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Research article

Characterization of the Roosting Sites of the Golden Crowned Flying Fox (*Acerodon jubaus*) and Philippine Giant Fruit Bat (*Pteropus vampyrus*) and Their Effects on Dipterocarp Forests

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ABSTRACT. In determining the causes of mortality in White lauan (*Shorea contorta*) at the bat roost area, physical observation and soil physico-chemical analysis were done. Likewise, the physico-chemical analysis revealed that there is no significant difference on the soil nutrient in both roosting and non-roosting site. Hence, this finding confirms that bat droppings may not be the cause of death of the White lauan trees.

Data analysis shows that vegetation structure in the bat roost area is significantly different with that of in the control plots or non-roost area. Such findings were accounted for the limited number, size and maturity of plant species found in the roost area. On the other hand, the roost area can be considered as disturbed forest with the presence of pioneer species and gap formed by dead trees which drive the bats to move to the inner part of the forest.

The tight roosting characteristic or activity of bats on the branches and twigs that results to defoliation of trees is suspected contributory factor in the mortality of the White lauan species as supported by its sensitive characteristics such that they become intolerant as they grow to maturity. To address the issue, recommendations were provided for the conservation and management of these endangered and threatened species.

Key words: *Shorea contorta, Acerodon jubatus, Pteropus vampyrus,* endemic Philippine bats

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INTRODUCTION

There are more than 1,000 species of bats worldwide. They are the only flying mammals in the world. Many of them are nearly going extinction. From 1986, only 12 species of bats were listed under IUCN red list but after a span of four years, 54 species were listed and four of them had become extinct by 1992 (Ang, 1998). In Southeast Asia, 63% of the fruit bats are threatened. Among the large fruit bats endemic to this region (genera *Acerodon, Dobsonia, Pteropus*), 75% are threatened (Mildenstein, 2002). Old world fruit bats, also called flying foxes, are members of the single family *Pteropodidae* in the *megachiropteran* suborder. These bats are distributed throughout the Old World tropics, from Africa through Southeast Asia and in the South

Pacific Islands. IUCN (2000) listed over 55% of these bats as threatened and endangered. *Pteropus mariannus* in the Marianas Island and Guam flying fox (*Pteropus tokudae*) have disappeared completely due to massive hunting. Bat is one of the sources of meat in this island. In Thailand, the flying foxes (*Eonycteris spelae*) are skinned and openly sold in the public markets (Ang, 1998). One of more fortunate species, *Pteropus rodricensis* or Rodriguez flying fox, in Rodriguez Island was saved from extinction by its local government. Realizing their decreasing population, the government took the initiative to stop the destruction of their habitat and planted fruit trees for their nourishment and trees for their roosting.

In the Philippines, there are at least 73 species of bats of which 25 are fruit bats. Sixty percent of the 25 recognized species of fruit bats are endemic. Ten of Philippine fruit bat species are listed as threatened and endangered (IUCN, 2000). The Panay fruit bat (*Acerodon lucifer*) has not been seen since 1998 while the bare-backed bat (*Dobsonia chapmani*) and tube-nosed bat (*Nyctimene rabori*) of Negros are now considered extinct as a result of destruction of their habitat and over hunting for consumption by some local inhabitants (Ang, 1998).

Today, two species of flying foxes are found in the forested mountain of Subic Bay. The Giant Fuit Bat or the Giant Flying Fox (*A. jubatus*) is the largest with a wingspan of up to two meters, weighing from 1 to 1.5 kg and comes in two colors, either in black or with reddish brown fur covering the forehead, neck, shoulders and back and it endemic to the Philippines (Figure 1). The Golden Crown Flying Fox (*P. vampyrus*) is the second largest bat in the world with up to 1.5 meters wingspan and weighs 1 kg. It has a golden patch of fur on its forehead that often narrows between the ears and over the back. Its geographic distribution is Southeast Asia (Figure 2). Although conservation status of the Philippine Giant fruit bat is already vulnerable, its neighbor Golden Crowned Flying fox is already listed as endangered (Mickleburgh, *et. al.*, 1992; IUCN, 2000). Rough estimate of the Subic Bay's flying fox colony size in 2004 is 80,000 individuals (SBMA Bat Count, 2004).

Today, flying foxes are threatened with unregulated hunting and continuous loss of habitat. Known for their exotic taste, bat meat is now of high demand in several local markets and restaurants. Bats are easy hunting target in the wild for indigenous and non- indigenous Filipinos. Government focuses its bat conservation efforts on the illegal hunting by non-indigenous hunters but the Aetas, an indigenous group, has been given the right to hunt wildlife, including bats.

A study done by Mildenstein (2002) identified several areas in Subic Bay forest where bats usually forage. Since most of the hunting occurs at night, this is useful information to limit poaching by patrolling the target areas. Loss of habitat is of prime consideration in the conservation of bats. Several causes of forest degradation are accounted to forest fire, timber harvesting, illegal logging, fuel wood, timber poaching, burning, encroachment, conversion to agricultural production areas and industrial development.

