

**Conserving Threatened and Endemic Fruit Bats  
in Isolated Forest Patches in Cebu**  
*with notes on new records and rediscoveries*

---

A survey of fruit bats in five isolated forest patches (Alcoy forest, Dalaguete forest, Tabunan forest, Mt. Lantoy in Argao, and Carmen forest) in Cebu island, Philippines was conducted from February 2001 to January 2004 using mist nets for small to medium sized fruit bats and direct roost observations for flying foxes. A total of twelve species of fruit bats composed of six threatened species, six endemic species and four new island records (Golden-crowned flying fox *Acerodon jubatus*, Harpy Fruit Bat *Harpyionycteris whiteheadi*, Philippine Pygmy fruit bat *Haplonycteris fischeri*, and Large flying fox *Pteropus vampyrus*) were documented bringing the total record of Cebu to 13 species of fruit bats. Roosting colonies of flying foxes monitored over two years have shown marked reduction in roost counts indicating increased disturbance. Despite the relative difference in forest sizes, the smaller forest patch of Dalaguete recorded the highest number of fruit bats as compared to the larger forest in Alcoy. However, bat species (Harpy fruit bat and Philippine Pygmy fruit bat) more intolerant to habitat disturbances were captured only in Alcoy. Hunting, cutting of trees for charcoal, and habitat loss were among the major threats observed.

---

#### Introduction

The island of Cebu is the 9<sup>th</sup> largest in the country, located in central Philippines, and part of the Negros-Panay faunal region—a region composed of the islands of Negros, Panay, Masbate, Guimaras and Ticao. The islands of Cebu, Masbate, Ticao, and Guimaras have lost almost all of their original vegetation with only second growth and patches of secondary forests remaining in inaccessible areas (Stattersfield, Crosby, Long, & Wege, 1998; Heaney & Regalado, 1996; Heaney, Walker, Tabaranza, & Ingle, 2000; Heaney & Mallari, 2000; Rabor, 1959; and Uzzurum, 1992). Within the faunal region, a total of 14 species of fruit bats were recorded of which one (Philippine Bare-backed fruit bat *Dobsonia chapmani*) is endemic to the region and six are threatened species (IUCN 2004).

Very few studies on land mammals have been conducted in Cebu (Paguntalan, Pedregosa, & Catacutan, 2004; Heaney & Heideman, 1987; Rabor, 1977; Sanborn, 1952; Taylor, 1934). A total of ten species of fruit bats including the rediscovered supposed extinct Philippine Bare-backed fruit bat are known to occur in the island (Heaney *et al.*, 1998; Heaney *et al.*, 2000; Paguntalan *et al.*, 2004). Information was based on museum collections and studies conducted in Cebu. Based on these reports and collections, studies and surveys were limited to Naga, Central Cebu, Carmen and Buhisan. Most of these areas are now cultivated and badly degraded habitats of less than 100 hectares (Paguntalan *et al.*, 2004; Mallari, Tabaranza, & Crosby, 2001; Collar *et al.*, 1999). In 1999, an island-wide survey reported several patches of forests patchily distributed across Cebu (Gonzalez, Dans, Pedregosa, & Chiu, unpub.). These forest patches included Tabunan; Nug-as in Alcoy; Mt. Lantoy in Argao; Mt. Kambulagsing in Alegria; Mt. Capayas in Carmen – Catmon; Dalaguete forest patches, and Tuburan forests. Among these forest patches, three (Tabunan; Nug-as – Mt. Lantoy range and Mt. Kambulagsing in Alegria – Malabuyoc) were included as Key Conservation Sites (Mallari *et al.*, 2001).

A total of 25 species of fruit bats are recorded in the country (Ingle & Heaney, 1991; Heaney *et al.*, 1998) and the highest record for a single, small island is ten (Heaney *et al.*, 2000). The number of fruit bats recorded in Cebu was much lower than expected and reflects the inadequacy of data (Heaney *et al.*, 2000). However, most of the forests in Cebu were cleared in the early 19<sup>th</sup> century and by the 1970s, only 16% of the island was forested (Bullecer, 2006). It was suspected then that the loss of habitat was also coupled with the loss of its biodiversity (Heaney & Regalado, 1996; Heaney *et al.*, 2000).

The current survey visited a total of five forest patches distributed across the island. The forest patches varied in size and quality and very few studies have been conducted in these sites and only one has been published. We suspect that the larger forest patches and those with good habitat quality would hold more species of fruit bats than those smaller patches and badly degraded habitats. Caves were also visited to determine presence of cave-roosting fruit bats. No population estimates were conducted. Hence this study aims to generate baseline data for effective management tools in conservation of fruit bats in the island.

