The Biodiversity of the Lower-Montane Forest Habitats of the 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

- Prepared by -

Amy Turner, Terrestrial Projects Co-ordinator
Elly Sanderson, Terrestrial Projects Co-ordinator
Michael Sweet, Project Scientist
Peter Raines, Managing Director

2006

Coral Cay Conservation Ltd
Ground Floor, 40-42 Osnaburgh Street, London NW1 3ND, UK
Tel: +44 (0)870-750-0668
Fax: +44 (0)870-750-0667
terrestrial@coralcayconservation.com
www.coralcay.org

Contents

I Acknowledgements

The NRCP is indebted to the staff of the Negros Forests and Ecological Foundation Inc (NFEFI) for their continued support. Particular thanks are due to Gerardo Ledesma, Jose Maria (Toti) Ledesma, Donato Poblador, Davoy Castor and the other staff of NFEFI. The NRCP would like to thank the Department of the Environment and Natural Resources (DENR) for their continued interest and assistance with the project.

The work was supported both directly and indirectly by a number of research collaborators, including Marisol Pedregosa (University of the Philippines), Larry Heaney, Jodi Sedlock, Sypro Rodgrigazo (formally PEMO), PEMO (Provincial Environment Management Office), Vickie Demonteverde (FORESTS), Cynthia Dolino, Lisa Marie Paguntalan and Apolinario Carino (Silliman University), Domingo Madulid and Maribel Agoo (Philippines National Museum), Thomas Brooks (Conservation International), and Peter Wilkie (Royal Botanic Gardens, Edinburgh) Matthew Struebig (Queen Mary's College, University of London), Andreas Hamann (University of Alberta, Canada) and the British Ecological Society.

We are also indebted to the people of Campuestuhan for their continuing support and efforts with all aspects of the project work. Finally, we would like to thank the staff and volunteers of Coral Cay Conservation.

II Executive Summary

- This report outlines the findings of the Rapid Biodiversity Assessment undertaken by Coral Cay Conservation as part of the Negros Rainforest Conservation Project. The research was conducted in the North Negros Forest Reserve, Negros Island, the Philippines during the period of May-November 2005.

- Six Lower-montane forest habitats (below 1500m in altitude) were identified within the reserve and surveyed. These range from low-lying forest edge areas, secondary forest regrowth to mossy old growth. Fieldwork was halted at the old growth survey site due to logging.

- Fieldwork focused on four main faunal groups: birds, bats, butterflies and non-volant (non-flying) mammals.

- Bird species were recorded using MacKinnon List observations at the six survey sites until logging began in the old growth region. Forty species were identified from 23 families. Fifteen of the species recorded are endemic to the Philippines, including the Tarictic Hornbill, which is classified as endangered.

- Mist-netting techniques were used to capture bats. In total, 76 individuals were recorded. The majority of captures were Megachiropterans (fruit bats), with 5 species represented. Microchiropterans (insectivorous bats) were represented by 2 species. The critically endangered Philippine-tube nosed bat was recorded.

- A total of 347 butterflies were caught across the survey sites using hand nets on transects through forest habitats. Three of the fifteen families were represented: Pieridae, Nymphalidae and Satyridae. Four species are only found in the Negros-Panay faunal region.

- Surveying of small, non-flying mammals suggests a high dominance of rodents associated with disturbed forest habitats. However the extremely rare Visayan Warty Pig and Philippine Spotted Deer were sighted during the period.

- The NRCP has continued to develop and expand the Environmental Education Scheme with a scholarship programme for local students and counterparts, open days for local school groups and on-going participatory events with local stakeholders.

- Recommendations for future work include implementing an interactive Geographical Information System for the local watershed. It is hoped information on the biodiversity of the forest habitats will contribute to local natural resource management plans (including protected area designation) for the region.

- Future work for the NRCP aims to build upon existing knowledge of the NNFR and build up a long-term assessment of forest status and regeneration as well as identify new sites for research.

III List of Tables

List of Figures

1. Introduction

1.1 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) and per hectare may harbour more biological diversity than any other country in the world (Philippines Biodiversity Conservation Priorities, 2002).

The Philippine Archipelago consists of over 7,000 islands. As a consequence of their geology, different biogeographical regions have evolved. Six major regions have been identified and these are shown in Figure 1.1. The regions are generally aligned to the formation of the larger Philippine Islands of Luzon, Mindoro, Mindanao, Palawan, Negros-Panay and Sulu Islands.

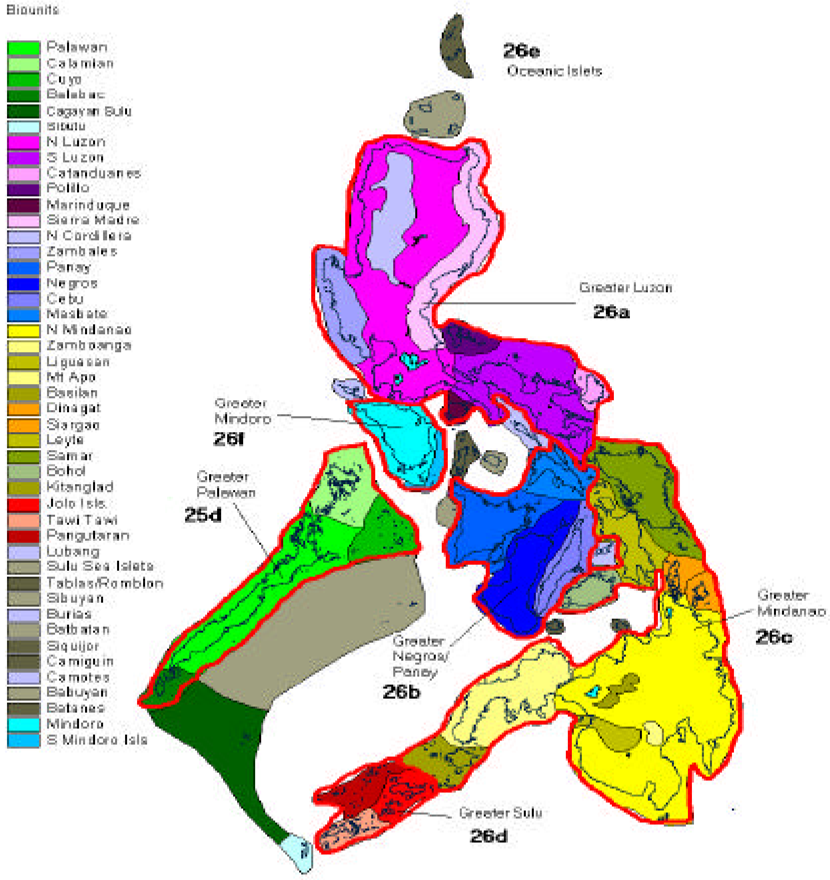

Figure 1.1 Biogeographical regions of the Philippines. Highlighted in red are the six major regions, including Greater Negros-Panay. Taken from ARCBC (2006).

Within these regions high levels of endemic and restricted range species have evolved. Endemism 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 (PBCP, 2002). Therefore conservation has to be comprehensive enough to ensure all species are represented across all the islands and across all biogeographical regions.

Despite this unique biodiversity, forest habitats are continually under threat through habitat destruction and fragmentation. Native forests in the Philippines would have originally covered 95% of the archipelago but now around 6% of that forest remains (Heaney & Regaldo, 1998).

There are currently approximately 10,773,000 ha of forest in the Philippines but estimates suggest that 2,031,000 ha of forest have been lost in the last 15 years (FAO, 2005). The average annual rate of deforestation is 1.4% loss per year between 2000 and 2005. Much of the remaining old growth, which is thought to cover less than 1% of land area, is mossy, montane forest (Poffenberger, 1999).

MacArthur & Wilson's (1967) theory of island biogeography states that small habitat islands should contain fewer species than larger blocks of continuous habitat, just as small oceanic islands have fewer species than larger ones. Thus, as habitat is reduced, species should be lost in a characteristic way. Species endemic to the area are at risk of global extinction and many other species could be lost locally.

Therefore the numbers of threatened forest species is directly related to proportion of deforestation (Brooks et al, 2002). There are 704 species listed on the IUCN Red List for the Philippines (IUCN, 2004). Of these, 257 are forest species, many of whose populations are in decline.

The specific nature of biodiversity in the Philippines; the high levels of endemism combined with the amount of habitat already lost consequences of threats posed to the region, makes the country one of the 25 global biodiversity hotspots (Mittermeier et al, 2005).

1.2 Negros Island

Negros Island, in the Greater Negros–Panay region (see Figure 1.1 and Figure 1.2), can be seen as a microcosm for many of the environmental issues and changes occurring throughout the Philippines.

The island supports a unique biodiversity and includes many endemic forest vertebrates such as threatened hornbills (*Penelopides panini* and *Aceros waldeni*), the endangered Philippine spotted deer (*Cervus alfredi*), and the Philippine warty pig (*Sus cebifrons*) (Wildlife Conservation Society of the Philippines, 1997). The latter two species have been extirpated from 95% of their former range (Cox, 1987). They were once common throughout the Visayas (the geographical region encompassing the main islands of Panay, Negros, Cebu, Guimaras and Bohol and other smaller islands) 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.

Despite Negros harbouring some of the highest levels of endemism in the Philippines, the island has suffered from excessive deforestation. Recent estimates place forest cover on the island at around 50,110ha (Curio, 2002), less than 4% of its original cover (Turner et al, 2001).

Today, forest cover on Negros exists as tiny patches of montane and mossy rain forest near the tops of the mountains (Heaney et al, 2002). These key forest fragments are threatened further by population pressures and demands for agricultural land and remaining forests underrepresented in national protected area systems (Curio, 2002). Table 1.1 shows the number and area covered by protected areas in the Philippines and for Negros.

Area	Total		National Park/ National Marine Park		Game/Bird Sanctuary		Wilderness Area		Watershed Reserve	
	No	Area (ha)	No	Area (ha)	No	Area (ha)	No	Area (ha)	No	Area (ha)
Philippines	209	2,599,6 29	71	524,116	8	918,5 85	16	3,297,00	87	1,153,6 29
Region VI including Negros Occidental	12	158,332	3	26,555	-	-	-	-	9	131,77 7
Region VII Including Negros Oriental	18	54,391	4	21,670	1	920	4	1,307,00	4	30,494

Table 1.1 Summary of protected areas in the Philippines and Negros.
Taken from DENR (2004).

1.3 The North Negros Forest Reserve

The North Negros Forest Reserve is situated on the North of Negros Island, in Negros Occidental, Region VI (see Figure 1.2). The reserve was established in 1946 and covers one of the largest remaining fragments of forest on Negros (see Figure 1.2). The reserve makes up part of the newly designated North Negros Natural Park, which also includes Mambukal and Patag areas. This fragment is comprised of approximately 4,700 ha of old growth, 5,200 ha of mossy forest and 6,600 ha of secondary forest at altitudes between 800-1500m (Hamann, 2002).

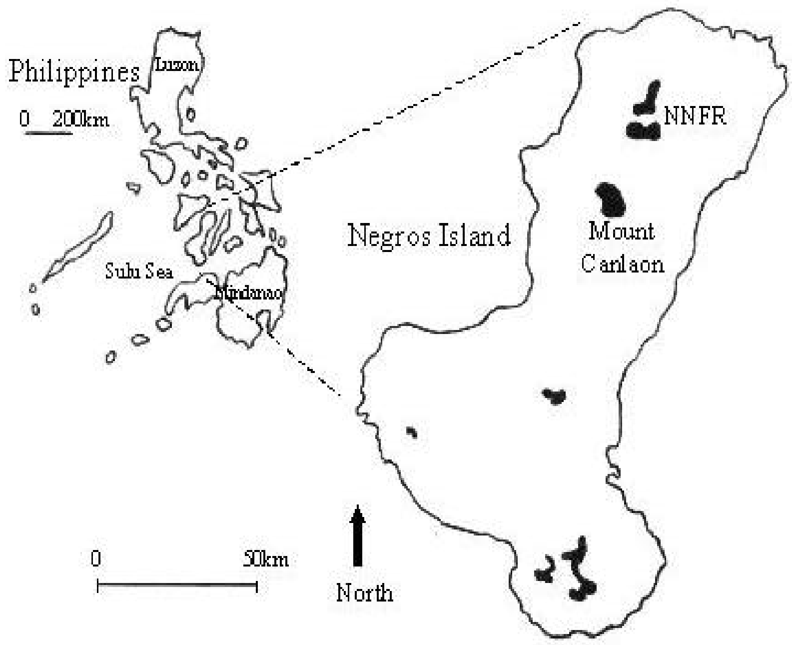

Figure 1.2. The remaining forest patches of Negros Island and the location of the North Negros Forest Reserve (NNFR), Negros Island, Philippines.

These forests play an important environmental role for the region as a whole. In addition to harbouring high levels of 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.

Under the Philippine Biodiversity Conservation Priority-setting Programme (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 and ‘very high’ area of socio-economic pressures. NNFR has additionally been identified as an area that should be developed as a terrestrial biodiversity corridor. It is equally vital as a habitat for volant mammals, e.g. the critically endangered bat species *Nyctimene rabori*, thought to be limited to Southern Negros prior to 2002. (Heaney & Regalado,1998; Turner et al, 2002).

The 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. For information on how these results relate to the project site and the North Negros Forest Reserve (NNFR) please see Tamblyn et al (2005).

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.

1. 4 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 (See Turner et al, 2001).

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.

1.5 Survey Locations

The NRCP project area is situated in the Upper Imbang-Caliban watershed within the NNFR. The elevational gradient within the watershed means the region displays a range of forest habitats (Hamann, 2002).