The dipterocarp species in the Philippines is suffering from over exploitation for its timber (Ashton, 1998). All of these species are endemic to the Philippines. Their unusual interaction was observed in the forests in the Subic Bay Forest Reserve (SBFR).

In one of the bat roosting areas in SBFR showed that the While lauan (*Shorea contorta*) are used as roost trees and often lead to death and/or slow regeneration of the tree species. A large number of these trees are

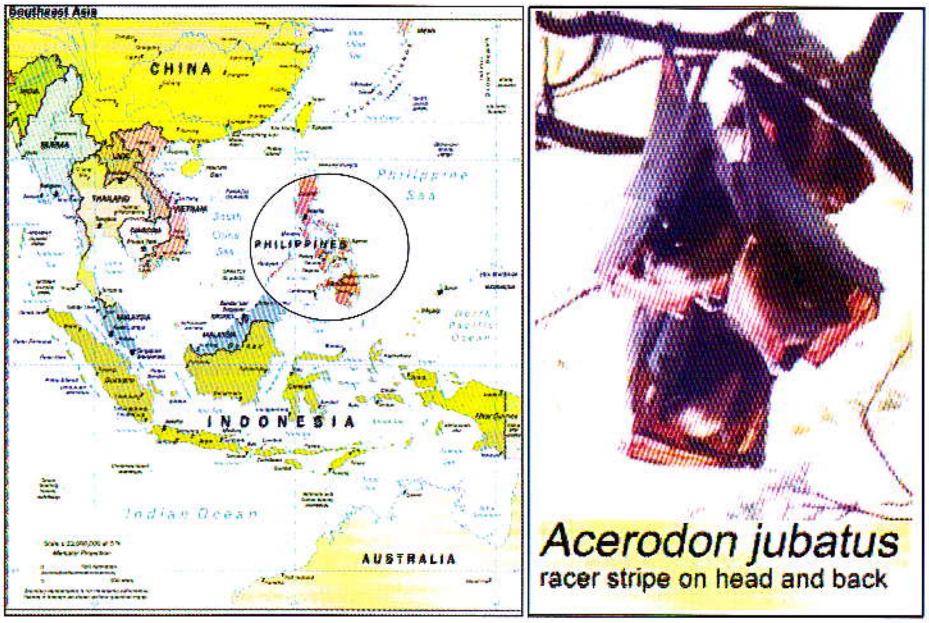

Figure 1. Species distribution of *Acerodon jubatus* in the Philippines

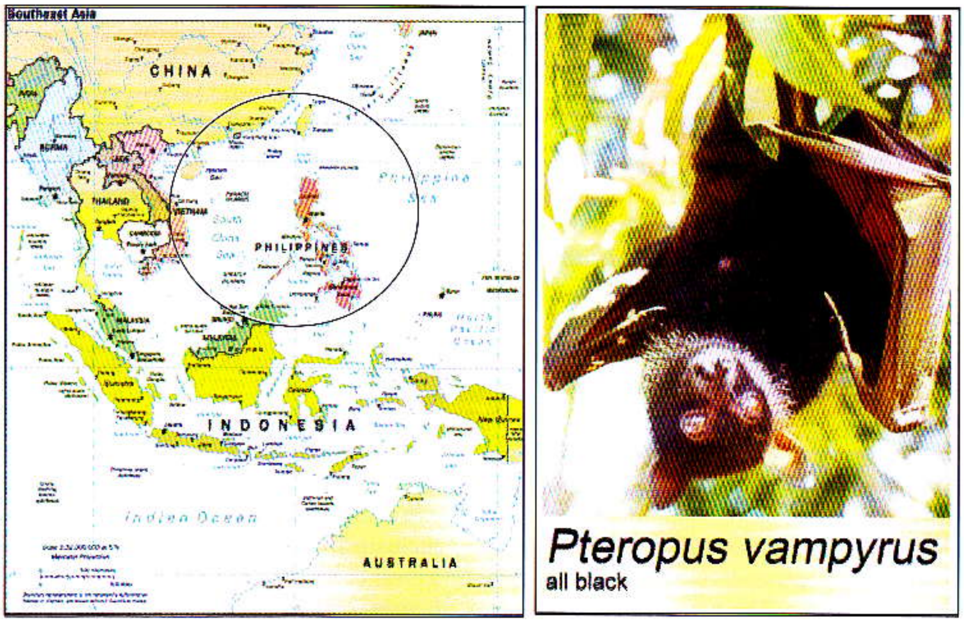

Figure 2. Species distribution of *Pteropus vampyrus* in Asia

now found affected in the area. Not much is known about the impact of bat roost on tree growth and development specifically on White Lauan. Hence, characterization of the vegetation of roosting site and the symbiotic effect of bats on trees is needed to serve as basis for the conservation, regeneration and management of Subic Bay's bats and White Lauan's dwindling population.