## Study Areas

### Tabunan Forest

The forest of Tabunan (TF) (Figure 1) forms a thin, segmented strip of forest on steep limestone hillside, with closed-canopy areas of only less than 10 ha (Orlanes, 2002). It is part of the Central Cebu Protected Landscape and managed by the Protected Area Management Board (PAMB). The elevation of the area ranges from 400 to 880 m above sea level. Common species of trees include *Ficus* species, *Homolanthus* sp., *Synzygium*, *Macaranga*, *Leeia* sp., *Sterculia philippinensis*, *Dillenia* sp., *Leucosyke* sp., *Diospyrus philippensis*, and *Mangifera* sp. Cultivated farms form the forest perimeter mostly planted with high-value crops, vegetables, ornamentals and cut flowers. A well-developed road from the Cebu Trans-central highway leads to a high concentration of village houses about 100 meters from the forest edge.

### Alcoy Forest

The Alcoy Forest (AF) (Figure 1) is lowland secondary limestone forest (300-900 m elevation) totaling more than 1000 ha including plantations and scrubland (Mallari *et al.*, 2001). The largest intact forest totals 780 ha covering four barangays, namely Nug-as, San Agustin, Atabay, and Poblacion, and managed by four local organizations through a Community Based Forest Management Agreement (CBFMA) with the Department of Environment and Natural Resources (DENR). Several plantations composed of Mahogany (*Sweitenia macrophylla*), Gmelina (*Gmelina arborea*), Eucalyptus and mountain agoho (*Casuarina rumphiana*) with Rattan (*Calamus* sp) surround the forest. Prominent species include *Artocarpus* sp., *Syzygium* sp., *Ficus* spp., *Casuarina rumphiana*, *Melia dubia*, *Macaranga* sp., *Cinnamomum cebuense*, and *Melastoma* sp. Vegetable farms were observed in between plantations, on forest edges and, in some cases, in gullies inside the forest.

### Dalaguete Forest

Dalaguete Forest (DF) is made up of three separate forest fragments namely: Babayongan-Bulak-Malones forest (500-800 m), Obo-Sacsac-Mantalongon (300-500 m) forest and the Obong-Caliongan forest patch (60-200 m) (Paguntalan *et al.*, 2004). The natural limestone

forest of DF is highly dominated by *Vitex parviflora*, *Buchanania*, *Ficus* and *Syzygium* spp. This forest type is confined to very steep areas where farming is very difficult. It is characterized by a relatively open canopy and small trees with height reaching up to 4 m to 5 meters. The other dominant plant species in the area are *Nauclea*, *Pittosporum pentandrum*, *Ficus pseudopalma*, *Dracaena*, *Sterculia philippensis*, *Leea manillensis*, *Leucosyke capitellata*, and *Breynia*. Large *Ficus* species are commonly located in riverbanks. Vines are abundant, creating an illusion of thick vegetation.

### **Mt. Lantoy Forest**

The Mt. Lantoy Forest (MLF) is located within the municipality of Argao. It is naturally bounded by the Argao River and was declared as watershed area under the initial component of NIPAS through Presidential Proclamation 414 known as the Argao River watershed forest reserve. The reserve covers some of the adjacent forest patches within the municipality, river banks, and several forest patches of Dalaguete.

Mt. Lantoy is a lowland secondary forest with typical karst limestone formation and elevation of up to 500 m ASL. There are some old grown trees along the river banks and along the hills. Plantations of exotic trees like *Gmelina arborea*, Mahogany *Sweetenia macrophylla*, Teak *Tectona grandis*, and Acacia *Samanea saman* surround the native vegetation. Fruit bearing trees like lanzones (*Lansium domesticum*) and Jackfruit (*Artocarpus*) were also planted along river banks and slopes. Farmlands and grazing areas dominate the landscape.

### **Carmen Forests (CF)**

The patches of secondary forest in Caurasan are limited to steep slopes and highly inaccessible areas. The forest approximately totals 60 ha dominated by typical secondary forest tree species including *Alstonia macrophylla*, *Macaranga* sp., *Ficus septic*, and *Mallotus* sp., all with average canopy height of four meters. Clearings inside the forests were planted with abacca *Musa textiles* and taro *Colocasia esculenta* while coconuts were planted between cleared portions of the forest. The majority of the surrounding local community are occupied in subsistence farming or making charcoal (mostly from forest trees).

## **Methods**

### **Mist Netting**

In order to catch and identify the fruit bats, mist-nets measuring 6 m long by 4 m wide with a 36 mm mesh size were used. Nets were set across and along trails, forest edge, forest gaps, forest interior, and river banks. Nets were set at least a meter to five meters above ground with some nets set along ridges (Ingle, 1993). A total of 15-18 mist nets were operated from 18:00hr till 06:00hr and were checked every hour to retrieve bats. Nets were closed during heavy rain. Captured bats were measured and weighed; sex and aged were determined and the bats were photographed and released. No voucher specimens were taken during the survey. Species identification was based on *A Key to the Bats of the Philippine Islands* (Ingle & Heaney, 1992) and in addition, photographs and biometrical measurements were verified by Dr. Larry Heaney of the Chicago Natural History Museum. Mist netting were conducted between August 21-30, 2003; November 20-23, 2003 in Dalaguete; February 27-March 3, 2001 and November 4-7, 2002 in Tabunan. A survey was also conducted in Alcoy from

March 21-25, 2004; November 11-14, 2002, and January 26-30, 2003; while Mt. Lantoy in Argao was visited on October 14-19, 2003. Carmen was surveyed in March 29-31, 2004.