Six survey locations have been identified in different forest habitat types, representing the major habitat types of the NNFR and these are outlined in Table 1.2. Surveys were conducted from May to November 2005.

Survey Location	Habitat Type
Badjagawan	Lower-montane Secondary Growth
Crater I	Mossy Montane
Dam	Lower-montane Secondary Growth
Katmon	Secondary Growth
Malanog	Edge Forest
Mawa	Lower-montane Old Growth

Table 1.2 Survey locations by habitat type.

A large proportion of forest within the NNFR can be considered Lower-montane. Lower-montane forests generally occur at 750m-1500m above sea level (Whitmore, 1998). These are habitats characterized by the presence of a diversity of ferns, mosses, gingibers, and orchids. Trees appear stunted with a low canopy. Moisture levels tend to be higher than at lower elevations as they received higher levels of humidity from cloud and fog.

Lower-montane forests are key habitats because they exhibit a variety of ecotones (transitions between habitats at different altitudes), which can harbour different faunal and floral communities. Lower-montane forests lie between lowland dipterocarp forests, associated with high levels of biodiversity and upper-montane, mossy forests, which harbour highly specialised and therefore sometimes restricted range species. This means Lower-montane forests are often important reservoirs of endemic species, especially for birds (BirdLife, 2006).

Detailed inventory work on the species in lowland dipterocarp forests has been conducted throughout the Philippines, however, less has been completed on the sub montane and montane regions and forest fragments, including the NNFR.

Lower-montane forests are not as accessible as other habitats and therefore considered to be less threatened by deforestation. However, they are far more sensitive than generally perceived due to their poor soil, slow growth and low productivity, and equally at risk if not more-so (Sodhi et al, 2004). Hence 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).

The vegetational make-up throughout the NNFR fragment differs from the typical dipterocarp dominance, with species of Lauraceae, Burseraceae, Sapotaceae and Icainaceae prevalent and equally or more important (Hamann et al, 1999).

The old growth region is characterised by tall, dense canopies comprised of families such as Dipterocarpaceae, Burseraceae, Lauraceae and Sapotaceae. Additional understorey families include Euphorbiaceae, Melastomaceae, Moraceae, Myriceae, Symplocaceae and Tiliaceae. However, during the course of the project survey work at the Old Growth site of Mawa was halted due to increased logging activity in this area.

The secondary growth sites are similar in plant species composition, however these areas have been selectively logged for dipterocarp species, softwoods, palms and tree ferns and almost totally exploited. It has been regenerating for 15-20 years. The secondary growth forest is dissected by well-trodden paths. The area has been associated with hunting in the past and may have lost many of the larger mammal species found locally.

The mossy forest region is at a higher altitude (1000-1500m) and 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. These forests are of particular importance in moisture capture and in protecting the headwaters of the watershed (Poffenberger, 1999).

The final habitat type surveyed is classified as forest edge. Parts of this area have been deforested and either left as disused farmland, or as working farms with fragments of forest between resident farmland areas. This area is intended to provide a useful comparison of the status of habitats within the NNFR.

1.6 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.

1.7 Report Outline

This report aims to assess the diversity and distribution of species from four main faunal groups: birds, bats, butterflies and non-volant (non flying) mammals. The study will look at species diversity and distribution within six forest habitats (lower-montane old growth, lower-montane secondary growth, secondary forest, montane mossy and forest edge habitat) across the Imbang–Caliban watershed over a six-month period. All ecological survey work has concentrated within these forest habitat types.

The following chapters detail the aims; methods used to survey each faunal group; a discussion of the survey results and conclusions and recommendations.

2. Birds

2.1 Introduction

Asia is home to over 323 threatened bird species, 80% of which are forest dependent (Chan et al, 2004). These species face increasing threats to their survival due to logging and forest clearance (BirdLife, 2005b). The Philippines biodiversity hotspot has a disproportionate number of species becoming increasingly threatened with extinction.

The Philippines currently has the highest proportion of restricted range and threatened bird species worldwide (Stattersfield et al, 1998). The Philippine archipelago is home to 572 bird species. Of these 183 are thought to be endemic (Kennedy et al, 2000). There are also high levels of localised endemism within the archipelago. The Philippines have been subdivided into seven Endemic Bird Areas of which the Greater Negros-Panay region is included (EBA 152, BirdLife International, 2005a). In this area, species that are threatened include both lowland and montane forest specialists, some of which are highly localised.

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; Whittaker, 1999). 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.

Negros island supports more than 190 species of avifauna of which approximately 100 are thought to be forest dependent. In fragmented forest regions such as Negros, bird ecology and species richness, abundance and distribution is directly related to forest structure and size of forest fragments (Watson et al, 2004). Decreasing quantity and quality of forest habitats reduces the likelihood of occupancy by forest-dwelling species and hence a decrease in species richness (Sodhi et al, 2000; Gonzalez & Chaneton, 2002). Nesting and feeding, of particularly frugivorous specialist species (such as hornbills) can be greatly affected by habitat fragmentation.

Furthermore island biogeography also influences the nature of bird communities and their vulnerability to disturbance. The movement of the islands in the archipelago over geological periods and the subsequent relative isolation of the Philippines from mainland Southeast Asia means the Philippines only has a few species which are not capable of dispersing over water, compared to the mainland (Whittaker, 1999). This isolation over time has also led to the evolution of various restricted range bird species.

The endemic birds found on tropical islands such as Negros are some of the most threatened in the world due to serious threat by further loss and fragmentation of the forests (Whittaker, 1999). Due to excessive hunting in the NNFR, larger birds including hornbills and fruit pigeons, are scarce. Many of these species are endangered and endemic with a staggering 59 species found on Negros endemic to the Philippines and a further nine restricted to the Negros-Panay faunal region (Brooks et al, 1992).

2.2 Aims

- To update the ongoing bird species inventory for the study watershed;
- To 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). A list of species sighted is compiled by the observation group by recording each new species until a predetermined number of species is reached. A species was noted following positive identification by sight or birdsong heard. Based on preliminary surveys, the list length was set at the advised minimum of 10 species (Bibby et al, 1998). 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. 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, 2002).

2.4 Results

Species accumulation curves were calculated for each survey location following completion of MacKinnon Lists. The number of MacKinnon Lists undertaken is plotted against the cumulative number of species recorded at each site. Species accumulation curves are used since a number of factors, which may not be quantified can affect discovery – size of habitat surveyed, influence of disturbance, seasonal variations (Thompson et al, 2003).

Table 2.1 shows the number of MacKinnon lists undertaken at each location by name and habitat type revealing comparative survey effort across each site.

Survey Site	Habitat Type	Lists
Badjagawan	Lower-montane Secondary Growth	7
Crater I	Mossy Montane	6
Dam	Lower montane Secondary Growth	5
Katmon	Secondary Growth	5
Malanog	Edge Forest	9
Mawa	Lower-montane Old Growth	Surveying halted by logging

Table 2.1 Number of MacKinnon lists completed at survey sites.

Figure 2.1 shows the results of species accumulation analysis. Looking at Figure 2.1 there is dissimilarity in species discovery between survey sites. Crater I and Badjagawan both reach plateaus at around six lists. This could indicate that the discovery of new species at these sites is unlikely. Malanog shows a steady increase in new discoveries and does not plateau, despite receiving the highest survey effort. As this site is a forest edge, the chances of discovering bird species from both forest and other habitats (grassland, agricultural etc) are potentially higher.

Overall, it is also important to note the relatively low numbers of lists undertaken across all survey sites and hence the certainty of new discoveries remains unclear.

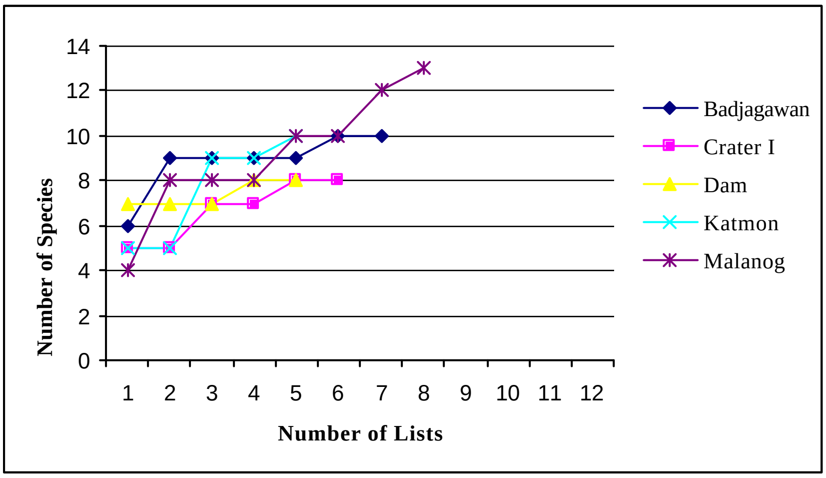

Figure 2.1 Species accumulation curves for MacKinnon lists.

An Index of Relative Detectability (IRD) was generated for each species recorded on MacKinnon Lists by location. This is a comparative measure of species abundance and the number given for each species represents the proportion of lists on which it appears at each location. 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.

IRD values given in Table 2.2 reveal that the Mountain White-eye (*Zosterops montanus pectoralis)* scored highest across all survey sites and was therefore the most commonly sighted species during surveys. Other common species, present at all survey sites included the Philippine Bulbul (*Hypsipetes Philippininus guimarasensis*), Pied Fantail (*Rhipidura javanica)* and Blue-headed Fantail (*Rhipidura cyaniceps).*

Less commonly recorded species and those restricted to one survey site included: Philippine Swiftlet (*Collocalia mearnsi*), Pygmy Swiftlet (*Collocalia troglodytes*), White-breasted Wood Swallow (*Artamus leucorynchus*), Plain-throated Sunbird (*Anthreptes malacensis*), Yellow-bellied Whistler (*Pachycephala philippinensis*), Elegant Tit (*Parus elegans albescens*), Philippines Scops Owl (*Otus meglotis*) and Middendorff's Grasshopper Warbler (*Locustella ochotensis*). Conjectures as to the paucity of recordings of these species are limited as survey effort and the numbers of species recorded on MacKinnon lists varied across the sites.

Table 2.2 Birds IRD value by species and MacKinnon list location.

Family	Species	Common Name	Dam	Crater I	Bagiawan	Malanog	Katmon
Accipitridae	*Halisturs Indus*	Brahminy Kite	0.2	0.00	0.00	0.22	0.00
Apodidae	*Collocalia esculenta*	Glossy Swiftlet	0	0.67	0.00	0.00	0.00
Apodidae	*Collocalia mearnsi*	Philippine Swiftlet	0	0.17	0.00	0.11	0.00
Apodidae	*Collocalia troglodytes*	Pygmy Swiftlet	0	0.33	0.00	0.00	0.00
Artamidae	*Artamus leucorynchus*	White-breasted Wood Swallow	0	0.00	0.14	0.00	0.00
Bucerotidae	*Penelopides panini*	Tarictic Hornbill	0	0.00	0.14	0.11	0.20
Columbidae	*Chalcophaps indica*	Common Emerald Dove	0.4	0.00	0.43	0.33	0.60
Columbidae	*Columba vitiensis*	Metallic Pigeon	0	0.33	0.88	0.44	0.00
Columbidae	*Ducola aenea*	Green Imperial Pigeon	0	0.00	0.14	0.00	0.00
Columbidae	*Macropygia phasianella*	Reddish Cuckoo-Dove	0	0.67	0.43	0.11	0.00
Columbidae	*Phapitreron leucotis*	White-eared Brown Dove	0.2	0.00	0.00	0.00	0.00
Corvidae	*Corvus macrorhynchos*	Large-billed Crow	0.2	0.00	0.00	0.00	0.00
Cuculidae	*Centropus viridis*	Philippine Coucal	0.4	0.33	0.43	0.11	0.20
Dicruridae	*Dicrurus baliacassius mirabilis*	Balicassiao	0	0.00	0.29	0.00	0.00
Dicaeidae	*Diaceum bicolor viridissiumum*	Bicoloured Flowerpecker	0.4	0.00	0.00	0.00	0.00
Dicaeidae	*Diaceum pygmaeum*	Pygmy Flowerpecker	0	0.00	0.00	0.22	0.00
Dicaeidae	*Diaceum trigonostygma dorsale*	Orange-bellied Flowerpecker	0	0.00	0.00	0.33	0.60
Muscicapidae	*Eumyias panayensis*	Mountain Verditer Flycatcher	0	0.17	0.00	0.22	0.00
Muscicapidae	*Ficedula westermanni*	Little Pied Flycatcher	0	0.17	0.00	0.11	0.00
Muscicapidae	*Hypothyrmis azurea*	Black-naped Monark	0	0.17	0.00	0.00	0.00
Muscicapidae	*Rhipidura javanica*	Pied Fantail	0.4	0.33	0.88	0.56	0.20
Muscicapidae	*Rhipidura cynaniceps*	Blue-headed Fantail	0.6	0.00	0.86	0.69	0.60
Motacillidae	*Motacilla cinerea*	Grey Wagtail	0	0.17	0.00	0.11	0.00
Nectariniidae	*Anthreptes malacensis*	Plain-throated Sunbird	0	0.33	0.00	0.00	0.00

Table 2.2 Continued – Bird IRD value by species and MacKinnon list location

Family	*Species*	Common Name	Dam	Crater I	Bagiawan	Malanog	Katmon
Pachycephalidae	*Pachycephala philippinensis*	Yellow-bellied Whistler	0	0.00	0.00	0.22	0.00
Paridae	*Parus elegans albescens*	Elegant Tit	0	0.00	0.00	0.44	0.00
Phasianidae	*Gallus gallus*	Red Jungle Fowl	0.2	0.00	0.00	0.00	0.40
Picidae	*Dryocopus javensis*	White-bellied Woodpecker	0.2	0.00	0.71	0.56	0.60
Ploceidae	*Passer montanus*	Eurasian Tree Sparrow	0.2	0.00	0.43	0.22	0.00
Pycnonotidae	*Hypsipetes philippinius guimarasensis*	Philippine Bulbul	0.8	0.33	0.88	0.89	0.60
Strigidae	*Otus meglotis*	Philippine Scops Owl	0	0.00	0.43	0.00	0.00
Sturnidae	*Acridotheres cristatellus*	Coleto	0.6	0.33	0.98	0.82	0.60
Sylviidae	*Gerygone sulphurea*	Golden-bellied Flyeater	0.2	0.00	0.00	0.00	0.00
Sylviidae	*Locustella ochotensis*	Middendorf's Grasshopper Warbler	0	0.00	0.00	0.11	0.00
Sylviidae	*Phylloscopus borealis*	Arctic Warbler	0.2	0.00	0.43	0.10	0.20
Sylviidae	*Phylloscopus trivirgatus nigrorum*	Mountain Leaf-Warbler	0.6	0.00	0.00	0.67	0.00
Sylviidae	*Orthotomus castaneiceps rabori*	Philippine Tailorbird	0	0.17	0.00	0.11	0.00
Turdidae	*Turdus poliocephalus nigrorum*	Island Thrush	0.4	1	0.43	0.90	0.00
Zosteropidae	*Zosterops montanus pectoralis*	Mountain White-eye	1	0.67	0.98	0.90	0.80

Species diversity by location was analysed using five measures: total number of species (S); total number of individuals; species richness; Shannon-Weiner diversity and Pielou's evenness (see Carr, 1996) and Appendix I provides a discussion of diversity statistical calculations. The results of species diversity analysis is shown in Table 2.3.