The following are the objectives of the study:

1. To determine the vegetation structure in the bat roosting and non-roosting areas;

2. To determine the causes of mortality in White lauan trees (*Shorea contorta*) at the bat roost area through physical observation and soil physico-chemical analysis; and

3. To develop appropriate management recommendations for the conservation of Golden Crowned Flying Fox (*A. jubatus*), Philippine Giant Fruit Bat (*P. vampyrus lanensis*) and their roosting areas.

Study area

The Subic Bay Forest Reserve (SBFR), lies on the northwestern slopes of Mt. Natib, at the southern portion of the Zambales Biogeographic Zone, southwestern Luzon, Philippines . It is approximately 9,856 hectares and is noted for high level of diversity and endemism, which makes it a priority site for the National Integrated Protected Areas System (NIPAS).

Physical characteristics of this forest showed soil texture of generally clay to clay-loam and generally acidic. The topography of the area is characterized by series of narrow valleys separated by ridges. It extends from sea level along the coast to 585-meter volcanic vent, Mt. Sta. Rita and Hill 394 (Stier, 2003). Annual rainfall is 3,582 mm with rainy season from June to October (89.4%) (URS, 2001). The rest of the year is dry, with January to March being the driest (URS, 2001).

SBFR is host to the Philippine Giant Fruit Bat and the Golden Crowned Flying Fox, roosting on 26 hectares of the forest reserve and are specifically located at the southeastern part of Crown Peak Gardens. The roost of these bats is composed mainly of dipterocarp trees. The White lauan is one of the dominant species in dipterocarp forest of Subic Bay and the favorite tree species for roosting of the bats (URS, 2001 as cited in Rojo and Aragones, 1997). Aside from growing well up to a height ranging from 45 to 60 m and a trunk diameter of about 1.8 meter, this species makes an excellent tree for lumber manufacturing and habitat for wildlife species (Ganapin, 1985). It is usually found in the low lands to about 700 meters above sea level (URS, 2001).

Moreover, the reserve has diverse ecosystems for both flora and fauna. Fernando (1998) has recorded a total of 118 species of wildlife vertebrates and a total of 745 plant species.

METHODS AND MATERIALS

Flora inventory

The study was conducted in January 2004 to March 2004.

Flora inventory was done using stratified random sampling on two study sites: (1) the bat roost area and (2) the area outside of roost site to serve as the control (Figure 4). The inclusion of non-roost area was made to have a clear comparison and to draw the difference between the two areas.

The study area was divided into grid lines. Parallel transect lines 100 meters apart were drawn on a map to cover the entire roost area

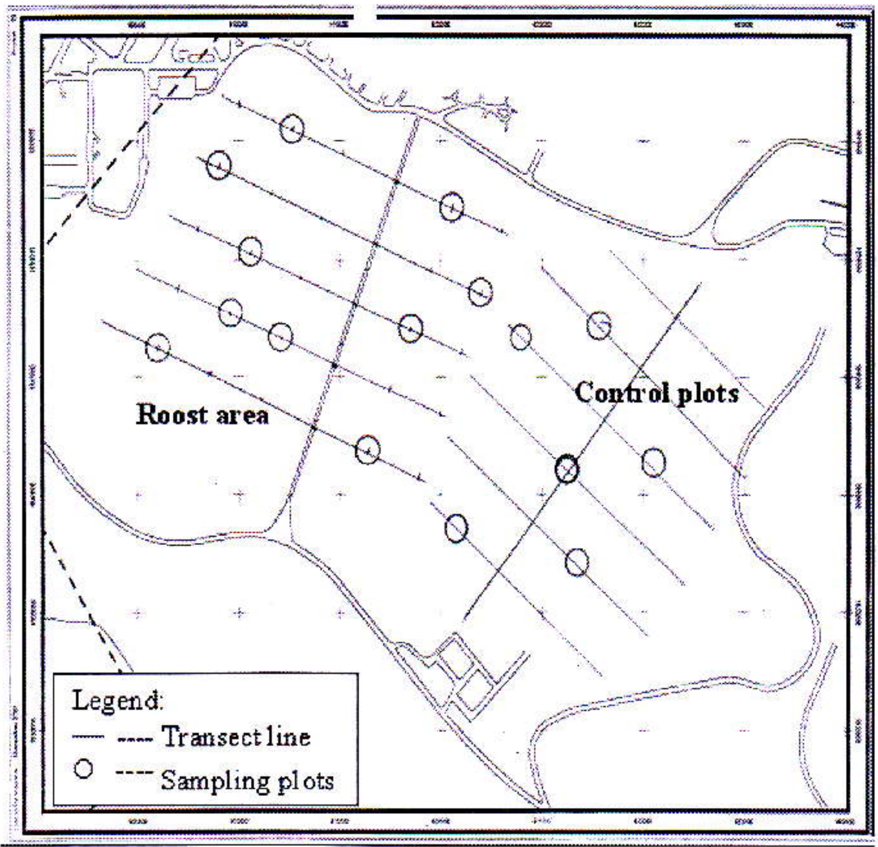

Figure 4. Sampling Plots in Bat Roost Area and Control Plots

and plots were located every 100 meters along each line. The electrical power line from the Navmag sentry to Upper Cubi Housing with length of about 580 meters was used as reference line/base line since it goes through/ traverses the bat roost area.

