Study on estimating the carrying capacity of the timberland in Barangay Jimilian and Mount Gumba, Loboc, Bohol, Philippines for the Philippine Tarsier *Carlito syrichta fraterculus*, Groves and Shekelle, 2010 = *Tarsius syrichta* L.

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ABSTRACT

The study was conducted in order to estimate the carrying capacity of the timberland in Barangay Jimilian and Mount Gumba, Loboc, Bohol, Philippines for the Philippine Tarsier *Carlito syrichta fraterculus*, Groves and Shekelle, 2010 = *Tarsius syrichta* L. It also assessed the vegetation of the area in order to determine the extent of suitable habitat for the said species. Species composition, density, and total height of the trees were used to describe the structure of stand in each site. Nested quadrat method was used to assess the vegetation of the area. The position of roosting sites in the different sampling stations was determined using a global positioning system receiver (GPS). Results of the study showed that the entire area of the Loboc timberland which is approximately 184.39 has is suitable for tarsier and has a total carrying capacity of 310 individual tarsiers. This is equivalent to 1.68 individual per hectare, based on the computation from Geographic Information System (GIS).

Keywords: Philippine Tarsier, *Carlito syrichta fraterculus*, Carrying capacity, Loboc Bohol

INTRODUCTION

The Philippine tarsier (*Tarsius syrichta* L. = *Carlito syrichta fraterculus* Groves and Shekelle 2010) [1] is considered as the smallest primate in the world with an average weight of 110-140 grams [2]. This is extremely shy and nervous; despite its cuddly looks and proportions, it does not like to be touched. Those taken into captivity seldom survive or reach full maturity. Fifty years of attempts to breed the species under controlled conditions locally and abroad have thus far met with very little success. Yet unenlightened foreign tourists and collectors have persisted in smuggling them home as pets. In Bohol, in the Central Visayas region with which the Philippine tarsier has most closely identified, only several hundred of the species remain. After many years of environmental neglect and ignorance as to its importance for the island’s ecosystem and the country’s biodiversity, help is finally underway to protect and revive this unique and living treasure.

The habitat of Philippine Tarsier is the secondary growth forest and the primary forest from sea level up to 700 m (2,300 ft). Its habitat also includes tropical rainforest with dense vegetation and trees like tall grasses, bushes and bamboo shoots. It prefers dense, low-level vegetation in secondary forests, with perching sites averaging two (2) meters above the ground [3].

One of the majors thrusts of the provincial government of Bohol is the conservation of the Philippine Tarsier, which is one of the major tourists’ attractions of the province. Very recently a memorandum of agreement was signed to seal the "mother of all conservation efforts" for the famous tarsier which is now known worldwide as the mascot of Bohol. A tri-partite agreement was formalized by the Philippine Tarsier Foundation, Inc. (PTFI), the local government units of Corella and Sikatuna, and the DENR as the lead government agency to oversee the operation of the sanctuary of the Philippine tarsier located in the Municipalities of Corella and Sikatuna, Bohol. The capacity of the said sanctuary to
support viable population of Tarsier, however, remains virtually unknown. Studies in the area have been limited to home ranges, spatial movements and patterns of habitat use [4] and habitat preference in a semi-captive environment [3]. Estimates on carrying capacity are needed before any conservation efforts are to be conducted. The results of this study would provide an important tool for directing conservation efforts targeted at the survival of this important primate. That is why this study determined the carrying capacity of the Timberland of the Municipality of Loboc, Bohol particularly in Barangay, Oy, Jimili-an proper and Sitio Sug-ong and determine the area of suitable habitat from less suitable habitat within the Timberland of the Municipality of Loboc, Bohol and identify the type of vegetation present within the Timberland Identify preferred roost/sleeping plants, Identify the natural and anthropogenic factors that influence carrying capacity. Further, there was no collection of tarsier during the actual survey.