Location	Total Species [1]	Total No. Individuals [2]	Species Richness (Margalef) [3]	Pielou's Eveness [4]	Shannon-Weiner Index [5]
Badjagawan	19	81	4.09	0.93	2.73
Crater I	18	40	4.60	0.94	2.72
Dam	17	35	4.50	0.95	2.68
Malanog	27	104	5.60	0.89	2.95
Katmon	12	28	3.30	0.95	2.37

Table 2.3 Bird species diversity analysis by survey location.
N.B [1-5] See Appendix 1 for formula notes on species diversity analysis.

Malanog yielded the highest total number of species, total number of individuals recorded (104) and diversity index (2.95, Shannon-Weiner score). Species richness at Badjagawan, Crater I and Dam is relatively similar. In terms of habitat types, this approximates that secondary forest areas (Badjagawan and Dam), have similar species composition. However overall species richness is lower at Badjagawan.

We would expect to see more variation at Crater I, a mossy-montane habitat, but this scored similar values to Dam and Badjagawan. This may well be a function of reduced comparative survey effort at Crater I and further survey work there could help identify bird species distribution over elevational gradients in the NNFR.

Patterns in community composition for birds were calculated using multivariate ordination and clustering techniques. Table 2.4 shows the results of Bray-Curtis Similarity analysis. Bray-Curtis similarity measure was then calculated (from IRD data) between every permutation of sample pairs (Clarke & Warwick, 1994).

Location	Dam	Crater I	Badjagawan	Malanog	Katmon
Dam	0	0	0	0	0
Crater I	36.8245	0	0	0	0
Badjagawan	50.66075	44.36345	0	0	0
Malanog	49.18362	49.96584	65.60182	0	0
Katmon	65.89412	31.34483	53.37781	49.54139	0

Table 2.4 Bray-Curtis similarity calculated using group-average by survey location.

The relationship between each survey site was analysed using a hierarchical agglomerate clustering technique (Clarke & Green, 1988). A dendrogram representing this relationship is given in Figure 2.2. From this, Crater I appears as an outlier. This supports the expected difference between a montane mossy habitat and lower-montane forest types. The Dam and Katmon, both secondary forest habitats form one cluster. Badjagawan (lower-montane secondary) and Malanog (edge forest) also cluster, highlighting shared community compositions at these sites. The clustering of these different habitats suggests that the edge effect at Malanog may not have detrimental effects on bird species numbers. However it should be noted that Malanog received the highest amount of survey effort (nine lists in total).

Figure 2.2 Bray-Curtis similarity calculated using group-average by survey location represented in dendrogram format.

Dissimilarity between the two lower secondary montane forest types, Badjagawan and Dam, is likely to indicate these sites are at different stages of regeneration. From this, it would appear Badjagawan is at an earlier stage of regeneration, hence it is clustered with Malanog, an edge habitat.

2.5 Discussion

Overall, the results of bird surveys show that a total of 23 bird families were represented by 40 different species of birds across the survey locations. Of these, 13 species are endemic to the Philippines and two are endemic to Negros Island (see Table 2.5).

The majority of species recorded during surveys 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.

All of the species recorded are categorised as Least Concern on the IUCN Red List (2004) with the exception of Tarictic Hornbill (*Penelopides panini),* which is listed as Endangered. Although the species was reclassified from Critically Endangered to Endangered in 2000, it has a very small, severely fragmented and rapidly declining population and occupies a range on Negros and Panay with perhaps just 10% of remaining forest (c.144 km²) below 1,000 m. Hornbills are thought to be targeted by hunters within the NNFR and have suffered from excessive hunting (Curio et al, 1996; Cariño et al, 2006). In some cases across Negros and Panay, hornbills are sold for as little as 20 pesos or US$1 (BirdLife, 2001).

Table 2.5 Bird species ecological and conservation status.

Family	Species	Common Name	Status[1]	IUCN Status[2]	CITES Status[3]
Accipitridae	*Haelaetus indus intermedius*	Brahminy Kite	Br	Lc	Appendix II
Apodidae	*Collocalia esculenta marginata*	Glossy Swiftlet	Br	Lc	-
Apodidae	*Collocalia mearnsi*	Philippine Swiftlet	Philippines endemic	Lc	-
Apodidae	*Collocalia troglodytes*	Pygmy Swiftlet	Philippines endemic	Lc	-
Artamidae	*Artamus leucorynchus*	White-breasted Wood Swallow	Br	Lc	-
Bucerotidae	*Penelopides panini*	Tarictic Hornbill	Negros Endemic	EN	Appendix II
Columbidae	*Chalcophaps indica*	Common Emerald Dove	Br	Lc	-
Columbidae	*Columba vitiensis*	Metallic Pigeon	Br	Lc	-
Columbidae	*Ducola aenea*	Green Imperial Pigeon	Br	Lc	-
Columbidae	*Macropygia phasianella*	Reddish Cuckoo-Dove	Br	Lc	-
Columbidae	*Phapitreron leucotis*	White-eared Brown Dove	Philippines endemic	Lc	-
Corvidae	*Corvus macrorhynchos philippinus*	Large-billed Crow	Br	Lc	-
Cuculidae	*Centropus viridis*	Philippine Coucal	Philippines endemic	Lc	-
Dicruridae	*Dicrurus baliacassius mirabilis*	Balicassiao	Philippines endemic	Lc	-
Dicaeidae	*Diaceum bicolor viridissiumum*	Bicoloured Flowerpecker	Philippines endemic	Lc	-
Dicaeidae	*Diaceum pygmaeum*	Pygmy Flowerpecker	Philippines endemic	Lc	-
Dicaeidae	*Diaceum trigonostygma dorsale*	Orange bellied Flowerpecker	Br	Lc	-
Muscicapidae	*Eumyias panayensis*	Mountain Verditer Flycatcher	Br	Lc	-
Muscicapidae	*Ficedula westermanni*	Little Pied Flycatcher	Br	Lc	-
Muscicapidae	*Hypothyrmis azurea*	Black-naped Monarch	Br	lc	-
Muscicapidae	*Rhipidura javanica*	Pied Fantail	Br	Lc	-
Muscicapidae	*Rhipidura cynaniceps*	Blue-headed Fantail	Philippines endemic	Lc	-
Motacillidae	*Motacilla cinerea*	Grey Wagtail	Va	Lc	-
Nectariniidae	*Anthreptes malacensis*	Plain-throated Sunbird	Br	Lc	-
Pachycephalidae	*Pachycephala philippinensis*	Yellow-bellied Whistler	Philippines endemic	lc	-
Paridae	*Parus elegans albescens*	Elegant Tit	Philippines endemic	Lc	-

Table 2.5 Bird species ecological and conservation status continued.

Family	Species	Common Name	Status[1]	IUCN Status[2]	CITES Status[3]
Phasianidae	*Gallus gallus*	Red Jungle Fowl	Br	Lc	-
Picidae	*Dryocopus javensis*	White-bellied Woodpecker	Br	Lc	-
Ploceidae	*Passer montanus*	Eurasian Tree Sparrow	Intro Br	Lc	-
Pycnonotidae	*Hypsipetes philippinius guimarasensis*	Philippine Bulbul	Philippines endemic	Lc	-
Strigidae	*Otus meglotis*	Philippine Scops Owl	Philippines endemic	Lc	-
Sturnidae	*Acridotheres cristatellus*	Coleto	Philippines endemic	Lc	-
Sylviidae	*Gerygone sulphurea*	Golden-bellied Flyeater	Br	Lc	-
Sylviidae	*Locustella ochotensis*	Middendorf's Grasshopper Warbler	Va	Lc	-
Sylviidae	*Phylloscopus borealis*	Arctic Warbler	Va	Lc	-
Sylviidae	*Phylloscopus trivirgatus nigrorum*	Mountain Leaf-Warbler	Br	Lc	-
Sylviidae	*Orthotomus castaneiceps*	Philippine Tailorbird	Philippines endemic	Lc	-
Turdidae	*Turdus poliocephalus nigrorum*	Island Thrush	Br	Lc	-
Zosteropidae	*Zosterops montanus pectoralis*	Mountain White-eye	Br	Lc	-

N.B

[1] Br – Breeder. Va – Vagrant. Intro – Introduced. After Kennedy et al (2000) & UNEP WCMC (2006).

[2] Lc – Least Concern EN – Endangered CR – Critically Endangered. See IUCN (2004) & BirdLife International (2001).

[3] Appendix II - species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival. CITES (2006) & UNEP WCMC (2006).

The results of bird surveys show that the NNFR supports a wide range of bird species. The recording of the Negros-endemic Tarictic Hornbill over at least the last two years within the NNFR can be seen as cause for optimism and suggests the forest areas regenerating may act as a refuge for key forest birds on Negros.

Previous reports for the NRCP (see Tamblyn et al, 2005) revealed that Mawa, an area of Old Growth within the NNFR is associated with high levels of bird species richness. As well as the Tarictic Hornbill, areas of Old Growth have been found to support other key indicator species. In particular endemic forest specialists like the endemic Philippine Leaf-warbler (*Phylloscopus olivaceus*), the near endemic White-vented Whistler (*Pachycephala homeyeri*) and the White-bellied Woodpecker (*Dryocopus javensis*) are all species that require forest that is undisturbed.

The reported incidence of logging in forests at Mawa in 2005 is a concern for the NNFR. Forest remnants like the NNFR need to be protected to prevent further fragmentation and loss altogether and to promote the rehabilitation of forest bird populations for endemic species like the hornbills. Larger species such as hornbills are thought to be higher risk from habitat alterations, as they occur at lower densities. The lack of year-round availability of fruits in areas suffering from deforestation makes survival difficult for frugivorous specialists like the hornbills (Sodhi et al, 2004).

For future work, bird surveys within the NNFR should be conducted evenly across the regions' habitats in order generate a more reliable comparison of the bird communities of the reserve.

Documenting forest regrowth in areas such as Dam and Badjagawan could help identify variations in bird communities recorded in this study. Attempts should be made to quantify these forest habitats, in terms of forest quality. A combination of vegetation assessment (tree and plant species diversity, growth patterns and distribution) and GIS techniques could be used to assess rates of forest regeneration and to assess forest core/edge areas within the NNFR. Ideally, these findings could be compared over timescales (10-20yrs minimum) to assess long-term forest regeneration and the effect on bird communities within the NNFR.

In addition, establishing more precise population numbers of threatened species such as the Tarictic hornbills and nesting locations would substantially improve knowledge of the species within the NNFR. This could contribute towards identifying target areas for improving conservation measures within the NNFR.

3. Bats

3.1 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 mammalian 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). Bats can be of economic value to humans as pollinators and seed dispersers, and providing guano for fertiliser (Heidemann et al, 1987; Ingle, 2003). They are a vital component of forest ecosystems, with over 300 plant species known to be reliant on Old World fruit bats (Pteropodidae) for their propagation (Shilten et al, 1999).

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 on the island, of which approximately 25% are known to be endemic to the Philippines (Heaney et al, 1989). Mickleburgh et al (1992) stressed (as one of twenty priority global projects) the urgent need to survey Negros Island. The area 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.

3.2 Aims

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

3.3 Methods

Mist-net Surveys

Mist-nets (38mm mesh, 6m x 2.6m) were used within the six survey locations, representing the forest habitats within the study area of the NNFR. Netting was stopped at Mawa due to logging activities being undertaken at the site.

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

Bats captured were identified using Ingle and Heaney (1992) and Francis (2001), sexed by observation of genitalia and nipples, and aged (to adult or juvenile) by assessment of the ossification of the joints of the digits of the wing. Measurements taken were obtained with dial calipers.

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 the number of mist net hours (average of 18:00-22.00 per night) multiplied by number of nets used.

3.4 Results

A total of 76 individual bats were captured across the survey locations within the NNFR. Of the captures, five Megachiropteran species were represented and two Microchiropterans were also found. Four bats captured were unidentified during survey work. Table 3.1 shows the species caught at each location.