Each plot was established using a compass and a meter tape. All dead trees located within the 10-meter wide trail path during trail plot establishment were recorded.

Ten plots were established in the whole roost area. These sample plots coded as 1 to 10 with area of 10m x 10m were established. In each sample plot, heights of all species with 15 cm in trunk diameter and above were identified, counted, and measured. For unidentified species, leaves were collected for later identification. A 5m x 5m subplot was also located at one corner of the 10m x 10m plot. In this smaller plot, all tree saplings 15 centimeter in diameter and below as well as other species were identified, counted and recorded such as rattans, bamboos and other plant species. Furthermore, a 1m x 1m plot was also located within the 10m x 10m plot. Here, all wildlings and other smaller plants (one meter and below) within the plot were likewise identified, recorded and counted.

Plots # 8 and # 9 in the roosting area were removed during data analysis since these plots fell outside of the roosting site. As such, only 8 plots were considered in the analysis.

Six (6) sample plots were made in the area outside of the roost site, which serves as the control. A simple random sampling was used to allocate the plots in the area (*No reference*). Each plot was located on the ground using a compass and a meter tape. The same procedures and plot measurement were used on this area.

Dead White lauan trees that falls within a plot were counted. Soil samples were taken and analyzed to find out if the soil nutrient is the one causing the death of these trees.

Soil sampling

Soil samples were taken using a soil auger boring equipment. One kilogram each of soil samples was taken at different soil depth as follows: 0 – 20 cm, 20 – 50 cm, 50 – 100 cm and 100 – below (Figure 5).

For the bat roost area, 3 sample plots were taken on pre-identified locations under (1) deceased, (2) dying and (3) healthy White lauan tree. This procedure was done to compare if the soil nutrient within each tree varies.

On the other hand, two sample plots were also taken outside of the roost area. One plot was taken on the lower slope while the other one was taken on the upper slope of the area.

Data Analysis

For flora analysis, Shannon and Simpson's indices were used in determining vegetation diversity of the area. To test the hypothesis that soil nutrient of the roosting area is different to non-roost, the t-test was used to determine the difference or condition of vegetation between the roosting and non-roosting area.

For soil analysis, samples were brought to the Bureau of Soils and three basic parameters such as soil pH, nitrogen and phosphorous were analyzed. Using the same hypothesis, a Chi-square test was used to compare the soil chemical content of the roost and non-roost area.

Figure 5. Soil sampling activity

RESULTS

Vegetation Analysis

Kupang (*Parkia roxburghii)* and White lauan (*Shorea contorta*) were observed to be present in most of the 10x10 plot in the roost area. Similarly, both species were the most frequent and highest in density. White lauan was counted the most number of individuals followed by Kupang. However, Kupang was the most dominant species in terms of importance value seconded by White Lauan.

It was observed that Kupang could accommodate more bats than White lauan. A 100 cm-diameter of White lauan can accommodate 150 to 200 bats or more while the same diameter of Kupang can accommodate 400 to 500 depending on its branches.

There are ten identified tree species in both the 10x10 and 5x5 plots in the control plots and only four species in the 1x1 plot. In contrast, in the roost area, there are twelve identified species in the 10x10 plots, 23 in the 5x5 and 11 in the 1x1 plots (Appendix 1). The obtained increase in the number of species in the roost area compared to the control plots can be attributed to the gaps or openings made by falling branches and death of the White Lauan species (Figure 6). It was observed that most of the species in the roost area are pioneer species as a result of the gaps formed.

The original roost site is now dominated by bamboo particularly the Bikal (*Dinochloa acutiflora*) and buho (*Schizostachyum lumampao*). These species belong to the grass family that can thrive in open and infertile soils. Grass, such as bamboo grow early in the succession, they have a distinct competitive advantage over the later germinating and slower growing mature phase of native species (Kooyman & Faught, 1996). Bamboo invasion is one such blocking influence and is probably the number one ongoing management problem for anyone involved in regeneration of local parks or protected areas such as in Subic Bay.

Figure 6. Photo showing dead White lauan trees and bats roosting on live trees

Other species like Uoko *(Mekania cordata)*, Rattan (*Calamus sp.*), Palasan (*Calamus merrilli*), *Chromolaena odorata* and other small vines and creepers dominate the roost area. Inventory shows that there are more species at the roost area compared to the area outside the roost site. Most of these are pioneer species. Pioneer species establish themselves by taking advantage of canopy light created by dead trees. In plant succession, pioneer species rapidly form a new canopy suitable for more shade-tolerant species to colonize.

Kooyman & Faught (1996) cited that, when gap is created in the canopy of the mature forest there is an immediate growth response. Saplings of the mature canopy trees are usually waiting as suppressed individuals in the understorey. The seedlings of the slow growing canopy trees are able to exist for many years under the shade of the canopy just waiting for a large tree to fall.