MATERIALS AND METHODS

Study Site
This study was conducted in the Municipality of Loboc, Bohol Philippines particularly in the Timberland of Barangays Oy (E 611079, N 10677637), Jimilian and Sitio Sug-ong (E 611072, N 1067161), which are parts of Mount Gumba, Loboc. Loboc has an elevation ranging from 300 to 350 m asl, a large part of which has a slope of 8-18% or undulating to rolling plain with a land area of 8,541 has.

Habitat Surveys and Characterization
Habitat surveys and characterization were conducted to cover a full range of habitat variants and disturbance gradients to determine habitat suitability and was assessed in order to determine its carrying capacity relative to the Philippine Tarsier. It was done in three (3) major slopes or locations, namely: Brgy. Oy, Brgy. Jimilian proper and Sitio Sug-ong.

Species composition, density and total height of the trees were used to describe the structure of stand in each site. Nested quadrat method was used to assess the vegetation structure. Nine plots representing lower, middle and upper slopes were laid out in each location. A total of 27 plots were used in the entire study in determining species composition and stand structure. In every plot three (3) layers, namely: canopy, intermediate or middle, and understory were studied. Position and altitude of the sampling points were determined.

Sleeping/Roost Site Surveys and Determination of the Carrying Capacity
Position and elevation of sleeping/roosting sites in the different sampling stations were determined using a global positioning system receiver and data was analyzed using Geographic Information System (GIS) software. Computation was based on the assumption that tarsiers are territorial and solitary; hence only one individual will occupy a single territory by dividing the area of suitable habitat by the area of the territory. The area of the territory was computed using the formula of the circle: \[ \pi r^2 \] where \( r \) is the average shortest distance covered between positive roosting sites.

Data Analysis
Values of each habitat variable were compared across the different habitat variants. Habitat variables were used to develop a site suitability index in which was fitted into the spatial optimization model to estimate the carrying capacity of the Philippine tarsier. The model utilized the spatial arrangement of the sleeping sites, which was generated using GIS software. Spatial optimization models particularly based on spatial arrangement of the home ranges were highly applicable for the Philippine tarsier.

RESULTS AND DISCUSSION

HABITAT ASSESSMENT:
The result of the survey is presented in Figure 1. Based on the source map that was fitted into the GIS software the area of the Timberland is approximately 184.29 hectares and the entire area is considered suitable habitat for tarsier.
A total of 52 species belonging to 28 families were encountered in the Loboc timberland. The most represented family with eight (8) species present was the Moraceae representing 15% of the total plant species followed by Euphorbiaceae (4 species) 8%, Anacardia, Apocynaceae, Guttiferae and Meliaceae with three (3) species each representing 6% of the total plant species. The dominance of species belonging to Moraceae and Euphorbiaceae and the absence of Dipterocarp species means that the area is still in the early stage of regeneration brought about by intense disturbance in the past. It is also interesting to note that saplings and wildlings of *Swietenia mahogony* (mahogany) and *Gmelina arboarea* (yemani) were encountered during the field survey, and these must come from the nearby reforestation projects within the timberland of Loboc.

**B. Frequency of Family Per Vegetation layer**

In the frequency of plant Family at different vegetation layer namely: Canopy, Middle, and understory layer. A total of 35 species was encountered in the canopy layer. This layer contains species, which will serve as mother trees thus potential sources of propagules for forest regeneration. The most frequently occurring and most abundant species in the canopy layer was *Alstonia macrophylla* (madbad) followed by *Cratoxylum sumatranaum* (paguringon). The other species that showed higher occurrence and abundance include *Ormosia calavensis* (bahay), *Alstonia macrophylla* (batino) and *Buchanania arborescens* (balinghasay).
Figure 2. Frequency of Families at the Different Vegetation Layer

Of the 37 species encountered in the middle layer, the most abundant and widely distributed species was *Carallia brachiata* (Bakauangubat). Four other most abundant and most frequently occurring species include *Buchanania arborescens* (Balinghasai), *Dysoxylum arboresens* (Kalimutain), *Ficus irisana* (Aplas) and *Swietenia mahogany* (Mahogany). Other abundant and frequently occurring species are *Terminalia pellucida* (Dalinsi), *Zanthoxylum diabolicum* (Madbad), *Syzygium brevistylum* (Sagimsim), *Evodia per gamentacea* (Tongamos), and *Cratoxyllum sumatranum* (Paguringon).

