The Staff House and James' Farm are shown to be more peripheral, demonstrating the differences found in species composition.

5.5 Discussion

Of the species that were recorded there are 5 notable species that are discussed below:

Nyctimene rabori: this species is classified on IUCN Redlist (2004) as critically endangered. The population seems to be continually decreasing during its assessments. Habitat loss and forest fragmentation seem to be the root cause of the problem. This species is also a Philippine and Negros endemic. Previously, this species has only been recorded in southern Negros in primary or good quality secondary forest. The discovery of this species in the NNFR is of significant interest.

Pteropus pumilus: this species is listed on IUCN Redlist (2004) as vulnerable with its populations decreasing. This species is found in good primary and secondary growth

forest and at forest edge, but not on agricultural regions. Habitat loss seems to a driving force of the population decrease.

Myotis macrotarsus: the species is listed IUCN Redlist (2004) as lower risk, near threatened, where species survival is linked with conservation efforts.

Rhinolophus philippenensis: this species is listed IUCN Redlist (2004) as lower risk, near threatened. This species is also endemic to the Philippines.

Rhinolophus virgo: the species is listed IUCN Redlist (2004) as lower risk, near threatened, where species survival is linked with conservation efforts. This species is also endemic to the Philippines.

Through the analysis of species composition in the NNFR survey sites, the forested areas show very similar composition. This could indicate forest regeneration in some of the more disturbed sites. Species that have been captured are known to prefer habitats of primary and good secondary forest (*Rhinolophus virgo* and *Rhinolophus philippenensis*), which suggest that the forest is healthy enough to support these populations.

The recording of the critically endangered species *Nyctimene rabori* is significant as it was only recorded in southern Negros. Finding individuals in the NNFR suggests a population exists here.

6. Discussion and Recommendations

Detailed analysis of the baseline data across all major taxa groups studied suggests significant similarities in species distributions in the majority of the surveyed forest habitats, the most significant similarities include the habitats of 'old growth', 'disturbed old growth' and 'secondary growth'. The other habitat types; 'riparian' 'mossy' and 'edge' show some similarities with the forest groups, however, species abundances seem to differ. Additionally species not found within forest habitats are being found in these locations.

The results of the 12-month surveys suggest that the forest ecosystem within the NNFR is regenerating as species distributions are becoming more constant across the NNFR. Species that are associated more with old growth forest are being found in disturbed old growth and secondary growth. The prime example of such a species is the critically endangered Tarictic Hornbill, which has been recorded in survey sites the Dam, Palahawayn I, Ginhawanan, Mawa and the mossy sites of Crater I and II.

Additional IUCN Redlist (2004) species include the critically endangered Philippine Tube-nosed bat (*Nyctimene rabori*), the vulnerable *Pteropus pumilus* and the lower risk categorised species *Myotis macrotarsus, Rhinolophus philippenesis* and *Rhinolophus virgo*. These species have been found across all survey locations including the edge of the forest.

There are continual reports of evidence of the Visayan warty-pig and the Visayan spotted-deer living within the NNFR. Further survey work and expansion of survey sites could well clarify these sightings.

Previous work conducted within the NNFR has been documented in the CCC/NFEFI report of 2003. As stated in the 2003 report, surveys were conducted in limited areas within the NNFR, focusing on three main habitat types. This report documents surveys that have expanded into more forest habitat types and previously lesser-known habitats (e.g. forest edge). This gives a more informed picture of the patchwork of habitats found within the NNFR and the species that these can support.

6.1 Recommendations

Recommendations for continual work fall in to three main categories.

Biodiversity Research
Research conducted has expanded in to many forested and non-forested regions within the Upper Imbang-Caliban watershed. Further expansion of survey sites will provide details of additional habitats and illustrate the patchwork of habitat types within this region. These results will be linked with the GIS system.

Base line biodiversity assessment will continue in all of these survey sites. Particular research should focus on the herpetofauna of the region and this has previously been limited. Vegetation analysis will also be conducted in these areas. Research on the other major taxonomic groups (birds, bats, mammals and butterflies) will also continue. Emphasis on more detailed analysis of behaviour of endangered and threatened species should also occur.

GIS Integration
The development of effective conservation decision support tools using integrated GIS systems is seen as a major goal in the successful management of the NNFR. Habitat mapping and ground truthing IKONOS imagery will ultimately provide the NNFR management council with the ability to make more informed decisions through the assessment of the area and the habitat types. These habitat types will be linked to species databases providing information across the watershed area. This is especially important when assessing endangered species habitats such as the Tarictic Hornbill and the Philippine Tube Nosed Bat.

Data Application
The data, which the NRCP has produced over the last few years, has highlighted not only important species discoveries (such as the Philippine Tube Nosed Bat) but has recently supported the theory of forest regeneration and the movement of old growth forest restricted species into areas of secondary re-growth and disturbed old growth. This would prove to be very insightful in topical rainforest conservation and management.

On a local scale the data that has been gathered should be presented to the NNFR Management Council by NFEFI. The results from the analysis should provide further impetus for the NNFR to be designated as a Protected Area, with increased levels of protection. A stakeholder forum should be set up for all local people in the municipalities surrounding the NNFR, the local government and local NGOs and education bodies. All stakeholders should be aware of the research and its interpretation and how this would affect the NNFR and the surrounding region.

On a national scale these results support the PBCPP (2002) desire to increase species inventory work in the battle to prevent 'the empty forest syndrome'. Baseline information within all ecosystems of the Philippines is urgently required to support biodiversity action plans, species-specific action plans and to strengthen the Protected Areas System.

This report documents successful habitat regeneration within the surveyed habitats of the NNFR. This should provide impetus for further forest regeneration initiatives by NFEFI. Forest edge areas, disused farm land and land previously cleared by slash and burn should be incorporated into the programme. Regeneration methods should also be considered in the wider NNFR boundaries and municipalities.

Additionally NRCP data should be provided to additional national stakeholders such as Haribon Foundation, WWF, FFI and the CBD national focal point. Dissemination of research and work that has been achieved in the Philippines is an important part of national capacity building.

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