Vegetation in the roosting site for the 10x10 plots is significantly different from the non-roosting or control plots as shown on the calculated t-test (Table 1). This may be due to high mortality of some big trees in the roosting area. Likewise, small trees 15 cm and below for the 5x5 plots and undergrowth for the 1x1 plots in the roosting area are significantly different from the non-roost area or control plots which means that there are more species recorded in the roost area compare to non-roost area. Table 2 shows that the mean species abundance in the roost area is higher than the control plots. This can be best explained to the observation that pioneer species occupy the gaps formed by dead trees. Categorically, roost site is a disturbed forest because of the presence of number of dead trees. Open or disturbed areas received enough energy from the sun and this condition favors the growth and survival of pioneer species. On the other hand, for the closed canopy or disturbed forest such as the control plots, young regenerants are limited.

Table 1. Species abundance in roosting and non-roosting sites (t-test)

	10 x 10 (trees > dbh)	5 x 5 (trees < dbh)	1 x 1 (understorev)
t-test computed	16.47*	24.13*	4.94*
t-test tab, α= 5%	2.1%	2.18	2.18

* - The roost area and control plots differed significantly (P<0.05, t-test)

Table 2. Mean species abundance in roosting and control plots

Samples	Control plots	Roost area
Trees >15cm dbh(10x10 plots)	3.5	3.6*
Trees<15cm dbh(5x5 plots)	2	10.6*
Understorey(1x1 plots)	1	2.5*

* - Means between roost area and control plots significantly different (P<0.05, t-test)

Most of the energy coming from the sun are trapped at the upper canopy and only a minute amount of energy are received by the undergrowth, thus limiting the growth of plants in the lower canopy.

Soil Analysis

The result of the soil chemical analysis shows that most of the plots have the same level of soil nutrients (Table 3). Soil pH for both sites range from 5.2 to 6.16. This range is still favorable for the plants although such pH level is on the boundary of becoming acidic.

On the other hand, the nitrogen content in all plots is relatively close to each other. Plot D has the highest N content with 0.0711 percent followed by Plot 1 with 0.058 percent. It was observed that nitrogen is higher in 0-50 cm soil depth (Table 4).

Urine of animals according to Foth (1951), contributes a lot in the nitrogen content of the soil. He cited that there is more nitrogen in the urine of most animals than in the feces. The continuous deposition of bat urine and their excreta contribute a lot in the accumulation of nitrogen in the area. One of the effects of excess nitrogen is the rapid vegetative growth of a tree with a consequent loss of fruit production (Jones, 1966). However, Jones (1966) cited that there is no sharp line to determine at which point nitrogen becomes

Table 3. Soil chemical analysis of the bat roosting area and control plots

	RANGE								
	pH			%N			P (ppm)		
Locations	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Control Plots									
Plo1	5.1	5.4	5.225	0.0405	0.068	0.058	10.9	12.6	11.75
Plot 2	5.5	5.6	5.525	0.036	0.056	0.0475	2.7	6	4.35
Roost Area									
*Plot D	5.6	5.8	5.73	0.0475	0.0955	0.0711	4.6	6.3	5.45
**Plot H	5.1	5.6	5.3	0.0395	0.0695	0.0555	3.7	6.5	5.1
***Plot K	6	6.3	6.16	0.038	0.072	0.0573	4.9	14.3	9.6

Plot 1 (sample taken on lower slope)
Plot 2 (sample taken on upper slope)
*Sample taken under dead White lauan tree
**Sample taken under healthy White lauan tree
***Sample taken under dying White lauan tree

Table 4. Nitrogen level in different soil depth

Soil Depth	Plot #1	Plot #2	Plot D	Plot H	Plot K
0-20	0.068	0.044	0.0955	0.0575	0.038
20-50	0.0565	0.056	0.0705	0.0695	0.072
50-100	0.067	0.054	0.0475	0.0395	0.062
100-below	0.0405	0.036			

excessive because there is a wide seasonal variation in nitrogen level in a given plant and wide variation among different plant species.

For the phosphorous content, Plot 1 exhibits the highest phosphorous content with 11.75 followed by Plot K with 9.55. Although Plot 1 on the average has the highest P content, Plot K has the highest P on 0-20 cm soil depth (Table 5). This may be because samples were taken under a dying White Lauan tree with bats roosting on top. Bat droppings contribute a lot in phosphorous content of the soil.

Litterfall in the bat roost is about 5 centimeters thick. Thick litterfall are concentrated along the boundary of the bat roost or on the new roost trees. Minimal litterfall was observed at the center of the bat roost since the area or trees are already devoid of leaves.

Result of Chi-square test (Table 6) shows that there is no significant difference in the soil nutrient content in both roosting and non-roosting areas, and therefore, is not the bat excreta or bat droppings that affect the mortality of White Lauan.