The most abundant species was the Philippine pygmy fruit bat *(Haplonycteris fischeri)* with a total of 38 captures or 29% of recordings and was present across all survey sites. Followed by the Musky fruit bat *(Ptenochirus jagori),* with 11 captures or 8% of recordings.

Malanog yielded the highest number of individual captures (49) and was almost entirely dominated by fruit bats with the exception of one capture of *Rhinolophus arcuatus*. However it is important to note the comparative survey effort for mist net hours across survey sites. Table 3.2 shows that Malanog received a disproportionate amount of mist net hours (1044).

Table 3.1 shows that Microchiropterans comprise a very low percentage of captures (3%). This highlights the inefficiencies of mist nets in capturing Microchiropterans, as the majority of insect eating species use echolocation for navigation and can therefore detect mist nets easily, compared to Megachiropterans.

Morphological data for captured bats was documented and summarised in Tables 3.3-3.6. These tables provide biometrics of adult and juvenile females and males. Each capture contributes to the sample set (N); with the mean, the range (minimum to maximum data point) and the standard deviation (St Dev) (variance of results) calculated.

Table 3.1 Summary of bat species captures by location.

Sub-Order	Family	Species	Common Name	Badjangawan	Crater I	Dam	Katmon	Malanog	Mawa	Total
Megachiroptera	Pteropodidae	*Cynopterus brachyotis*	Common short nosed fruit bat	-	-	-	2	1	-	3
Megachiroptera	Pteropodidae	*Haplonycteris fischeri*	Philippine pygmy fruit bat	1	2	6	2	26	1	38
Megachiroptera	Pteropodidae	*Macroglossus minimus*	Dagger-toothed flower bat	-	3	3	2	10	-	18
Megachiroptera	Pteropodidae	*Nyctimene rabori*	Philippine tube-nosed bat	-	-	-	1	-	-	1
Megachiroptera	Pteropodidae	*Ptenochirus jagori*	Musky fruit bat	-	-	1	-	11	-	12
Microchiroptera	Rhinolophidae	*Rhinolophus arcuatus*	Arcuate horse shoe bat	-	-	-	2	1	-	3
Microchiroptera	Rhinolophidae	*Rhinolophus virgo*	Yellow-faced horseshoe bat	-	1	-	-	-	-	1
			Total	1	6	10	9	49	1	76

Table 3.2 Bat species capture effort by location.

Species	Badjagawan	Crater I	Dam	Katmon	Malanog	Mawa
Effort Per Location*	32	108	672	192	1044	48
Cynopterus brachyotis	0	0	0	0.010	0.0009	0
Haplonycteris fischeri	0.031	0.018	0.008	0.010	0.02	0.020
Macroglossus minimus	0	0.027	0.004	0.010	0.009	0
Nyctimene rabori	0	0	0	0.005	0	0
Ptenochirus jagori	0	0	0.001	0	0.010	0
Rhinolophus arcuatus	0	0	0	0.010	0.0009	0
Rhinolophus virgo	0	0.009	0	0	0	0

*Effort is calculated as the number of mist net hours (average of 18:00-22:00 per night) multiplied by number of nets used.

Table 3.3 Bat species morphological data –adult females.

Species	Statistical Measure	Body Mass (g)	Fore-arm (mm)	Ear (mm)	Hindfoot (mm)	Tail (mm)	Body Length (mm)	Total Length (mm)
Haplonycteris fischeri	Range	20-54	46.8-69.6	7.2-11.9	9.40-17.6	-	74.5-92.8	74.5-92.8
	Mean	31.5	67.32	10.32	12.6	-	87.5	87.5
	St.Dev	16.03	17.34	2.19	3.53	-	9.51	9.51
	N	4	4	4	4	-	4	4
Macroglossus minimus	Range	16-42	42.6-63	9.2-11.9	11.-13	-	71.4-92.6	71.4-92.6
	Mean	26.66	49.63	10.4	12.06	-	78.8	78.8
	St.Dev	13.27	11.58	1.37	1	-	11.96	11.96
	N	3	3	3	3	-	3	3
Ptenochirus jagori	Range	77	99.4	15.6	13.4	7.9	110.7	110.7
	Mean	-	-	-	-	-	-	-
	St.Dev	-	-	-	-	-	-	-
	N	1	1	1	1	1	1	1

Table 3.4 Bat species morphological data –juvenile females.

Species	Statistical Measure	Body Mass (g)	Fore-arm (mm)	Ear (mm)	Hindfoot (mm)	Tail (mm)	Body Length (mm)	Total Length (mm)
Macroglossus minimus	Range	16	44.9	11.9	11.4	-	64.3	64.3
	Mean	-	-	-	-	-	-	-
	St.Dev	-	-	-	-	-	-	-
	N	1	1	1	1		1	1
Pipistrellus Javanicus	Range	6	44.6	6.7	17.7	20	37.5	57.5
	Mean	-	-	-	-	-	-	-
	St.Dev	-	-	-	-	-	-	-
	N	1	1	1	1	1	1	1
Rhinolophus virgo	Range	11	63.5	14.7	24	9.5	59	68.5
	Mean	-	-	-	-	-	-	-
	St.Dev	-	-	-	-	-	-	-
	N	1	1	1	1	1	1	1

Table 3.5 Bat species morphological data – adult males.

Species	Statistical Measures	Body Mass (g)	Fore-arm (mm)	Ear (mm)	Hindfoot (mm)	Tail (mm)	Body Length (mm)	Total Length (mm)
Cynopterus brachyotis	Range	20	62.4	9.8	13	6.3	99.3	105.6
	Mean	-	-	-	-	-	-	-
	St. Dev	-	-	-	-	-	-	-
	N	1	1	1	1	1	1	1
Haplonycteris fischeri	Range	11-69.9	46.3-88.8	6-12.9	4.6-15.9	-	64.8-98.8	64.8-98.8
	Mean	35.80	64.57	10.02	13.13	-	83.06	83.06
	St.Dev	14.75	9.16	2.41	5.37	-	12.94	12.94
	N	18	18	18	18	-	18	18
Macroglossus minimus	Range	14-38	41-44.3	7.3-12.2	4-14.2	-	63-73.5	63-73.5
	Mean	23.12	42.88	10.31	9.56	-	68.02	68.02
	St.Dev	8.95	1.4	2.49	3.07	-	4.18	4.18
	N	8	8	8	8	-	8	8
Nyctimene rabori	Range	74	82.1	10.4	20.6	20	127	147
	Mean	-	-	-	-	-	-	-
	St.Dev	-	-	-	-	-	-	-
	N	1	1	1	1	1	1	1
Ptenochirus jagori	Range	85-116	84-91.7	11.2-16.7	11.9-18.9	4-11.2	105.1-130	109.141.2
	Mean	93.4	87.34	13.92	16.56	6.16	115.64	125.1
	St.Dev	13.95	3.09	1.99	2.69	2.99	10.11	22.76
	N	5	5	5	5	5	5	5
Rhinolophus arcuatus	Range	11.-12	47.4-48.8	13.5-19.4	6-10.2	4.4-19.9	53.7-71.4	73.6-75.8
	Mean	11.5	48.1	16.45	8.1	12.15	62.55	74.7
	St.Dev	0.7	0.98	4.17	2.96	10.96	12.51	1.55
	N	2	2	2	2	2	2	2

Table 3.6 Bat species morphological data – juvenile males.

Species	Statistical Measures	Body Mass (g)	Fore-arm (mm)	Ear (mm)	Hindfoot (mm)	Tail (mm)	Body Length (mm)	Total Length (mm)
Cynopterus brachyotis	Range	18-30	60.9-61.2	8.6-11.8	9.4-12.9	4.6-8.2	87.1-92.9	91.7-101.1
	Mean		61.05	10.2	11.15	6.4	90	96.4
	St.dev		0.21	2.26	2.47	2.55	4.10	6.65
	N	2	2	2	2	2	2	2
Haplonycteris fischeri	Range	21-93.1	44.5-67.8	8.5-14.3	9.2-16.8	-	67.4-95.7	67.4-95.7
	Mean	34.81	60.36	11.27	11.81	-	81.57	81.57
	St. Dev	16.86	6.4	1.63	2.28	-	9.52	9.52
	N	16	16	16	16	-	16	16
Macroglossus minimus	Range	16-40	41.8-86.9	9.8-13.1	9.2-12.3	3.7	74.5-92.1	74.5-95.8
	Mean	27.2	58.94	11.14	10.14	3.7	81.42	85.15
	St.Dev	9.44	18.51	1.2	1.51	-	9.27	15.06
	N	6	6	6	6	1	6	1
Ptenochirus jagori	Range	64-93.9	66.8-86.4	12.8-17.3	13.9-20.4	3.4-10.2	93.9-127.8	97.3-138
	Mean	74.31	76.88	14.15	15.7	6.68	108.35	117.65
	St.Dev	19.94	10.7	1.63	2.42	2.91	11.62	28.77
	N	6	6	6	6	6	6	6
Rhinolophus arcuatus	Range	13	49	14.4	8.5	17.6	47.5	65.1
	Mean	-	-	-	-	-	-	-
	St.Dev	-	-	-	-	-	-	-
	N	1	1	1	1	1	1	1

Bat species diversity was calculated for the survey sites. Table 3.7 shows that Katmon and Malanog recorded the most species, with Malanog recording the highest number of individuals and highest diversity index (Shannon-Weiner). Crater I and Malanog show comparative evenness scores. Katmon scored highest for diversity (Shannon-Weiner).

Survey Site	Total Species[1]	Total Individuals[2]	Species Richness[3]	Pielou's Eveness[4]	Shannon-Weiner Diversity[5]
Badjagawan	1	1	0	0	0
Crater I	3	6	1.11	0.92	1.01
Dam	3	10	0.86	0.81	0.89
Katmon	5	9	1.82	0.98	1.58
Malanog	5	49	1.02	0.71	1.15
Mawa	1	1	0	0	0

Table 3.7 Diversity indices for bat captures by location.
NB [1-5] See Appendix 1 for formula notes on species diversity analysis.

Further analysis of the distribution of the species and patterns in community composition of bats found within the NNFR forest types was assessed using PRIMER (Clarke & Warwick, 1994). The Bray-Curtis similarity measure was then calculated between every permutation of sample pairs (Clarke & Warwick,1994).

The relationship between survey sites was analysed using a Non-metric MultiDimensional Scaling (NMDS) ordination and a hierarchical agglomerate clustering technique (Clarke & Green, 1988).

With the selected methods, the small sample size means observing trends is somewhat limited. However some broad patterns emerge. Figure 3.1 shows three main clusters formed by the survey sites. This representation confirms Malanog as an outlier and highlights the disproportionate survey effort across all sites.

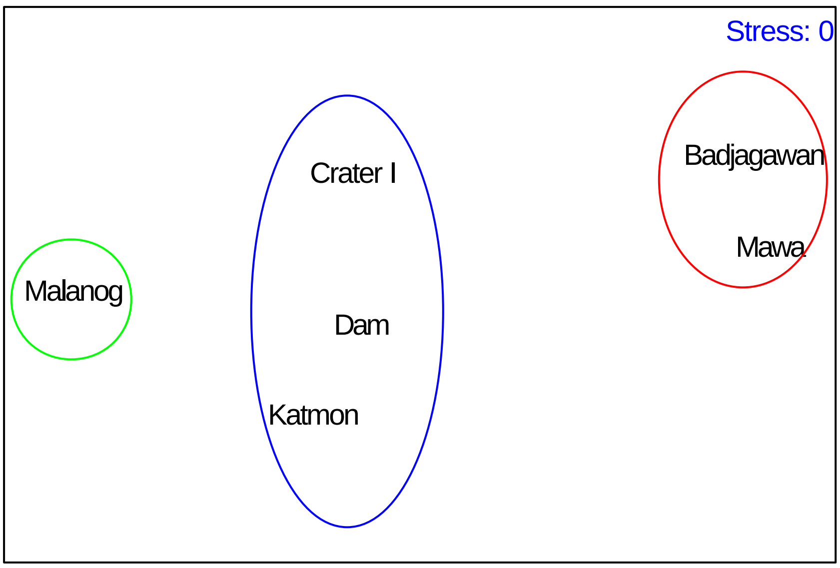

Figure 3.1 NMDS plot of location/habitat type for bat statistics.

3.5 Discussion

There are thought to be an estimated 14 fruit bat species and some 27 species of insectivorous bats found on Negros (Heaney et al, 2000). Previous NRCP surveys (see Tamblyn et al, 2005) have encountered up to nine species of fruit bat (including the Critically Endangered Philippine Tube-nosed Bat) and nine insectivorous species within the NNFR. However, no new species were added to existing inventories during this survey period.

Capture data for *H. fischeri* shows there was a strong bias towards capture of adult males (18 captures). Since males typically have smaller ranges within a nights' foraging this would suggest the existence of a natural bias as a result of socio-biology (male harems) (Clutton-Brock & Iason 1986).

The comparatively smaller numbers of bat species encountered during this study can be explained by the fewer number of survey sites covered in the 2005 research phase and discrepancies in survey effort at locations (logging at Mawa greatly affected bat capture results).

The results show that bat species abundance varies with habitat. Malanog, one of the most disturbed forest habitat types, yielded the highest numbers of individuals and species. Malanog is a forest edge habitat and the persistence of fruit bats here may not only be a function of mist net hours, but could also be related to the proximity of the village and opportunistic feeding on fruiting trees and plants found near to the village. Some species of nectar-feeding bat have been shown to "commute" up to 30km to feed, and pay repeat visits to one site on consecutive nights, and it would seem that Malanog offers the rich supply of fruit necessary to attract conspecific groups of foraging bats (Howell, 1979; Horner et al, 1998).