### **Direct Roost Observation**

Roosting colonies of flying foxes in Malones-Lanao gulley in Dalaguete and in Tabunan were visited on five separate occasions. Bats were observed using 15–60X60 Bushnell Discovery spotting scope and 10 x 42 Audobon binoculars from 20-40 m distance from the roosting tree. At least three observers in three separate vantage points observed, identified, and counted roosting flying foxes. Each observer counted the bats at least two times and all three records were revalidated and averaged. Counting and identifying bats were conducted at 09:00hr up to 10:00hr. Species identification was based on known prominent physical characteristics and roosting patterns following identification techniques used by Mildestein, Stier, Nuevo-Diogo, & Mills (2005) and external characteristics based on Ingle and Heaney's *A Key to the Bats of the Philippine Islands* (1992) and verified on site by Apolinario Cariño. We estimate that we counted at least 80% of all individuals in the roost as roosting colonies were small and located in open habitats. In some instances when identification was difficult, individuals were not included in the analysis but were counted as part of the roosting colony. The average number of roosting bats per tree, the total number of roost trees in a roost site, and the species ratio in a roost site were determined. Locations of roosts were recorded using Garmin 12XL Global Positioning System. Threats to the roost sites were identified with the help of interviews with the locals and observations in the field. Tabunan roost was visited in May 2002, August 2002 and March 2003 while Dalaguete roost was visited on October 19, 2003 and January 31, 2004.

### **Results**

The study recorded a total of 12 species of fruit bats including the endangered Golden-mantled flying fox *Acerodon jubatus*, Philippine Tube-nosed fruit bat *Nyctimene rabori*, and vulnerable Large flying fox *Pteropus vampyrus*. Four species were recorded for the first time in Cebu namely, Harpy fruit bat *Harpionycteris whiteheadi*, Philippine Pygmy fruit bat *Haplonycteris fischeri*, Golden-crowned flying fox *Acerodon jubatus*, and Large Flying fox *Pteropus vampyrus*. Three new localities for Philippine Tube-nosed fruit bat *Nyctimene rabori* were added.

The most common species netted in all sites was the Common Short-nosed Fruit Bat *Cynopterus brachyotis* followed by Common Rousette *Rousettus amplexicaudatus*, then by Dagger-toothed Flower Bat *Macroglossus minimus* (Table 1). Of the five sites, Dalaguete recorded the highest number (10 species) of fruit bats followed by Tabunan (9 species) and Alcoy (8 species) (Table 1). Mt. Lantoy in Argao recorded the lowest number of fruit bats.

Table 1.

Total number of bats mist netted in Cebu.

Species	Common Name	T	D	A	ML	C
<i>Cynopterus brachyotis</i>	Common Short-nosed Fruit Bat	63	225	67	5	16
<i>Rousettus amplexicaudatus</i>	Common Rousette	23	21	9	6	40
<i>Ptenochirus jagori</i>	<b>Musky Fruit Bat</b>	28	8	8	2	2
<i>Macroglossus minimus</i>	Dagger-Toothed Flower Bat	9	16	23	2	2
<i>Eonycteris spelaea</i>	Common Nectar Bat	16	5	1	---	2
<i>Haplonycteris fischeri</i> *	<b>Philippine Pygmy Fruit Bat</b>	20	---	71	---	---
<i>Harpyionycteris whiteheadi</i> *	<b>Harpy Fruit Bat</b>	---	---	3	---	---
<i>Nyctimene rabori</i>	<b>Philippine Tube-nose Fruit Bat</b>	2	---	---	---	---
<i>Pteropus hypomelanus</i>	Common Island Flying Fox	---	5	---	---	---
<i>Pteropus pumilus</i>	<b>Little Golden-mantled Flying Fox</b>	6	1	---	---	---
<i>Pteropus vampyrus</i> *	Large Flying Fox	---	---	---	---	---
<i>Acerodon jubatus</i> *	<b>Golden-Crowned Flying Fox</b>	---	---	---	---	---
<i>Dobsonia chapmani</i>	<b>Philippine Bare-backed fruit bat</b>	---	---	---	---	---
<b>Total number of species</b>		<b>9</b>	<b>10</b>	<b>8</b>	<b>4</b>	<b>5</b>
<b>Total Net nights</b>		<b>108</b>	<b>88</b>	<b>52</b>	<b>50</b>	<b>9</b>

\* new records for the island.