DISCUSSION

Possible causes of death of White Lauan

A. jubatus and *P. vampyrus* do not eat leaves or branches of their host trees. However, the great number of bats hanging together can easily break the twigs. Big trees such as the White Lauan with 100 cm trunk diameter can accommodate 150 to 200 bats or more depending on its branches. On the other hand, Kupang tree can accommodate as much as 400 to 500 bats because of its wide and spread branching structure. *P. vampyrus* tend to roost tightly packed together on roosting trees (Mildenstein, 2004). Based on field observation, leaves and big branches measuring about 8 to 10 cm. and below were damaged and fallen on the ground. On the other hand, leaves of the host trees near the center of the roost area were almost 90% to 100% gone.

Methane or musky odor is very distinct characteristic of the bat roost site, the odor becoming strong in the inner part of the roost area. Death of this tree could be compounded by the frequent damage on the branches and leaves of White Lauan. Based on observation,

Table 5. Phosphorous level in different soil depth

Soil Depth (cm)	Plot #1	Plot #2	Plot D	Plot H	Plot K
0-20	12.6	6	6.3	6.5	14.2
20-50	10.9	2.7	4.6	3.7	4.9

Table 6. Soil chemical level in roosting and non-roosting sites (Chi-square test)

	pH	Nitrogen	Phosphorous
χ^2 computed	0.02345*	0.00141*	0.22640*
χ^2 tab, a=10%	2.70554	2.70554	2.70554

* - No significant difference between the roosting area and control plots ($P<0.1$, χ^2-test)

most of the leaves and branches (10 to 15 cm diameter) in the center of the roost area are 80 to 90% damaged. Although bats move from one roost to another, they stay longer on their original area for 1 to 2 years. They return to their original roosting area after 5 to 10 months. By that time, roosting trees already recovered from the stress except for some White Lauan trees. It was also noted that concentration of bats are heavier or higher in the center of the bats roost. As such, pressure or stress is much intense on this area.

Abandoned Roost Trees

Bats are moving slowly Southeastern part of their roost area. Evidences of newly felled leaves and branches and their droppings show that they are moving to the inner part of the area. Moreover, there are no traces or evidence that these species returned to their original roosting trees as of the date of observation from January 2003 to March 2003. During plot establishment in January 2003, 14 dead trees were recorded in the roost area. Concentration of dead trees is located on the former roost area particularly on plots # 6, 5 and 7. These plots fall within the center of the former roost area. Bats prefer to roost on live rather than dead trees. Because of this attitude, they abandon the tree once it is already dead or devoid of leaves. Some trees that were abandoned were able to recover and survive. However, most of White Lauan, because of their sensitive characteristics, such that they are tolerant when young, but they become intolerant as they grow to maturity (Ganapin, 1985), was not able to recover after such kind of stress.

SUMMARY AND CONCLUSION

Physico-chemical analysis of the soil revealed that there is no significant difference on the soil nutrient content in both roosting and non-roosting areas. Therefore, bat droppings may not be the cause of death of the White Lauan trees. However, a thorough and detailed study of tree tissue analysis is recommended for future studies.

Based on data analysis, vegetation in the roost area is significantly different with the control plots or non-roost area. The limited number of small plants in the non-roost area indicates that the area is a mature and closed canopy forest. On the other hand, the roost area can be categorized as a disturbed forest due to the presence of young regenerants and gaps formed by dead trees. Open space or gap which is limited in close canopy forest, gives opportunity to small vegetation or pioneer species to grow and eventually dominate the area. The presence of dead trees at the former roost area shows that bats are moving to the inner part of the forest.

Finally, mortality of the White Lauan at the bat roost area could be attributed to physical factor due to tight roosting characteristic or activity of bats that result to defoliation of trees. Although this behavior of bats is natural, it has a negative effect to White lauan. Because of the sensitive characteristic of White lauan such that they become intolerant as they grow to maturity, this species is the most affected by the roosting activities of the bats.

MANAGEMENT RECOMMENDATION

A sound management recommendations can be made based on certain factors that must be given prime consideration in order to establish a more valid justification to which conservation efforts shall be devoted. That is making a clear-cut definition and putting emphasis on the usefulness, relevance and capability of the species to be conserved.

1. Enrichment planting could be started in areas no longer occupied by the bats. Kupang, which is more resistant and fast

growing, aside from being beneficial to bats as a source of their foods, could be a good species to be used for this purpose. White lauan and other endemic species could also be re-introduced in the area. Silvicultural treatment like liberation cutting could also be done to give way for other species to grow.

2. Movement of bat colony from one place to another is a natural behavior of bats. In the study area, movement of roost to inner part of the forest is not a problem since the forest can still accommodate the shifting of bat roost area despite the death of some trees. However, for areas where there are limited forests, bat colony cannot afford to move. Early assessment could be done and anticipate some appropriate mitigation measures to save this species of bats.