The most abundant species recorded was the Philippines Pygmy Fruit Bat (*H. fischeri*), a Philippines endemic. It is a common resident of primary forest habitats at middle elevations (150-2500m), becoming most abundant between 1200-1500m. It is thought to be less common in secondary or disturbed forests (Heaney et al, 2002) and is classified as Vulnerable on the IUCN Red List (2004).

The species is known to feed on *Ficus* fruits and may be dependent on flowers at certain times of the year (Heidemann, 1989). F*icus* have been identified as keystone plant resource group for frugivores, particularly in Southeast Asian rainforests (Lambert & Marshall, 1991) where many birds and mammals form conspecific relationships with *Ficus*.

The sighting of *Nyctimene rabori*, a critically endangered species only described in 1983 is exciting yet concerning – this species is a known tree-rooster and therefore more susceptible to damage from logging than cave-dwelling species (Heidemann et al, 1987).

Bat species do differ in the degree of catchability or detectability. Absolute abundance estimates are not possible. The disproportionate amount of microchiropterans captures in this study reflects inadequacies in mist-netting techniques for echolocating species, some of which can detect mist nets. Positioning of nets in habitual flight paths mean that bats are less likely to pay attention to the weak echoes off nets or traps. However, foraging bats are searching for weak echoes from insects in the airspace before them and will easily detect and avoid a net (Thomas & West, 1989). Tidemann et al (1978) and more recently, Kingston et al (2003) have shown the contrasting success rates of microchiropteran captures using mist nets and harp nets.

The results obtained do not necessarily suggest a lower density of Microchiropterans in the NNFR and should only be interpreted as a need for more efficient survey methods for future work in the reserve. The manner in which insectivorous bats feed may also come into play -some species fly continually foraging whilst others simply move small distances between perches to intersect insects, which could result in patchiness of certain species (Fenton, 1982).

Recommendations for further work on the composition of bat assemblages in the NNFR requires adapting alternative netting and survey techniques such as harp traps and ultrasonic detection. Attempts should also be made in order to achieve more comparable net effort units across all survey sites, in order that species abundance can be clarified across habitat types and elevations.

Further work should also be more spread out across the year to ensure a more thorough itinerary of species presence in the forest fragments. Longer-term monitoring of bat behaviour and abundance at different times of the year may help to identify breeding and feeding patterns. For example, *H.fischeri* females are known to be most receptive from May-July (Heidemann, 1988). Hence surveying during this period may mean males are more active.

Individual species also show high levels of specificity to certain fruits (Heaney et al, 1989; Estrada et al, 2001), and may be present as migrant feeders at different times of the year. This would be less pertinent in Crater, where there is less seasonality. This in turn may vary the activity level and hence likelihood of capture in males and females.

4. Butterflies

4.1 Introduction

Information on the invertebrates 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 (PBCP, 2002).

Tropical butterfly assemblages in particular are generally diverse, with many habitats 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 morpho-species are often used instead.

Furthermore, butterflies have been suggested as potential bioindicators of disturbance and fragmentation in both tropical and temperate regions since they demonstrate the most conspicuous responses to changes in environmental conditions. (Gilbert, 1984; Spitzer et al, 1997; Kremen et al, 1993).

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). For example host-plant butterfly larvae specificity means that a disturbance-related reduction in hosts will result in a clear reduction in the number of specific species of butterfly, with extinction the worst-case scenario (Koh et al, 2004 a&b).

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).

However the value of using butterflies as indicators has also been criticised and questions have been raised due to their complexity (i.e. vulnerability to disturbance at different life cycle stages); bias towards the apparency of adults, the most active stage of life and the difficulties of monitoring such highly mobile taxa (Dennis et al, 2006). In forest habitats particularly, species can often go undetected within dense canopies and sampling becomes non-random (Hardy & Dennis, 2005).

Information on butterfly species (see Treadaway, 1995), abundance and species distributions across the Philippines archipelago are not readily available. An estimated 938 species of butterfly are noted from the Philippines. About 30% of these are endemic and many rely on forest habitats (Posa & Sodhi, 2006).

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 (see Ong et al, 2002). Priority areas are also set to areas that have received little amounts of research. The NNFR falls in to priority areas for both research and conservation. Butterflies of the understorey of rainforest are often able to adapt only to a narrow range of environmental conditions; highly habitat-specific, and their geographic range of distribution is relatively small, often nearly endemic in a particular biogeographic forest types (Spitzer et al, 1997).

4.2 Aims

- To characterise the distribution of butterfly families and species
- To assess the species diversity within the survey areas
- To assess the abundance of species 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) were marked out and observation stations are marked every 50m (10 stations in total) for the point counts. Butterflies were surveyed along the transects using methods similar to those described for butterflies in temperate regions by Pollard (1977), and used in previous studies of tropical forest butterflies (Spitzer et al, 1993; Hill et al, 1995; Hamer et al, 1997; Hill & Hamer, 1998; 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 was to be maintained. During the walk butterflies were observed within an imaginary box around the observer (5m each side, 5m ahead and 5m above). Similarly, at each observation station binoculars were used to record butterflies observed during a 10 minute period within a 10m radius, and at all heights from the ground, in an attempt to include higher flying butterflies. These distances are similar to those used in other tropical butterfly studies (Spitzer et al, 1993; Hill et al, 1995; Hamer et al, 1997). Thus, any differences in butterfly diversity between sites was not due to differences in visibility, because recording is restricted to within 10m of the stations and within 5m of transects (Hamer et al, 1997).

Butterflies that cannot be identified to species or genus on the wing were, if possible, caught, and released immediately after identification. During these pauses the timer was 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. Species were identified using butterfly guides produced by D’Arbrera (1986) and Treadway (1995).

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

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 were baited with over-ripe bananas and hung from vegetation with the base of the trap at least 1m above ground level. The traps were tied to a branch so it is hanging freely and not touching vegetation. The netting was pulled down but a sufficiently large gap was left between the netting and the base to allow butterflies to fly into the trap. The bait was placed on to a large leaf and then placed on the centre of the baiting platform. Traps were spaced every 50m with 10 traps set at any survey location. Traps were set for a period of 48hrs, and checked every 12hrs. On checking traps, individuals were identified to species level, if unable to identify then photographic records were kept.

4.4 Results
A total of 347 individual butterflies were caught across the survey sites. Three of the fifteen families were recorded: Pieridae, Nymphalidae and Satyridae were represented by 11 species. Table 4.1 shows the butterfly species captured by location. *Melanitis leda* was the most abundant species across all sites with a total of 144 captures, 70 of which were identified to subspecies level *Melanitis leda leda*. *Mycalesis georgi canlaoon* was the second most abundant with 113 individuals captured, 33% of all captures.

Table 4.1 Butterfly species captures - transects and traps by location.

Family	Species	Badjawanan	Dam	Katmon	Malanog	Total
Pieridae	*Charaxes amycus negrosensis*	2	0	0	0	2
Nymphalidae	*Lexias satrapes amlana*	14	17	5	12	48
Nymphalidae	*Tanaecia howarthii*	2	0	0	9	11
Nymphalidae	*Mycalesis georgi canlaon*	40	4	26	43	113
Satyridae	*Mycalesis ita teatus*	0	0	0	2	2
Satyridae	*Melanitis boisduvalia boisduvalia*	2	21	0	0	23
Satyridae	*Tanaecia Lupina sp.*	0	0	0	1	1
Satyridae	*Melanitis leda leda*	0	70	0	0	70
Satyridae	*Melanitis leda sp.*	0	74	0	0	74
Satyridae	*Mycalesis perseus caesonia*	1	0	0	0	1
Satyridae	*Melanitis atrax cajetana*	0	1	1	0	2
Total		61	187	32	67	347

Table 4.2 Butterfly species distribution and status.

Family	Species	Habitat[1]	Species Distribution (sub sp)[2]	Occurrence[3]
Pieridae	*Charaxes amycus negrosensis*	LMS	Philippines (Negros)	Unknown
Nymphalidae	*Lexias satrapes amlana*	LMS S E	Philippines (Negros-Panay)	Uncommon
Nymphalidae	*Tanaecia howarthii*	LMS E	Negros-Panay (Negros)	Uncommon
Nymphalidae	*Tanaecial lupina sp.*	E	Philippines	Unknown
Satyridae	*Mycalesis georgi canlaon*	LMS S E	Philippines	Unknown
Satyridae	*Mycalesis ita teatus*	E	Philippines (Negros-Panay)	Unknown
Satyridae	*Melanitis boisduvalia boisduvalia*	LMS	Philippines	Uncommon
Satyridae	*Melanitis leda leda*	LMS	Asia	Common
Satyridae	*Melanitis leda sp.*	LMS	Asia	Unknown
Satyridae	*Mycalesis perseus caesonia*	LMS	Asia (Philippines)	Uncommon
Satyridae	*Melanitis atrax cajetana*	LMS S	Asia (Philippines)	Common

N.B
[1] E – Edge. LMS – Lower-montane Secondary Growth. S – Secondary Growth.
[2] After D'Arbrea (1986) & Treadway (1995).
[3] Treadway (1995).

Species diversity metrics were calculated from the total number of species found at each location, gained from both transect walks and feeding trap methodologies and this is shown in Table 4.3. Three measures of local diversity were calculated for each survey location and these included: Total number of species (S), Shannon-Weiner diversity $H=\sum(P_i * Log_e(P_i))$ where P_i is the number of individuals of the ith species as a proportion of the total number of all ith species, and Pielou's evenness $J=H/Log_e S$ (Carr 1996).

Location	Total Species[1]	Total Individuals[2]	Species Richness[3]	Pielou's Evenness[4]	Shannon-Weiner Index[5]
Badjagawan	5	58	0.98	0.53	0.85
Dam	6	187	0.95	0.73	1.30
Katmon	3	32	0.57	0.51	0.56
Malanog	5	67	0.95	0.63	1.02

Table 4.3 Butterfly diversity indices.
N.B [1-5] See Appendix 1 for formula calculations for species diversity indices.

Species evenness is used as communities which are dominated by one or two species is 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 evenesss suggests a more diverse area.

The analysis shows the Dam yielded the highest scores across the board. There is a noticeable gap in captures between the Dam and other survey sites. Evenness and diversity appears much lower at Badjagawan, Katmon and Malanog.

4.5 Discussion

There is little evidence available as to the state of butterfly species populations and endemism on Negros and as such, none of the species are recorded on the IUCN Lepidopteran Specialist Group Redlist. Further research is needed to fully identify sub species such as *Tanaecial lupina sp.* and *Melanitis leda sp* and to continue documenting butterfly distribution throughout the habitats of the NNFR. Of the captures, all but two species are endemic to the Philippines. Table 4.2 shows that three species are found in the Negros-Panay faunal region only and two only on Negros.

Butterfly results show a contrast between habitat types. Whereas for birds and bats, Katmon and Dam were relatively and were clustered together in both the dendrogram analysis for birds and NMDS analysis for bats, for butterflies, the Dam was more diverse than Katmon. However, with respect to *Melanitis Leda sp* and *Mycalesis sp*, species making up over 80% of the total captures, *Melanitis sp.* captures were almost exclusively in Dam whilst *Mycalesis sp.* were predominantly in Badjagawan and Malanog. This not only confirms similarity between the latter two sites but also suggests different habitat requirements and occupation of significantly different ecological niches for the two butterfly species.

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. This would also give a useful snapshot as to the invasion of more generalist species/ recovery of specialist species following deforestation and regeneration. It may be useful to include more edge habitats in future studies to gain a better understanding as to the relationship between butterfly species diversity and gap dynamics within the NNFR.

Comprehensive measurement of habitat variables such as light intensity, temperature and relative humidity (see Posa & Sodhi, 2006) should be recorded at survey sites, as these are factors known to influence butterfly activity. Furthermore seasonal variations such as fruiting, flowering activity of plants and trees and canopy density should also be taken into account.

Additional work could include addressing capture techniques. Butterfly mobility through forest canopies and limits to hand netting techniques means butterflies flying at higher elevations will be less conspicuous. Whilst the species lower in the canopy remain useful indicators, those higher in the canopy are the ones most threatened by logging activities, and their presence would be of particular importance. This should be addressed in future work, possibly with use of traps hung higher in the canopy. Other adjustments could 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.

Continuous additions to the NRCP Butterfly Field Guide (Slade et al, 2005) will help ensure future surveys have greater opportunities for identifying butterflies, and the increasing wealth of data will help create a full itinerary of species with ongoing project work. Whilst a comparatively small number of butterfly species was observed in this survey, the (virtual) exclusivity of survey sites occupied by *Melanitis* sp and *Mycalesis* sp illustrates the existence of subtle differences between outwardly similar habitats, and highlights the importance of maintaining as much of the existing forest as possible, at whatever stage of deforestation or regeneration to preserve the many niches and guilds offered.

5. Mammals

5.1 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 are also one of the most endangered groups in the world (Heaney et al, 2000).

An index of faunal endangerment developed by Heaney (1988), 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 eight native species threatened to a significant degree:

- Visayan Warty Pig (*Sus cebifrons)* **Critically Endangered**
- Negros Shrew (*Crocidura negrina)* **Critically Endangered**
- Philippines Tube-nosed Fruit Bat (*Nyctimeme rabori*) **Critically Endangered**
- Golden-capped Fruit Bat (*Acerodon jubatus*) **Endangered**
- Visayan Spotted Deer (*Cervus alfredi*) **Endangered**
- Fischer's Pygmy Fruit Bat (*Haplonycteris fischeri*) **Vulnerable**
- Little Golden-mantled Flying Fox (*Pteropus pumilus*) **Vulnerable**
- Negros Naked-backed Fruit bat (*Dobsonia chapmani*) **Extinct** (however a study by Palaan et al, 2004 found remnant populations of this bat in caves in southwestern Negros and species will subsequently be reclassified).