T – Tabunan

D – Dalaguete

A – Alcoy

ML - Mt. Lantoy

C - Carmen

Among the five sites visited, only Dalaguete and Tabunan have roosting colonies of flying foxes. The colony in Dalaguete recorded four species of flying foxes namely the endangered Golden-Crowned Flying Fox *Acerodon jubatus*, Island Flying Fox *Pteropus hypomelanus*, Little Golden-mantle Flying Fox *Pteropus pumilus*, and the Large Flying Fox *Pteropus vampyrus* roosting in *Ficus* spp. The roost in Tabunan yielded only *P. hypomelanus* species although *P. vampyrus* was reported in the same roosting trees (*Ficus* and *Mangifera altissima*) in 1998 (Gonzalez *et al.*, unpub.). The presence of all four species in Dalaguete forests came as a surprise as *P. vampyrus* and *A. jubatus* are known to prefer tall dipterocarp forest although they use to some extent disturbed habitats (Mildestein *et al.*, 2005; Utzurum, 1992; Heaney & Heideman, 1987). The roosting tree was only eight and six meters tall, located on a steep ravine and beside a stream. This is the first time that *A. jubatus* was observed in Cebu

and the first time all four species of flying fox were observed roosting together in at least three roosting trees.

The species composition of the roosting flying foxes in Dalaguete varie over three years of monitoring (Table 2). During the first visit in 2003, all four species of flying foxes (*P. vampyrus*, *P. hypomelanus*, *P. pumilus* and *A. jubatus*) were observed roosting together in two roosting trees. When the roost was visited a month later, only two species (*P. hypomelanus* and *P. vampyrus*) were recorded in two roosting trees. In both occasions the bats were undisturbed by our presence and remained in their roosts throughout observation time. When the roost site was visited again in January 2004, all four species were recorded roosting together but had moved to a different roosting tree about 300 meters from the first roosting trees.

Table 2.

Species composition and population estimates of roosting colonies of flying foxes in two sites in Cebu Island (2002 to 2004).

	<b>A. jubatus</b>	<b>P. vampyrus</b>	<b>P. hypomelanus</b>	<b>P. pumilus</b>
<b>DALAGUETE</b>				
4 Sept. 2003	7	139	2024	19
19 Oct. 2003	---	343	573	---
31 Jan. 2004	5	353	407	8
<b>TABUNAN</b>				
May 2002	---	---	84	---
August 2002	---	---	74	---
March 2003	---	---	78	---

## New Island Records and Other Observations

### Flying foxes

Several individuals of Golden-crowned flying fox were observed roosting in the same tree with three other species (Large Flying fox, Island Flying fox, and Little Golden-mantled flying fox) of flying foxes. The *A. jubatus* was observed occupying the upper branches of a large-leaf *Ficus* tree with limited leaves on it. The roosting individuals appear to be evenly distributed in the branches. Individuals were of the same size as *P. vampyrus* but larger than *P. hypomelanus* and *P. pumilus*. Only those individuals positively identified based on the prominent light yellow or golden color on top of the head that extends down the back of the neck and shoulders were recorded as *Acerodon*. It is likely that some individuals were missed during the survey.

A total of 19 individuals of Little Golden-mantled flying fox were observed at one time roosting with other four flying foxes in Dalaguete forests. The species was identified based on its smaller size and body coloration. Six individuals were netted in a clearing beside secondary forests in one of the forest patches near Tabunan. One individual was caught on a

ridge near the roosting site in Dalaguete. It was observed that four *P. pumilus* skins were used as “scarecrows” in ricefields in Argao in March 2004. Three sub-adult female were netted and one juvenile male was caught in the month of March.

An average number of 278 individuals were recorded in Dalaguete. The bat was first reported in Tabunan but was not encountered during the roost counts in 2002 and 2003. Individuals were identified based on their relatively larger body size than *P. pumilus* and *P. hypomelanus* with generally dark brown or black coloration with a wide rusty orange color on the head extending towards the shoulders and forming an abrupt horizontal line (Mildestein *et al.*, 2005). Two *P. vampyrus* skins were observed used as “scarecrows” in ricefields in Argao in March 2004.

### *Haplonycteris fischeri*

A total of 71 individuals of *H. fischeri* were netted in forest interior and forest edges only in Alcoy and Tabunan forests. The average adult morphological measurements of the species (n=57) are the following: forearm: 51.43 mm (range: 45 -55.8mm); hind foot: 11.422 mm (range: 6.4 -19.7 mm); no tail; ear: 12.41 (range: 6-19.7 mm); total length: 68.49 mm (range: 63.5 - 88.1 mm); weight: 21.9 grams (range 4 – 45 g). Juveniles and sub-adults were recorded in the months of November, February, and March while lactating and pregnant females were netted in the months of November. Individual Pygmy fruit bats were observed roosting in understory trees or vines in forest interiors appearing like dead leaf.

### *Nyctimene rabori*

The species was caught in Tabunan in February 2001. The species is quite rare in Cebu but was caught in several degraded habitats and clearings beside second growth areas. Two individuals were reportedly caught in Cambantug, Argao in April 2005 and one was netted in Kawasan Falls, Badian (H. Albuero, pers. comm.). The bat was also netted in 1999 in Tabunan forest (Gonzalez *et al.*, unpub.) and in Alcoy in April 2001 (Pedregosa, unpub.). Two sub-adults (one male and one female) were netted in the month of March 2001.