3. SBMA reforestation projects within the 15-kilometer radius from the bat roost should use species that are more beneficial and favorable to bats like White lauan, kupang, etc. Study shows that, foraging of bats is concentrated within 15-kilometer radius only (Bat Count, 2004). Use of exotic species like *Swietenia macrophylla*, *Acacia mangium*, Eucalyptus, etc. in the reforestation projects should be discouraged.

4. Identified species that serve as food for the bats like tangisang bayawak (*Ficus variegata*), tibig (*F. nota*), amugis (*Koordersiodendron pinnatum*), etc. can also be used in the SBMA reforestation program. Bats will feed in this area once the planted native species matured and give fruits and in effect reduce the mortality or hunting pressure on bats outside the protected area.

5. The SBMA as the authority should intensify its protection activities around the roosting area. Installation of signages on different strategic locations could be an information and education campaign for this conservation activity.

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Appendix 1. List of Species with relative density, dominance, frequency and importance value on the following:

A. Roost area (10x10)

Common name	Scientific name	Family name	Number of Plots	Number of Individuals	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Kupang	*Parkia roxburghii*	Fabaceae	4	5	0.5	2.396164	0.2	3.096164
White lauan	*Shorea contorta*	Dipterocarpaceae	4	6	0.5	0.754259	0.24	1.494259
Magabuyo	*Celtis luzonica*	Celtidaceae	3	3	0.375	0.131731	0.12	0.626731
Santol	*Sandoricum koetjape*	Meliaceae	2	3	0.25	0.081708	0.12	0.451708
Alupag	*Dimocarpus longan*	Sapindaceae	1	1	0.125	0.059396	0.04	0.224396
Lamut	*Syzigium incarnatum*	Myrtaceae	1	1	0.125	0.050273	0.04	0.215273
Taluto	*Pterocymbium tinctorium*	Malvaceae	1	1	0.125	0.039761	0.04	0.204761
Guijo	*Shorea guiso*	Dipterocarpaceae	1	1	0.125	0.024053	0.04	0.189053
Tambalau	*Knema glomerata*	Myristicaceae	1	1	0.125	0.022698	0.04	0.187698
Tamayuan	*Strombosia philippinensis*	Olacaceae	1	1	0.125	0.022698	0.04	0.187698
Apitong	*Dipterocarpus grandiflorus*	Dipterocarpaceae	1	1	0.125	0.020106	0.04	0.185106
Bolong-eta	*Diospyros philosantea*	Ebenaceae	1	1	0.125	0.017672	0.04	0.182672

B. Roost area (5x5)

Common name	Scientific name	Family name	Number of Plots	Number of Individuals	Relative Density	Relative Frequency	Importance Value
Tamayuan	*Strombosia philippinensis*	Olacaceae	5	6	0.625	0.11	0.735
Katagpo	*Ardisia clementis*	Myrsinaceae	4	5	0.5	0.09	0.59
Katong matsing	*Chisoccheton pentandrus*	Meliaceae	4	5	0.5	0.09	0.59
Anayatan	*Cleisanthus blancoi*	Euphorbiaceae	3	3	0.375	0.05	0.425
Bolong eta	*Diospyros philosantea*	Ebenaceae	3	3	0.375	0.05	0.425
Tambalau	*Knema glomerata*	Myristicaceae	3	3	0.375	0.05	0.425
Bagang aso	*Anaxagoria luzonensis*	Annonaceae	2	9	0.25	0.16	0.41
Nabol tilos	*Elacarpus fusicarpus*	Elaeocaceae	2	2	0.25	0.04	0.29
Balitbitan	*Cynometra ramiflora*	Fabaceae	2	2	0.25	0.04	0.29
Butong manok	*Drypetes microphylla*	Euphorbiaceae	1	4	0.125	0.07	0.195
Apitong	*Dipterocarpus grandiflorus*	Dipterocarpaceae	1	2	0.125	0.04	0.165
Amugis	*Koordersiodendron pinnatum*	Anacardiaceae	1	1	0.125	0.02	0.145
Takip asin	*Macaranga grandifolia*	Euphorbiaceae	1	1	0.125	0.02	0.145
Guijo	*Shorea guiso*	Dipterocarpaceae	1	1	0.125	0.02	0.145
White lauan	*Shorea contorta*	Dipterocarpaceae	1	1	0.125	0.02	0.145
Ardrisia sp.	*Ardrisia* sp.	Myrsinaceae	1	1	0.125	0.02	0.145
Busbusilak	*Ervatania ecarinata*	Apocinaceae	1	1	0.125	0.02	0.145
Magabuyo	*Celtis luzonica*	Celtidaceae	1	1	0.125	0.02	0.145
Takulau	*Milusa vidalii*	Annonaceae	1	1	0.125	0.02	0.145
Malaikmo	*Celtis philippinensis*	Celtidaceae	1	1	0.125	0.02	0.145
Aparuyan	*Canthium glandulosom*	Rubiaceae	1	1	0.125	0.02	0.145
Mali-mali	*Leea guineensis*	Vitaceae	1	1	0.125	0.02	0.145
Katap-tilos	*Trigonostemon acuminatus*	Euphorbiaceae	1	1	0.125	0.02	0.145