NB. Species threat status taken from IUCN (2004).

Negros is an oceanic island that is geologically young and therefore it's mammalian fauna is as diverse as other areas of the Philippines (Heaney et al, 2000). Negros Island itself harbours 54 mammalian species from 6 families. Non-volant species represent 5 of the families consisting of Insectivora, Primates, Rodentia, Carniviora and Artiodactyla. 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 (Cox, 1987). 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, which carry implications for the genetic viability of remaining populations. 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, 2002).

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 across The Philippines, information on new species emerges. In 2005, a previously unrecorded species of mouse was 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). Rodent species such as *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.

Furthermore, indiscriminate subsistence and sports hunting continue to be a major threat to the survival of many threatened species on Negros (Cariño et al, 2006). This is especially true for the endangered endemics such as the Visayan spotted deer and warty pigs.

5.2 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).

5.3 Methods

Mammal Traps

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 was 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.

5.4 Results

A total of 117 individuals were captured during the survey period. Table 5.1 shows the species captured by location. Two orders of mammals are represented, Rodentia and Insectivora. Species diversity across the sites is generally low. Rodents are by far the most abundant. *Rattus exulans*, the Polynesian rat, represents 55% of all mammals caught and *Suncus Murinus*, the Asian House Shrew, represents 16% of captures.

The relative dominance of small mammals reflects the trapping methods used in the study. Tables 5.2 and 5.3 show the capture effort for Sherman traps and small mammal cages. Other large mammals observed within the NNFR include the Common Palm Civet (*Paradoxurus hermaphroditus*), Malay Civet *(Viverra tangalunga)*, Long-tailed Macaque (*Macaca fascicularis*), are common in secondary growth areas and near habitation. These mammals are larger than traps used during surveying and are therefore not represented within capture results.

The site with the most captures was Malanog, an edge habitat. A total of 38 small mammals were recorded here, the most abundant species being *Rattus Exulans*.

Table 5.1 Mammal species captures by location.

Family	Species	Common Name	Badjagawan	Crater I	Dam	Katmon	Mawa	Malanog	Total
Muridae	*Rattus everetti*	Common Philippines Forest rat	1	0	11	5	0	13	30
Muridae	*Rattus exulans*	Polynesian rat	10	9	1	4	3	20	47
Muridae	Unknown rat species	Unknown	2	6	9	1	5	3	26
Soricidae	*Suncus murinus*	Asian House Shrew	2	4	3	3	0	2	14
		Total	15	19	24	13	8	38	117

Table 5.2 Sherman trap effort for species by location.

Species	Badjagawan	Crater	Dam	Katmon	Mawa	Malanog
Effort Per Location*	1008	576	360	1008	144	1080
Rattus everetti	0	0	0	0.0030	0	0.0064
Rattus exulans	0.0089	0.010	0	0.0092	0	0.0027
Suncus murinus	0.0039	0.0034	0	0.0010	0	0.0046
Unknown	0.0010	0	0.016	0.0010	0.013	0.0018

Table 5.3 Cage trap effort for species by location.

Species	Badjagawan	Crater	Dam	Katmon	Mawa	Malanog
Effort Per Location*	1008	504	288	1008	432	1080
Rattus everetti	0.0059	0	0	0.0069	0.016	0
Rattus exulans	0.0039	0.0039	0	0.0039	0.0069	0.0055
Suncus murinus	0	0	0	0.0019	0	0
Unknown	0.0039	0.0039	0.013	0.00099	0	0.0018

* Effort is calculated as number of trap hours multiplied by number of cages used.

Table 5.4 Mammal captures morphological data – adult females.

Species	Statistucal Measures	Mass (g)	Ear (mm)	Hindfoot (mm)	Tail (mm)	Body Length (mm)	Total Body Length (mm)
Rattus exulans	Range	71-138	10.5-17.1	21.7-32.7	93.9-209.7	112.8-150	200-352.3
	Mean	99.40	13.55	25.32	140.20	133.16	411.63
	St Dev	41.81	2.72	4.43	44.18	14.19	61,19
	N	5	4	5	5	5	5
Suncus murinus	Range	24-69	7.6-11.8	8.4-19.2	43.3-71.7	81.2-190.7	139.02-256.6
	Mean	38.8	38.8	15.72	61.02	118.26	179.28
	St dev	17.82	1.75	4.27	11.04	41.99	46.15
	N	5	5	5	5	5	5
Unknown	Range	80-173	14.5-18.9	31.3-35.4	149-161.7	121.6-182	270.6-340
	Mean	123	16.7	32.7	156.23	154.46	310.7
	St Dev	46.89	2.2	2.33	6.53	30.55	35.93
	N	3	3	3	3	3	3

Table 5.5 Mammal captures morphological data – Juvenile females.

Species	Statistical Measures	Mass (g)	Ear (mm)	Hindfoot (mm)	Tail (mm)	Body Length (mm)	Total Body Length (mm)
Unknown rat	Range	42	15.9	26.2	127.3	112.7	240
	Mean	42	15.9	26.2	127.3	112.7	240
	St dev	-	-	-	-	-	-
	N	1	1	1	1	1	1
Suncus murinus	Range	17-48	7.6-8.6	8.4-18.1	58-111.68	81.2-98.2	139.2-209.88
	Mean	32.5	8.1	13.25	84.84	89.7	174.54
	St dev	21.92	0.7	6.85	37.95	12.02	49.97
	N	2	2	2	2	2	2
Rattus everetti	Range	64	12.6	24.5	124.5	114.5	239
	Mean	-	-	-	-	-	-
	St dev	-	-	-	-	-	-
	N	1	1	1	1	1	1

Table 5.6 Mammal captures morphological data – adult males.

Species	Statistical Measures	Mass (g)	Ear (mm)	Hindfoot (mm)	Tail (mm)	Body length (mm)	Total Body Length (mm)
Rattus exulans	Range	49-179	7-18.2	19-33.6	92.2-170	94.5-195.6	202.6-365.5
	Mean	97.55	14.63	39.39	141.17	144.94	286.11
	St dev	45.97	2.76	47.91	26.7	27.3	50.06
	N	20	20	20	20	20	20
Unknown Rat	Range	44-160	4-22.8	22-35.8	100.8-168	98.3-158	199.1-320.1
	Mean	106.63	13.87	27.59	138.56	131.25	269.82
	St Dev	40.57	6.11	5.53	26.53	20.38	45.37
	N	11	12	12	12	12	12
Suncus murinus	Range	41-61	8.3-14.8	18.3-28.1	65.9-118.9	103.6-133.8	169.5-252.7
	Mean	50	8.5	21.86	84.26	113.66	197.93
	St Dev	10.14	0.28	5.14	30.01	17.43	47.44
	N	3	3	3	3	3	3
Rattus everetti	Range	44-166	9.1-20.6	24.5-130.9	68-214.8	129.5-190.6	197.5-405.5
	Mean	136.46	15.19	35.17	166.26	159.1	325.36
	St dev	32.05	3.2	27.37	39.01	23.15	58.42
	N	15	15	15	15	15	15

Table 5.7 Mammal captures morphological data – Juvenile males.

Species	Statistical Measures	Mass (g)	Ear (mm)	Hindfoot (mm)	Tail (mm)	Body Length (mm)	Total Body Length (mm)
Rattus exulans	Range	40-68	11-16.7	20.3-27	69.1-124.8	97.1-134.1	192.5-255.7
	Mean	57.33	14.18	24.09	104.05	118.65	222.70
	St Dev	9.81	2.05	1.88	19.26	15.75	27.55
	N	12	12	12	12	12	12
Unknown Rat	Range	39-72	14.1-17.8	26.9-28.6	85.3-136.5	110.4-141.2	214.3-261.6
	Mean	57	15.97	27.7	106.45	123.65	230.07
	St Dev	15.25	1.8	0.78	21.59	13.14	21.63
	N	4	4	4	4	4	4
Rattus everetti	Range	38-61	7.9-17.2	19.7-29.4	69.8-148.2	65-130.4	134.8-270.8
	Mean	45.4	12.61	25.2	110.81	109.24	220.05
	St Dev	9.05	2.97	3.06	24.15	18.81	40.72
	N	10	10	10	10	10	10

5.5 Discussion

So far, 63 species of rats and mice have been recorded from The Philippines. These species exhibit an extraordinary variety of sizes, colours and habitat preferences. They also play key roles within forests. Small mammals, in particular rodents, are important for the regeneration of forest vegetation as they are key seed predators (Pardini et al, 2005).

All of the small mammal species captured during surveys are widely distributed throughout most parts of Southeast Asia. Non-native species such as *Suncus murinus* thrive in a wide range of habitats and 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, 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).

Contrary to popular belief (rodents are regularly seen as pests and vermin), native rodents can be greatly affected by forest fragmentation and subsequent changes to forest structures. After disturbance, smaller fragments will support fewer species than large fragments or areas of continuous forest. This is particularly true in the case of small mammal species, which, unlike volant mammals and birds, are less mobile and cannot disperse easily over relative distances. Introduced species often have a greater tolerance to fragmentation than native species (Bennett, 1990). Therefore native small mammal richness and density is expected to be lower in remnant forest patches and the results for this survey would support this view.

Human induced forest fragmentation, combined with the introduction of exotic and domesticated species (livestock, dogs, cats) means indigenous mammal species that are sparsely distributed and intolerant of conditions such as edge effect (changes in microclimate) are particularly susceptible to loss through fragmentation (Turner, 1996).

Further work could include behavioural ecological studies of the larger mammals present in the NNFR such as the Visayan warty pig (*Sus cebifrons*) and the Philippine spotted deer (*Cervus alfredi*). Only casual observations of pigs and deer have been noted so far by the NRCP. Locating and collecting larger mammal scats could help identify other smaller mammals, as prey for predators, not captured by trapping methods. Additionally it would be useful to ascertain the presence of smaller mammals such as those that are susceptible to being out-competed by *S murinus* and *Rattus exulans,* and to the effects of habitat fragmentation.

6. Community and Environmental Education

It is recognised that any attempts at sustainable natural resource management in a given region must include all local stakeholders. To this end, CCC integrated community and educational initiatives as part of the objectives of the NRCP (as outlined in Chapter 1). These objectives include some of the key principles of sustainable development: fostering environmental responsibility and stewardship for future generations. The NRCP aims to achieve this by encouraging community participation and environmental education.

6.1 Community Interactions

The NRCP is based in the mountain village of Campuestuan, which is a hub for the communities in the surrounding region. The village is unlike other mountain tourist hotspots such as Patag on the other side of the NNFR. The village is situated at the end of a road, which is in bad condition and deteriorates in rain, which contributes to isolation and difficulties in communications and transportation for the community. However the village is lively and holds a well-attended annual fiesta celebrating their village and the community.

The participation of local community members in the NRCP is valued highly and the project has benefited inordinately from local knowledge of the forest, navigation and local customs and traditions. The NRCP is a significant employer for the villagers via cooks and guides and the project continues to involve community members from Campuestuan and the surrounding area, including employing two local Mountain Guides from Patag. The Mountain Guides receive formalised personal training and development and are subsequently involved in the training of new volunteers in trekking protocol, camp skills and survey approaches in the field.

6.2 Environmental Education

An integral part of CCC's work in Negros is capacity building within the project area. The importance of inspiring young conservationists and instilling environmentally conscious communities is highlighted in the Negros Environmental Education Scheme, which NFEFI and CCC have been running since 2002. The scheme encourages local involvement and long-term sustainability for the NRCP and associated initiatives. Local students and counter-part trainees are heavily subsidised for their participation by fees paid by non-Filipino volunteers.

Over the research period, two local volunteers participate each month. These are either trainees from NFEFI, volunteers with other NGO's or local students from the Negros State College of Agriculture. Each participant receives full training; attending the Skills Development Programme and participates in surveys.

The Environmental Education Scheme run by CCC continues to encourage and develop new approaches in communicating ecology in Negros. The project received funding support from the British Ecological Society's Educational Innovation and Research Grant in 2005. It is designed with a 'hands on' approach in mind and is targeted at both local school groups and university students. The BES grant contributed towards acquiring and implementing teaching materials for use in the Scheme. During 2005, primary and secondary school workbooks were designed for use with local schools visiting the NRCP project base. It is hoped the scheme will result in continual knowledge exchange within schools for future generations.

The NRCP also hold interactive field days for local school groups, which take the format of a 'Forest Camp'. Schools visit for the whole day, and undertake activities such as attending practical demonstrations of surveys and participate in lectures and seminars on the ecology and conservation of the NNFR. Activities are targeted appropriately at each group and elementary school groups often receive a puppet show, some art classes and other fun games orientated around conservation.

In 2006 the Environmental Education Scheme for Negros is being expanded. A pilot project has been scheduled for a UK school group who will attend and participate as volunteers on the NRCP. It is hoped the scheme will help formalise links and the educational structure for school groups from the UK and the Philippines, allowing pupils to participate on CCC projects as part of fieldwork units or coursework credits.

7. Conclusions and Recommendations

This report documented the continued exploration of the Lower-Montane forest habitats of the NNFR, Negros. Analysis of the baseline data across all major taxonomical groups: birds, bats, butterflies and mammals concluded that no species previously unidentified on inventories in the NNFR were found during the course of this research phase.