### *Harpionycteris whiteheadi*

A total of three individuals were netted in Alcoy including two lactating females with young attached to its body in November 2002. A roosting colony of Harpy fruit bats were also observed in the understory tree in the forest interior in Alcoy. This is the first time the species was encountered and recorded in Cebu and this bat was encountered only in Alcoy forest.

## Threats

Of the five sites visited, Mt. Lantoy in Argao records the highest threats in terms of hunting and habitat destruction. Hunters from adjacent municipalities and the local residents of the uplands of Argao hunt bats in known fruiting trees and clearings between forest patches mainly for food. The effect of extensive hunting activities were demonstrated when a total of 18 mist nets set along ridge tops, fruiting trees, clearings and forest edges did not yield a single individual for three nights sampling. Only a total of 15 individuals composed of four common species were caught in 50 net-nights. Local lanzones (*Lanzium*) growers set nylon lines with hooks around the branches of fruiting trees to capture bats and prevent damage of the fruit or shooting them with gun or airgun to disperse them from feeding on the lanzones

fruit. Flying foxes (*P. vampyrus*, *P. pumilus* and *P. hypomelanus*) were also observed used as “scarecrows” in rice paddies. These incidents have been reported to the PAMB and CENRO-Argao in 2003 but two *P. hypomelanus* and two *P. pumilus* skins were seen hanging from a bamboo pole in the rice fields along the national road in January 2007.

A visit to Casiyay Cave in Argao also showed traces of hunting activities where torches, left-over fire inside the cave, plastics, cans, bottles, vandals and guano extraction were observed. Indigenous traps made up of thorny vine or rattan shaped like a big fly swat tied to a bamboo pole and thorny vines or rattan tied to form a large thorny broomstick were kept in houses and used for hunting and collecting bats either in cave openings or near fruiting trees and ridges. Locals have reported that in the late 1990s they would catch about half a sack or a sack full of bats in just two hours of hunting near cave openings or in fruiting trees. In 2004, they would hunt for five to six hours just to get about 200 individuals of bats. After asking questions and asking locals to describe and identify the bats that were usually hunted in caves and fruiting trees, *Rousettus*, *Cynopterus*, *Ptenochirus*, *Eonycteris*, and even insect bats were taken as food.

### Discussion

The known records of fruit bats in Cebu are only nine species including the rediscovery of the supposed extinct Philippine Bare-back fruit bat *Dobsonia chapmani* in 2001 (Paguntalan *et al.*, 2004; Heaney *et al.*, 2000; Heaney *et al.*, 1998). The additional records of this study bring the total number from nine to 13 species of fruit bats including four new island records (*A. jubatus*, *P. vampyrus* *H. whiteheadi* and *H. fischeri*).

The presence of four species of flying foxes roosting together in badly degraded habitat was surprising. Large flying fox were reported in many instances to roost together with Golden-crowned flying fox and in some instances with Island flying fox in other parts of the Philippines (Mildestein, 2005; van Weerd, Guererro, Tarun, & Rodriguez, 2003; Mickleburgh, Hutson, & Racey, 1992), but not to share the same roost with three other species of flying foxes. This is the first time all four species were recorded roosting together in the Philippines. The distribution of the species within the tree also showed variation. The Golden-crowned flying foxes were roosting in one section of the tree equally spaced from each other while the Large flying foxes were roosting in small groups of three to five individuals occupying same branches with Island Flying Fox located in the topmost and outermost branches of the tree. The Little Golden-mantled flying foxes were occupying the lower branches roosting in small groups. We suspect that *A. jubatus* is a temporary member of the colony, roosting temporarily as it moves between islands. Flying foxes are capable of making long distance foraging flights (Shilton, Altringham, Compton, & Whittaker, 1999) and several roosting colonies have been identified in Negros and Bohol islands, both a distance of less than 50 km from Cebu island.

The composition of the roosting flying foxes also varied. As expected, more Island Flying foxes were observed as compared to the other four species with Golden-crowned flying fox being the smallest colony. We counted more Large Flying fox than expected (with numbers more than half of the Island flying foxes) considering that the area is badly degraded. Previous studies showed that Large Flying fox and Golden-crowned flying fox use both disturbed and undisturbed tall, dipterocarp forests (Mildestein *et al.*, 2005; Heideman & Heaney, 1992b; Rickhart, 1993, and Uzzurum, 1992). The presence of both species roosting in badly degraded second growth habitats tells something about the ability of the species to



persist in disturbed areas when there are few options left. While Alcoy forest is less than 10 km away from Dalaguete forest, the ravine in Dalaguete offers better protection to the species compared to the hilly landscape in Nug-as. Flying foxes were also known to use riparian areas or close to body of water (Mildestein *et al.*, 2005) such as in Dalaguete. This could partly explain why there are no flying foxes in the larger and better forest habitat in Alcoy as there are no rivers or streams in the area.

None of the small and medium-size strict forest resident species (e.g. Harpy fruit bat and Philippine Pygmy fruit bat) were recorded in Dalaguete. Alcoy forests which have a better secondary forest cover recorded both *H. fischeri* and *H. whiteheadi*. Despite the relatively good quality forest left in Tabunan, only *H. fischeri* was recorded and no *H. whiteheadi* were caught in mist-nets.