C. Roost area (1x1)

Common name	Scientific name	Family name	Number of Plots	Number of Individuals	Relative Density	Relative Frequency	Importance Value
Kupang	*Parkia roxburghii*	Fabaceae	1	7	0.125	0.29	0.415
Alupag	*Dimocarpus longan*	Sapindaceae	1	6	0.125	0.25	0,375
Santol	*Sandoricum koetjape*	Meliaceae	1	2	0.125	0.08	0.205
Canthium sp.	*Canthium* sp.	Rubiaceae	1	2	0.125	0.08	0.205
Tagotoi	*Palaquium foxworthyi*	Sapotaceae	1	1	0.125	0.04	0.165
Tamayuan	*Strombosia philippinensis*	Olacaceae	1	1	0.125	0.04	0.165
Anubing	*Artocarpus ovatus*	Moraceae	1	1	0.125	0.04	0.165
Bagang aso	*Anaxagoria luzonensis*	Annonaceae	1	1	0.125	0.04	0.165
Anyatan	*Cleisanthus blancoi*	Euphorbiaceae	1	1	0.125	0.04	0.165
Agpoi	*Bauhinia integrifolia*	Fabaceae	1	1	0.125	0.04	0.165
Nito	*Lygodium flexvosum*	Schizaceae	1	1	0.125	0.04	0.165

D. Non roost area (10x10)

Common name	Scientific name	Family name	Number of Plots	Number of Individuals	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Kupang	*Parkia roxburghii*	Fabaceae	2	2	0.1	1.747515	0.33	2.177515
Guijo	*Shorea guiso*	Dipterocarpaceae	3	4	0.2	0.691859	0.5	1.391859
Apitong	*Dipterocarpus grandiflorus*	Dipterocarpaceae	1	2	0.1	1.1071	0.16	1.3671
Alupag	*Dimocarpus longan*	Sapindaceae	4	4	0.2	0.089339	0.66	0.949339
White lauan	*Shorea contorta*	Dipterocarpaceae	1	1	0.05	0.541062	0.16	0.751062
Igyo	*Pysoxylum gardichardianum*	Meliaceae	2	2	0.1	0.134225	0.33	0.564225
Bolong-eta	*Diospyros philosantea*	Ebenaceae	2	2	0.1	0.04575	0.33	0.47575
Bayok	*Pterospermum diversifolium*	Malvaceae	1	1	0.05	0.159044	0.16	0.369044
Ilang-ilang	*Cananga odorata*	Annonaceae	1	1	0.05	0.11959	0.16	0.32959
Magabuyo	*Celtis luzonica*	Celtidaceae	1	1	0.05	0.02688	0.16	0.23688

A. Roost area (10x10)

Common name	Scientific name	Family name	Number of Plots	Number of Individuals	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Kupang	*Parkia roxburghii*	Fabaceae	4	5	0.5	2.396164	0.2	3.096164
White lauan	*Shorea contorta*	Dipterocarpaceae	4	6	0.5	0.754259	0.24	1.494259
Magabuyo	*Celtis luzonica*	Celtidaceae	3	3	0.375	0.131731	0.12	0.626731
Santol	*Sandoricum koetjape*	Meliaceae	2	3	0.25	0.081708	0.12	0.451708
Alupag	*Dimocarpus longan*	Sapindaceae	1	1	0.125	0.059396	0.04	0.224396
Lamut	*Syzigium incarnatum*	Myrtaceae	1	1	0.125	0.050273	0.04	0.215273
Taluto	*Pterocymbium tinctorium*	Malvaceae	1	1	0.125	0.039761	0.04	0.204761
Guijo	*Shorea guiso*	Dipterocarpaceae	1	1	0.125	0.024053	0.04	0.189053
Tambalau	*Knema glomerata*	Myristicaceae	1	1	0.125	0.022698	0.04	0.187698
Tamayuan	*Strombosia philippinensis*	Olacaceae	1	1	0.125	0.022698	0.04	0.187698
Apitong	*Dipterocarpus grandiflorus*	Dipterocarpaceae	1	1	0.125	0.020106	0.04	0.185106
Bolong-eta	*Diospyros philosantea*	Ebenaceae	1	1	0.125	0.017672	0.04	0.182672

F. Non roost area (1x1)

Common name	Scientific name	Family name	Number of Plots	Number of Individuals	Relative Density	Relative Frequency	Importance Value
Anubing	*Artocarpus ovatus*	Moraceae	2	2	0.33	0.4	0.73
Malaikmo	*Celtis philippinensis*	Celtidaceae	1	1	0.16	0.2	0.36
Bagang aso	*Anaxagoria luzonensis*	Annonaceae	1	1	0.16	0.2	0.36
Amugis	*Koordersiodendron pinnatum*	Anacardiaceae	1	1	0.16	0.2	0.36
Apitong	*Dipterocarpus grandiflorus*	Dipterocarpaceae	1	1	0.16	0.2	0.36