However disparities in survey effort (MacKinnon Lists for birds and Mist-netting hours for bats) are believed to have affected results and analysis. This can be used to highlight the difficulties of surveying in tropical forest environments. The methods used are often dependent upon conditions within the forest (e.g rainfall) and the welfare of both the surveyors and wildlife concerned should always take precedent in such occasions.

During the research phase, logging at the lower-montane old growth site of Mawa, meant surveys here were restricted. This unfortunately meant no valid comparisons could be made between the old growth habitat type and regenerating areas.

However some trends did emerge. The forests at Dam and Katmon showed similarities in terms of bird and bat species suggesting areas of secondary regrowth are regenerating and this gives cause for optimism in future.

The results of this survey also support previous NRCP studies (see Tamblyn et al, 2005) that broadly suggest that the forest ecosystem within the NNFR is regenerating. Species that are associated more with old growth forest are being found in disturbed old growth and secondary growth.

Analysis revealed the forest habitats of the NNFR support some of the key threatened endemic species found on Negros. Such species recorded in this study were:

- The critically endangered Tarictic Hornbill (*Penelopides panini)*, recorded at Badjagawan (Lower-montane secondary regrowth), Katmon (secondary regrowth) and Malanog (edge).
- The critically endangered Philippine Tube-nosed bat (*Nyctimene rabori*) captured at Katmon (secondary growth).
- The vulnerable Philippines Pygmy Fruit Bat (*Haplonycteris fischeri*) captured at all survey sites.

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.

Recommendations for further work:

- *Continued surveying of existing sites*

Continued periodic monitoring of existing survey sites within the NNFR is encouraged in order to generate a long-term view of forest status and regeneration. This is particularly key for the species of conservation status, such as the Tarictic Hornbill.

Continued surveying will also help contribute to increasing the understanding and awareness of trends in populations of target faunal groups in the NNFR and to re-enforce and validate the designation of the area as the North Negros Natural Park.

- *Expand surveys into new locations within the NNFR*

Future research as part of the NRCP will look towards expanding in to other forested and non-forested regions within the Upper Imbang-Caliban watershed. Expansion of new survey sites will provide details of additional habitats and will be used to illustrate the patchwork of habitat types within this region.

In particular, focus areas are the herpetofauna of the region and this has previously been limited. Vegetation analysis will also be conducted at survey sites to assess tree and plant community regeneration.

- *Data application*

Further effort shall be directed towards applying the information gathered so far within the NNFR. Base line biodiversity data collection will continue in the montane forest habitats covered in this study in order to maintain and improve current species inventories as well as to generate long-term data sets for future comparisons.

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.

Assessing the effects of forest fragmentation on the major faunal group communities is a key priority. For this end, it is hoped GIS will enable detailed assessment and quantification of forest distribution, extent and status within the NNFR. This in turn can be used to assess the quality of habitats in terms of forest core/edge.

The data that has been gathered here should be presented to the NNFR Management Council and the Regional Development Council by NFEFI as a resource for providing further impetus for the NNFR to be fully recognised as a protected area as part of the new North Negros National Park in the Philippines. With this status would come 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.

8. References

Asian Regional Centre for Biodiversity Conservation. (2006) *Bioregions of the Philippines*. Available at: www.arcbc.org. Accessed 04/04/06.

Beccaloni, G.W. & Gaston, K.J. (1995) Predicting the Species Richness of Neotropical Forest Butterflies-Ithomiinae (Lepidoptera, Nymphalidae) as indicators. *Biological Conservation*, **71**, 77-86.

Bennett, A. (1990) Habitat Corridors and the Conservation of Small Mammals in a Fragmented Forest Environment. *Landscape Ecology*, **4 (2)**, 109-122.

Bibby, C. Jones, M. & Marsden, S. (1998) *Expedition Field Techniques: Bird Surveys*. Royal Geographic Society, London.

BirdLife International. (2001) *Threatened Birds of Asia: The BirdLife International Red Data Book.* Available at: www.birdlife.org. Accessed 10/02/06.

BirdLife International. (2005a) *BirdLife Fact Sheet Endemic Bird Area 152: Negros-Panay*. Available at: www.birdlife.org. Accessed 20/02/06.

BirdLife International. (2005b) *BirdLife Asia Programme.* Available at: www.birdlife.org/regional/asia/index.html. Accessed 06/01/06.

BirdLife International. (2006) *Key Forest Regions for Threatened Birds of Asia*. Available at: www.birdlife.org/action/science/species/asia_strategy/forests.html#tag9 Accessed 04/04/06.

Blau, W.S. (1980) The Effect of Environmental Disturbance on a Tropical Butterfly Population. *Ecology*, **61**, 1005-1012.

Brooks, T.M. Evans, T.D. Dutson, G.C.L. Anderson, G.Q.A. Asane, D.A. Timmins, R.J & Toledo, A.G. (1992) The Conservation Status of the Birds of Negros, Philippines. *Bird Conservation International*, **2**, 273-302.

Brooks, T.M. Pimm, S.L. & Collar, N.J. (1997) Deforestation Predicts the Number of Threatened Birds in Insular Southeast Asia. *Conservation Biology*, **11**, 382-394.

Brooks, T.M. Mittermeier, R.A. Mittermeier, C.G. Fonseca, G.A.B. Rylands, A.B. Konstant, W.R. Flick, P. Pilgrim, J. Oldfield, S. Magin, G. Hilton-Taylor, C. (2002) Habitat Loss and Extinction in the Hotspots of Biodiversity. *Conservation Biology*, **16 (4)**, 909-923.

Cariño, A. Cadeliña, A.M & Tiempo, F.A. (2006) *An Ethnobiological Survey of Wildlife Hunters on Negros Island, Philippines.* Bristol, Clifton & West of England Zoological Society and Flora and Fauna International – Philippine Biodiversity Conservation Programme, UK.

Carr, M.R. (1996) *PRIMER (Plymouth Routines in Multivariate Ecological Research*). Plymouth Marine Laboratory, Plymouth, UK.

Chan, S. Crosby, M. J. Islam, M. Z & Tordoff, A.W. (2004) *Important Bird Areas in Asia Key Sites for Conservation.* BirdLife International, Cambridge.

CITES. (2006) *CITES-Listed Species Database*. Available at: www.cites.org/eng/resources/species.html. Accessed 10/03/06.

Clarke, K.R. & Green, R.H. (1988) Statistical Design and Analyses for a 'Biological Effects' Study. *Marine Ecological Progress Series*, **46**, 213-226.

Clarke, K.R. & Warwick, R.M. (1994) *Similarity-Based Testing for Communities - An Approach to Statistical Analysis and Interpretation*. Plymouth Marine Laboratory, Plymouth, UK.

Clutton-Brock, T.H. Iason, G.R. (1986) Sex Ratio Variation in Mammals. *Quarterly Review of Biology*, **61 (3)**, 339-374.

Collar, N.J. Mallari, N.A. & Tabaranza, B.R. (1999) *Threatened Birds of the Philippines*. The Haribon Foundation/BirdLife International Red Data Book. Bookmark, Philippines.

Conservation International. (2005) *Philippines Unique and Threatened Biodiversity.* Available at: www.biodiversityhotspots.org/xp/Hotspots/philippines/biodiversity.xml. Accessed 21/02/05.

Convention on Biological Diversity. (2003) *The Ecological and Socio-Economic Impact of Invasive Alien Species on Island Ecosystems.* Available at: www.issg.org/cii/info.html. Accessed 22/02/05.

Cox, R. (1987) The Philippine Spotted Deer and the Visayan Warty Pig. *Oryx*, **21**, 37-42.

Curio, E. Hamann, A. Heubüschl, P. and Lastimosa, L. L. (1996) Hornbill Research and Conservation in the Philippines. *EEP Hornbill Taxon Advisory Group Newsl.* **2**, 26–27.

Curio, E. (2002) Prioritisation of Philippine Island Avifaunas for Conservation: A New Combinatorial Measure. *Biological Conservation*, **106**, 373-380.

D'Abrera, B. (1986) *Butterflies of the Oriental Region.* Part III. Hill House, Melbourne.

Davis, S.D. (1995) Identifying the Sites of Global Importance for Conservation: The IUCN/WWF Centres of Plant Diversity Project. In Primack R.B and Lovejoy T.E (Eds) *Ecology, Conservation and Management of Southeast Asian Rainforests*. Yale University Press, New Haven, USA.

Dennis, R.L.H. Shreeve, T.G. Isaacc, N.J.B. Roy, D.B. Hardy, P.B. Foxe, R & Ashere, J. (2006) The Effects of Visual Apparency on Bias in Butterfly Recording and Monitoring. *Biological Conservation*, **128**, 486-492.

Department of Environment and Natural Resources. (2004) *Summary of Protected Areas in The Philippines By Region*. Available at: www.denr.gov.ph/section-facts-figures. Accessed 30/03/06.

Dinerstein, E. Wikramanayake, E.D & Forney, M. (1995) Conserving the Reservoirs and Remnants of Tropical Moist Forest in the Indo-Pacifc Region. In Primack R.B & Lovejoy T.E. (Eds) *Ecology, Conservation and Management of Southeast Asian Rainforests*. Yale University Press, New Haven, USA.

Estrada, A & Coates-Estrada R. (2001) Species Composition and Reproductive Phenology of Bats in a Tropical Landscape at Los Tuxtlas, Mexico. *Journal of Tropical Ecology*, **17**, 627–646.

Fenton, M.B. (1982) Echolocation Calls and Patterns of Hunting and Habitat Use of Bats (Microchiroptera) from Chillagoe, North Queensland *Australian Journal of Zoology* **30 (3)**, 417 – 425.

Food and Agricultural Organisation. (2005) *Global Forest Resource Assessment.* Available at: www.fao.org. Accessed 20/02/06.

Francis, C.M. (2001) *A Photographic Guide to Mammals of South-east Asia*. New Holland Publishers, London.

Ghazoul, J. (1997) The Pollination and Breeding System of *Dipterocarpus obtusifolius* (Dipterocarpaceae) in Dry Deciduous Forests of Thailand. *Journal of Natural History*, **31**, 901-916.

Gilbert, L.E. (1984) The Biology of Butterfly Communities. In Vane-Wright, R.I & Ackery, P.R. (eds.) *The Biology of Butterflies*. Academic Press, London.

Gonzalez, A & Chaneton, E. (2002) Heterotrophic Extinction, Abundance and Productivity in a Fragmented Microecosystem. *Journal of Animal Ecology*, **71**, 594-603.

Hamann, A. (2002) The North Negros Forest Reserve: A Biodiversity Hotspot at Risk. *Silliman Journal*, **43 (1)**, 84-88.

Hamann, A. Curio, E. (1999) Interactions among Frugivores and Fleshy Fruit Trees in a Philippine Submontane Rainforest. *Conservation Biology*, **13**, 776.

Hamer, K.C. Hill, J.K. Lace, L.A. & Langan, A.M. (1997) Ecological and Biogeographical Effects of Forest Disturbance on Tropical Butterflies of Sumba, Indonesia. *Journal of Biogeography*, **24**, 67-75.

Hammond, P.C. & Miller, J.C. (1998) Comparison of the Biodiversity of Lepidoptera within Three Forested Ecosystems. *Annals of the Entomological Society of America*, **91**, 323-328.

Hardy, P.B. & Dennis, R.L.H. (2005) Is Richness of Local Tropical Butterfly Faunas Underscored? Perspectives Gained from Biases in Transect Observations. *Acta*

Zoologica Sinica, **51**, 237–250.

Heaney, L.R. (1986) Biogeography of the Mammals of Southeast Asia: Estimates of Colonization, Extinction, and Speciation. *Biological Journal of the Linnean Society,* **28**, 127-165.

Heaney. L.R. Gonzales, P.D & Alcala. A.C. (1988) An Annotated Checklist of the Taxonomic and Conservation Status of Land Mammals in the Philippines. *Silliman Journal (Philippines).* **34**, 32-66.

Heaney, L.R. Heideman, P.D. Rickart, E.A. Utzurrum, R.B & Klompen, J.S.H. (1989) Elevational Zonation of Mammals in the Central Philippines. *Journal of Tropical Ecology*, **5**, 259-280.

Heaney, L.R. (1993) Biodiversity Patterns and the Conservation of Mammals in the Philippines. *Asia Life Sciences*, **2**, 261-274.

Heaney, L.R. & Regalado, J.C. Jr. (1998) *Vanishing Treasures of the Philippine Rain Forest*. The Field Museum, Chicago, USA.

Heaney, L.R. Walker, E.K. Tabaranza, Jr, B.R. & Ingle, N.R. (2000) Mammalian Diversity in the Philippines: An Assessment of the Adequacy of Current Data. *Sylvatrop Tech. Journal of Philipp. Ecosystems and Nat. Res.* **10 (1&2)**, 6-27.

Heaney, L.R. Balete, D.S. Dolar, M.L. Alcala, A.C. Dans, A.L.T. Gonzales, P.C. Ingle, N. Lepiten, M. Oliver, W. Rickart, E. A. Tabaranza Jr, B.R. & Utuzurrum, R. C.B. (2002) *A Synopsis of the Mammalian Fauna of the Philippines*. Available at: www.fieldmuseum.org/philippine_mammals/credits.htm. Accessed 16/02/05.

Heaney, L. R. Balete, D. S. Rickart, E. A. Josefa Veluz, M. & Sarmiento, J. (2005) *Welcome surprises from Mt. Banahaw.* Available at: www.haribon.org.ph/?q=node/view/128. Accessed 16/02/05.

Heidemann, P. D (1988) The Timing of Reproduction in the Fruit Bat *Haplonycteris fischeri* (Pteropodidae): Geographic Variation and Delayed Development. *Journal of Zoology* **21**, 577-595.