*Haplonycteris fischeri* was common in Alcoy and uncommon in Tabunan forest patches and was not encountered in the other three forest patches. Among the three forest patches, Alcoy and Tabunan forests have taller and bigger trees, defined stratification and are less disturbed compared to Carmen and Mt. Lantoy in Argao. Among the forest patches, Alcoy forest is the largest, followed by Tabunan, Carmen then Mt. Lantoy Argao. The difference in quality, extent of disturbances and size of the forest may explain the absence of the Pygmy fruit bat in Mt. Lantoy in Argao and Carmen and its numerous captures in Alcoy compared to Tabunan forests. The bat is known to strongly prefer good quality forest habitats over degraded ones (Utzurum, 1992). Within the island of Cebu, the only remaining forest that closely resembles good forest is Alcoy and Tabunan forests.

The Pygmy fruit bat and the Harpy fruit bat were not recorded in the earlier collections. Cebu was reportedly badly degraded and lost most of its forest cover in the late 1950s (Rabor, 1959). Remnant populations of these species may have survived within the second growth forests in the late 1950s up to the present. The forest of Alcoy and Tabunan are separated by at least a 100 km distance and in between remnant second growth areas (e.g. Mt. Lantoy) exist and yet the Harpy and Pygmy fruit bat were not found there.

### **Conservation Initiatives and Management Implications**

The information generated from the study has been used as basis to campaign for the conservation of bats in Cebu emphasizing the role of bats as pollinators and agents of forest regeneration. Based on our studies, the municipal government of Dalaguete implemented the Dalaguete Biodiversity Conservation Management Programme (DBCMP) using flying foxes as flagship species and created the office of the Municipal Agriculture and Natural Resources Office (MANRO) to develop and implement the five-year development plan for the programme. Local forest guards (Dalaguete Bantay Lasang Task Force) were appointed by the municipality to protect the forest and wildlife within the wildlife sanctuary. In Alcoy, local forest wardens take part in regularly monitoring caves with roosting colonies of bats. In Carmen, local environmental guards were appointed by the municipality mainly to protect cave roosting bats with particular emphasis on the Philippine Bare-back fruit bat.

While it is important to continue conservation initiatives in Dalaguete, Carmen and Alcoy, it is also imperative to engage the cooperation of neighboring municipalities e.g. Argao, for the conservation and protection of bats. Interventions should incorporate conservation education both at the local and provincial level. More attention should be given to areas where bats are popularly hunted by the locals, e.g., Argao.

## Acknowledgements

This project was primarily supported by United Nations Development Programme Global Environment Facility Small Grants Programme and the Rufford Small Grants Programme, North of England Zoological Society - Chester Zoo, British Embassy, BAT Biodiversity Partnership Fund, Rotary Club of Mandaue East and AZA Bat Taxon Advisory Group Small Grants Program. We thank Dr. Larry Heaney, Dr. Nina Ingle, Jodi Sedlock and Apolinario Cariño for reviewing the manuscript. We would like to thank Juan Carlos Gonzales, Marisol P. Hospodarsky for sharing their 1998 and 2001 data and Hemres Alburo for sharing information on *Nyctimene rabori*.

We also acknowledge the invaluable contributions of the following persons: William Oliver of the Philippine Biodiversity Conservation Programme of Flora and Fauna International-Philippines; A.B. Cariño, M.J.G. Catacutan, O.O. Roxas, M. Cordova, V. Linggo; C.R. Montecillo; G. Boysillo; G. Bejec; G. Geagonia; Mayor N. de los Santos of Alcoy; Mayor R.A. Cesante of Dalaguete; Mayor W. Caminero of Argao; Vice-Mayor Villamor of Carmen and Hon. G. Villamor; Central Cebu Protected Landscape PAMB; DENR-PAWD 7; For. L. Rivac; For. M.R. Salmago; L. Saldanas of CENRO Argao; A. Limas; I.J. Modesto; Barangay Tabunan Council; Kapunungan sa Mag-uuma sa Yutang Lasangnon sa Bulalacao (KMYLB); Alps Mountaineering Society and Geospicus Cavers Club.

## References

- Alcala E.L., Paalan, R.B., Averia, L.T., & Alcala, A.C. (2004). Rediscovery of the Philippine Bare-Backed Fruit Bat (*Dobsonia chapmani*) in Southwestern Negros Island, Philippines. *Silliman Journal*, 45, 2, 123-136.
- Bullecer, R., Elago, E., Embalzado, F. Jr., Escobido, G.M., Gonzaga, M., Largo, M.L., Layese, J. Jr., Limocon, M., Moneva, L., Blanco, L.A., & Lucero, R. (2006). Review and evaluation of Community-based Tenure Instrument in Central Philippines: Certificate of Stewardship Contract (CSC) and Community-Based Forest Management Agreement (CBFMA). Digital Library of Commons.
- Cariño A.B. (2004). Studies of Fruit Bats on Negros Island, Philippines. *Silliman Journal*, 45, 2, 137-159.
- Collar, N.J., Mallari, N.A.D. and Tabaranza, B. Jr. (1999). Threatened Birds of the Philippines: the Haribon Foundation/BirdLife International Red Data Book with contributions from Crosby, M.J. Long, A.D., Lowen, J.C., Tobias, J.A. and Villasper, J.M. in collaboration with Department of Environment and Natural Resources and The Environment Agency of Japan. Bookmark: Makati City.
- Gonzalez, J.C.T., Dans, A.T.L., Pedregosa, M.dG., & Chiu, S.C.H. (1998). Cebu Biodiversity Conservation Project: A report on Island-wide survey of forests and inventory of selected sites for priority conservation on Cebu. Unpublished report submitted to Darwin Initiative and Fauna and Flora International.
- Heaney, L.R., Gonzales, P.C., & Alcala, A.C. (1987). An annotated checklist of the taxonomic and conservation status of land mammals in the Philippines. *Silliman Journal*. 34, 1-4, 32-66.
- Heaney, L.R., Balete, D.S., Dolar, M.L., Alcala, A.C., Dans, A.T.L., Gonzales, P.C., Ingle, N. R., Lepiten, M.V., Oliver, W.L.R., Ong, P.S., Rickart, E.A., Tabaranza, R.B., & Utzurum, R.C.B. (1998). A synopsis of the mammalian fauna of the Philippine Islands. *Fieldiana: Zoology series*. Chicago: Field Museum of Natural History.
- Heaney, L.R., & Regalado, J.C., Jr. (1998). Vanishing treasures of the Philippine rain forest. Chicago: Field Museum of Natural History.
- Heaney L.R., Walker, E.K., Tabaranza, B.R. Jr., & Ingle, N.R. (2000). Mammalian diversity in the Philippines: An assessment of the adequacy of current data. *Sylvatrop*, 10, 1 & 2, 6-27.

- Heaney, L.R. (1993). Biodiversity patterns and the conservation of mammals in the Philippines, Asia. *Life Sciences*, 2, 261-274.
- Heaney, L.R. (2004). A second chance to avert extinction: Good news for Philippine biodiversity. *Silliman Journal*, 45, 2, 111-112.
- Heaney, L.R. & Heideman, P. (1987). Philippine fruit bats, endangered and extinct. *Bats*, 5, 35.
- Heideman, P.D., Heaney, L.R., Thomas, R.L., & Erickson, K.R. (1987). Patterns of faunal diversity and species abundance of non-volant mammals on Negros Island, Philippines. *Journal of Mammalogy*, 68, 884-888.
- Ingle, N. R., & Heaney, L.R. (1992). A Key to the Bats of the Philippine Islands. *Fieldiana: Zoology new series*, 69, 1-44.
- Ingle, N.R. (1993). Vertical stratification of bats in a Philippine rainforest. *Asia Life Sciences*, 2, 215-222.
- Mallari, N.A., Tabaranza, B., & Crosby, M. (2001). Key Conservation Sites in the Philippines. Manila: Bookmark.
- Mickleburgh S.P., Hutson, A.M., & Racey, P.A. (1992). Old World Fruit Bats: An Action Plan for their Conservation. IUCN.
- Mildenstein, T., Stier, S., Nuevo-Diago, C.E., & Mills, L.S. (2005). Habitat selection of endangered and endemic Large Flying-Foxes in Subic Bay, Philippines. *Biological Conservation*, 126, 93-102.
- Oliver, W.L.R., Dolar, M.L., & Alcala, E. (1992). The Philippine spotted deer, *Cervus alfredi* Sclater, conservation program. *Silliman Journal*, 36, 1, 47-54.
- Orlanes O.B. (2002). Ecological dynamics of the Tabunan Forest. Unpublished Master's Thesis. University of the Philippines at Los Baños, Laguna.
- Paguntalan, L.M.P., Pedregosa, M.dG., & Catacutan, M.J.G. (2004). Rediscovery of the Philippine Bare-backed fruit bat *Dobsonia chapmani* Rabor, 1952 on Cebu. *Silliman Journal*, 45, 2, 113-122.
- Pedregosa, M.dG. (2000). The conservation status of Alcoy forests. Unpublished report submitted to North of England Zoological Society–Chester Zoo.
- Rabor, D.S. (1952). Two new mammals from Negros Island, Philippines. Natural History (Chicago Academic Science). *Miscellanea*, 96, 1-7.
- Rabor, D.S. (1977). Philippine birds and mammals. Quezon City: University of the Philippines Press,
- Rickart, E.A. (1993). Diversity patterns of mammals along elevational and disturbance gradients in the Philippines: Implications for conservation. *Asia Life Sciences*, 2, 251-260.
- Rickart, E. A., Heaney, L. R., Heidemann, P.D., & Utzurrum, R.C.B. (1993). The distribution and ecology of mammals in Leyte, Biliran and Maripipi Islands, Philippines. *Fieldiana: Zoology*, n.s., 72, 1-62.
- Sanborn, C.C. (1950). New Philippine fruit bats. Proceedings of the Biological Society of Washington, 63, 189-190.
- Shilton, 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. Proceedings of the Royal Society of London. Biological Sciences series, 266, 1416.
- Stattersfield, A.J., Crosby, M.J., Long, M.J., & Wege, D.C. (1998). Endemic bird areas of the world: Priorities for biodiversity conservation. Cambridge, U.K.: BirdLife International. Conservation Series 7.
- Taylor, E.H. (1934). Philippine land mammals. Monograph, 30. Manila: Bureau of Science, 1-548.