Heidemann, P. D. (1989) Delayed development in Fischer's pygmy fruit bat, *Haplonycteris fischeri*, in the Philippines. *Journal of Reproductive Fertility*, **85**, 363-382.

Heidemann, P.D. Heaney, L.R., Thomas, R.L. & Erickson, K.R. (1987) Patterns of Faunal Diversity and Species Abundance of Non-volant Small Mammals on Negros Island, Philippines. *Journal of Mammalogy*, **69**, 884-888.

Heideman, P. D & Heaney, L.R. (1992) Species Accounts. In Mickleburgh, S.R, Racey, P.A & Hutson, A.M (eds). *Old-World Fruit Bats: An Action Plan for the Family Pteropodidae*. IUCN Press, Gland, Switzerland.

Hill, C.J. Gillison, A.N & Jones, R.E. (1992) The Spatial Distribution of Rainforest Butterflies at Three Sites in North Queensland, Australia. *Journal of Tropical Ecology*, **8**, 37-46.

Hill, J.K. Hamer, K.C. Lace, L.A & Banham, W.M.T. (1995) Effects of Selective Logging on Tropical Forest Butterflies on Buru, Indonesia. *Journal of Applied Ecology,* **32**, 754-760.

Hill, J.K & Hamer, K.C. (1998) Using Species Abundance Models as Indictors of Habitat Disturbance in Tropical Forests. *Journal of Applied Ecology,* **35**, 458-460.

Hill, J.K. (1999) Butterfly Spatial Distribution and Habitat Requirements in a Tropical Forest: Impacts of Selective Logging. *Journal of Applied Ecology,* **36**, 564-572.

Horner, M.A.Fleming, T.H. Sahey, C.T. (1998) Foraging Behaviour and Energetics of a Nectar-Feeding Bat, *Leptonycteris curasoae* (Chiroptera: Phyllostomidae) *Journal of Zoology,* **244**, 575-586.

Howell, D.J. (1979) Flock Foraging in Nectar-Feeding Bats: Advantages to the Bats and to the Host Plants. *American Naturalist,* **114**, 23-49.

Ingle, N. R. & Heaney, L. R. (1992) A Key to the Bats of the Philippine Islands. *Fieldiana: Zoology,* **69**, 1-44. Chicago Field Museum of Natural History.

Ingle, N. R. (1993) Vertical Flight Stratification of Bats in a Philippine Rainforest. *Asia Life Sciences,* **2**, 215–222.

Ingle, N.R. (2003) Seed Dispersal by Wind, Birds, and Bats between Philippine Montane Rainforest and Successional Vegetation. *Oecologia,* **134(2)** 251-261.

IUCN Regional Biodiversity Programme Asia. (2001). *Alien Invasive Species: Report of Workshop on Alien Invasive Species Global Biodiversity Forum. South and Southeast Asia.* IUCN. Columbo.

IUCN. (2004) *The IUCN 2004 Red List*. Available at: www.redlist.org. Accessed 20/02/06.

Kato, M. (1996) Plant-Pollinator Interactions in the Understory of a Lowland Mixed Dipterocarp Forest in Sarawak. *American Journal of Botany*, **83**, 732-743.

Kennedy, R, S. Gonzales, P, C. Dickinson, E, C. Miranda, H & Fisher, T, H. (2000) *A Guide to the Birds of the Philippines.* Oxford University Press, Oxford.

Kingston, T. Francis, C.M Akbar, Z & Kunz, T, A. (2003) Species Richness in an Insectivorous Bat Assemblage from Malaysia. *Journal of Tropical Ecology,* **19**, 67-79.

Koh, L.P. Sodhi, N.S. Brook, B.W. (2004a) Ecological Correlates of Extinction Proneness in Tropical Butterflies. *Conservation Biology,* **18 (6)**, 1571-1578.

Koh, L.P. Sodhi, N.S. Brook, B.W. (2004b) Co-Extinctions of Tropical Butterflies and their Hostplants. *Biotropica*, **18**, 1571-1578.

Kremen, C. Colwell, R.K. Erwin, T.L. Murphy, D.D Noss, R.F. Sanjayan, M.A. (1993) Terrestrial Arthropod Assemblages: Their Use in Conservation Planning. *Conservation Biology*, **7(4)**, 796-808.

Kunz, T.H. Thomas, D.W. Richards, G.C. Tidemann, C.R. Piersom, E.D & Racey, P.A. (1996) Observational Techniques for Bats. In Wilson, D.E., Cole, F.R. Nichols, J.D., Rudran, R, & Foster, M.S (eds). *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals.* Smithsonian Institution Press, Washington, USA.

Lambert, F.R & Marshall, A.G. (1991) Keystone Characteristics of Bird-Dispersed Ficus in a Malaysian Lowland Rainforest. *Journal of Ecology,* **79 (3)**, 793-809.

MacArthur, R. H & Wilson, E. O. (1967) *The Theory of Island Biogeography*. Princeton University Press. USA.

MacKinnon, J. & Phillips, K. (1993) *A Field Guide to the Birds of Sumatra, Java and Bali.* Oxford University Press, Oxford.

Maunder, L. & Turner, C.S. (2003) *Mammal Field Guide: North Negros Forest Reserve.* Coral Cay Conservation, London.

Mickleburgh, S. P. Hutson, A.M. & Racey, P.A. (eds) (1992) *Old World Fruit Bats. An Action Plan for their Conservation*. IUCN/SSC Chiroptera Specialist Group. IUCN, Gland, Switzerland.

Mittermeier, R. Gil, P. R, Hoffman, M. Pilgrim, J. Brooks, T. Mittermeier, C.G. Lamoreux, J & de Fonseca, G.A.B. (eds.) (2005) *Hotspots Revisited: Earth's Biologically Richest and Most Threatened Ecoregions.* Conservation International, Virginia, USA.

Motokawa, M, Lu, K. H, Harada, M. & Lin, L. K. (2001) New Records of the Polynesian Rat *Rattus exulans* (Mammalia: Rodentia) from Tawain and the Ryukus. *Zoological Studies*, **40 (4**), 299-304.

Oliver, W.L.R. & Heaney, L.R. (1996) Biodiversity and Conservation in the Philippines. *International Zoo News*, **43**, 329-337.

Ong, P.S. Afuang, L.E & Rosell-Ambal, R.G (eds) (2002) *Philippine Biodiversity Conservation Priorities: A Second Iteration of the National Biodiversity Strategy and Action Plan*. DENR Biodiversity Conservation Program, UP Center for Integrative & Development Studies, and Conservation International. Manila, Philippines.

Palaan, R. B. Alcala, E. L & Averia, L. T. (2004) Responses of Mammalian Fauna of Southwestern Negros Island, Philippines to Fragmentation of the Tropical Rainforest. *Sylvatrop*, **14 (1 & 2)**.

Pardini, R. de Souza, S. M. Braga-Neto, R. Metzger, J.P. (2005) The Role of Forest Structure, Fragment Size and Corridors in Maintaining Small Mammal Abundance and Diversity in an Atlantic Forest Landscape. *Biological Conservation,* **124**, 253-266.

Philippine Biodiversity Conservation Priorities. (2002) *A Second Iteration of the National Biodiversity Strategy and Action Plan.* DENR-PAWB, CI Philippines, BCP-UPCIDS.

Poffenberger, M. (ed). (1999) *Communities and Forest Management in Southeast Asia.* IUCN, Gland, Switzerland.

Pollard, E. (1977) A Method for Assessing Changes in the Abundance of Butterflies. *Biological Conservation*, **12**, 115-134.

Pollard, E. (1988) Temperature, Rainfall and Butterfly Numbers. *Journal of Applied Ecology*, **25**, 819-828.

Pollard, E. & Yates, T.J. (1993) *Monitoring Butterflies for Ecology and Conservation.* Conservation Biology Series, Vol.1, Chapman & Hall, London.

Posa, M. R. C & Sodhi, N. S. (2006) Effects of Anthropogenic Land Use on Forest Birds and Butterflies in Subic Bay, Philippines. *Biological Conservation*, **129**, 256-270.

Shilten, L.A. Altringham, J.D. Compton, S.G. & Whittaker, R.J. (1999) Old World Fruit Bats Can Be Long-Distance Seed Dispersers through Extended Retention of Viable Seeds in the Gut. *Royal Society of London*, **266,** 219-223.

Slade, E. (2001) *The Effects of Logging on Butterfly Diversity and Distribution in a Sub-montane Tropical Rainforest in the Philippines.* MSc Thesis, University of Aberdeen.

Slade, E. Cummings, M, Turner, C.S & Turner, A. (2005) *A Photographic Guide to the Butterflies of the North Negros Forest Reserve, Negros Occidental, Philippines.* Coral Cay Conservation, London.

Sodhi, N.S. & Liow, L.H. (2000) Improving Conservation Biology Research in Southeast Asia. *Conservation Biology*, **14**, 1211-1212.

Sodhi, N.S. Liow, L.H. & Bazzaz F.A. (2004) Avian Extinctions from Tropical and Subtropical Forests *Annual Review of Ecology, Evolution, and Systematics,* **35**, 323-345.

South Pacific Regional Environment Programme. (2000) *Invasive Species in the Pacific: A technical Review and Draft Regional Strategy*. SPREP. Samoa.

Spitzer, K. Novotny, V. Tonner, M. & Leps, J. (1993) Habitat Preferences, Distribution and Seasonality of the Butterflies (Lepidoptera, Papilionoidea) in a Montane Tropical Rainforest, Vietnam. *Journal of Biogeography*, **20**, 109-121.

Spitzer, K. Jaroz, J. Havelka, J & Laps, J. (1997) Effects of Small-scale Disturbance on Butterfly Communities of an Indochinese Montane Forest. *Biological Conservation*, **80**, 9-15.

Stattersfield, A.J. Crosby, M.J. Long, A.J. & Wege, D.C. (1998) *Endemic Bird Areas of the World: Priorities for Biodiversity Conservation*. BirdLife Conservation Series No.7. Cambridge.

Sutton, S.L. & Collins, N.M. (1991) Insects and Tropical Forest Conservation. In Collins, N.M & Thomas, J.A. (eds). *The Conservation of Insects and Their Habitats.* Academic Press, London.

Tamblyn, A. Turner, C. S. Turner, A. & Raines, P. (2005) *A Comparative Study of the Habitats of the Upper Imbang-Caliban Watershed, North Negros Forest Reserve, Negros Occidental, Philippines*. Coral Cay Conservation, London.

Thomas, D.W. & West S.D. (1989) Sampling Methods for Bats – General Technical, United States Department of Agriculture. Available at: www.treesearch.fs.fed.us/pubs/9090. Accessed 24/04/06.

Thompson, G. G. Withers, P. C. Pianka, E. R & Thompson, S. A. (2003) Assessing Biodiversity with Species Accumulation Curves; Inventories of Small Reptiles by Pitfall Trapping in Western Australia. *Austral Ecology*, **28**, 361-383.

Tidemann, C.R. and DP Woodside, D.P. (1978) A Collapsible Bat-Trap and a Comparison of Results Obtained with the Trap and with Mist-nets. A*ustralian Wildlife Research*, **5(3)**, 355 – 362.

Treadaway, C. G. (1995) Checklist of the butterflies of the Philippine Islands. *Nachr Entomol Vers Apollo Suppl*, **14**, 7-118.

Turner, C.S. Slade, E.M. & Ledesma, G. (2001) The Negros Rainforest Conservation Project: Past, Present & Future. *Silliman Journal*, **42 (1)**, 109-132.

Turner, C.S. Ledesma, G. & Raines P.S. (2002) *Negros Rainforest Conservation Project Annual Research Report for Gratuitous Permit No. 90.* Submitted to the Department of the Environment and Natural Resources and the Negros Forests and Ecological Foundation, Inc. Coral Cay Conservation, London.

Turner, C.S. King, T. O'Malley, R. Cummings, M. & Raines, P.S. (2002) *Danjugan Island Biodiversity Survey: Final Report*. Coral Cay Conservation, London.

Turner, I.M. (1996) Species Loss in Fragments of Tropical Rain Forest: A Review of the Evidence . *Journal of Applied Ecology*, **33(2)**, 200-209.

UENP WCMC (2003). *Species Database*. Available at: www.unep-wcmc.org/. Accessed 10/09/06.

Walpole, M.J. (1999) Sampling Butterflies in Tropical Rainforest: An Evaluation of a Transect Walk Method. *Biological Conservation*, **87**, 85-91.

Watson, J.E.M. Whittaker, R. J. & Dawson, T. P. (2004) Avifaunal Responses to Habitat Fragmentation in the Threatened Littoral Forests of Southeastern Madagascar. *Journal of Biogeography*, **31**, 1791-1807.

Wildlife Conservation Society of the Philippines. (1997) *Philippine Red data book*. Bookmark, Makati city, the Philippines.

Whitmore, T.C. (1998) *An Introduction to Tropical Rainforests.* Oxford University Press, Oxford.

Whittaker, R. (1999*) Island Biogeography: Ecology, Evolution and Conservation*. Oxford University Press, Oxford.

Willott, S.J. Lim, D.C. Compton, S.G. & Sutton, S.L. (2000) Effects of Selective Logging on the Butterflies of a Bornean Rainforest. *Conservation Biology*, **14**, 1055-1065.

Wood, B & Gillman, M.P. (1998) The Effects of Disturbance on Forest Butterflies Using two Methods of Sampling in Trinidad. *Biodiversity & Conservation*, **7**, 597-616.

Appendix I – Notes on formulas used to calculate species richness and diversity

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 (($d=(S-1)/\text{Log}(N)$)). 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 $H' = -\sum_i p_i \text{ Log }(p_i)$ 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.