Utzurum, R.B. (1992). Conservation status of Philippine fruit bats (Pteropodidae). *Silliman Journal*, 36, 27-45.

Van Weerd, M., Guererro, J.P., Tarun, B. A., & Rodriguez, D.G. (2003). Flying Foxes of the Northern Sierra Madre Natural Park. *The Sierra Madre Mountain Range: Global relevance, local realities*. Tuguegarao, Cagayan Province: Golden Press, 54-62.

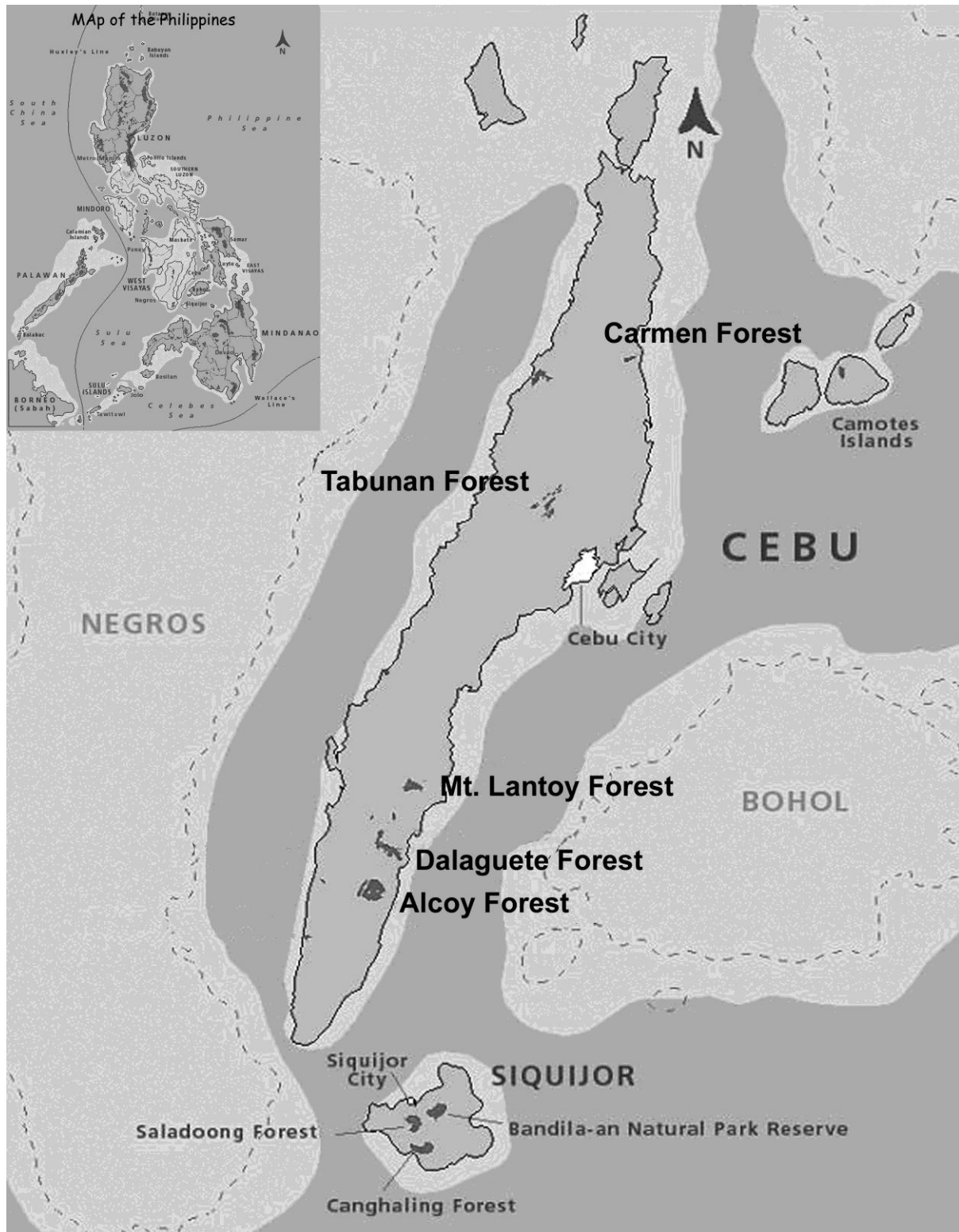


Figure 1. The map of Cebu showing the five study sites.