Most of these frequently occurring species except mahogany are members of transitional young forest community, which were allowed to regenerate after disturbance in the past. This layer provides a locomotive substrate of the Philippine tarsier in which most of their activities are concentrated.

The most abundant and most frequently occurring species in the ground layer, which is composed of 28 species, are: *Carallia brachiata* (Bakauangubat) followed by a palm, *Heterospathe elata* (Sagisi). Other species showed high abundance and frequency include *Syzygium brevistylum* (Sagimsim), *Zanthoxylum diabolicum* (Madbad), *Dysoxylum arboresens* (Kalimutain), *Swietenia mahogany* (Mahogany), *Adenanthera intermedia* (Tanglin), *Symplocos odor atissima* (Agosip), *Buchanania arborescens* (Balinghasai), *Ficus irisana* (Aplas), and *Thotteasp* (Taguibun-e). This layer is composed of the regenerants, which eventually will replace the middle layer through time along successional gradient. The abundant regenerants present in the site is an assurance of maintaining a healthy habitat for the Philippine Tarsier, especially that it includes Taguibun-e and sagisi which are some of the known most preferred roosts of the species. It should be noted, however, that wildlings of mahogany have proliferated already in the site which may somehow adversely affect the integrity of Loboc timberland as tarsier habitat.

The result shows that most species encountered in Loboc timberland are transitional species. The site thus requires periodic disturbance to maintain species composition and stand structure as part of habitat manipulation strategies. Practically, this means maintaining the low density of big trees to allow proliferation of saplings in the middle layer and wildlings in the ground layer. This can be done by selectively removing big trees, the removal of which must be scheduled in a manner that it will not bring about drastic changes in the structure. The introduction of fast-growing
species as much as possible must also be avoided as this will alter structural complexity of the habitat thereby reducing the welfare of the species population.

C. Preferred Roosting Plant
Based on actual observation one of the preferred roosting plants is Evodia pergamentacea (Tongamos) of Family Ruracea (Figure 3).

![Figure 3. A Tarsier Found Roosting on Evodia pergamentacea (Tongamos)](image)

D. Stand Structure
The stand structure of the tarsier habitat in Loboc timberland is shown in Table 1. The canopy layer is composed of small-sized trees with an average total height of 7.86 meters and average diameter of 14.39 cm. Tree density is quite low at 6.71 per 100 m². The area is practically devoid of big trees and generally dominated with trees of sapling size. These saplings had an average total height of 3.28 meters and diameter at breast height of 3.13 cm. Sapling and wildling density were 16.42 per 9 m² and 19.77 per m², respectively. The findings conform to recent studies showing that the tarsier habitat is generally composed of many small-diameter trees as a substrate for the locomotive advantage of species.

Table 1. Stand Structure of the Tarsier Habitat in the Timberland of Loboc, Bohol.

<table>
<thead>
<tr>
<th>SLOPE CATEGORY</th>
<th>TREE LAYER (10x10 m)</th>
<th>SAPLING LAYER (3X3 m)</th>
<th>GROUND LAYER (1X1 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Height (m)</td>
<td>DBH (cm)</td>
<td>Tree Density</td>
</tr>
<tr>
<td>Upper</td>
<td>8.97</td>
<td>16.32</td>
<td>7.44</td>
</tr>
<tr>
<td>Middle</td>
<td>7.74</td>
<td>13.04</td>
<td>5.56</td>
</tr>
<tr>
<td>Lower</td>
<td>6.89</td>
<td>13.81</td>
<td>7.11</td>
</tr>
<tr>
<td>Mean</td>
<td>7.86</td>
<td>14.39</td>
<td>6.71</td>
</tr>
</tbody>
</table>

Table 1. Stand Structure of the Tarsier Habitat in the Timberland of Loboc, Bohol.
CARRYING CAPACITY:
Positive roosting sites were surveyed inside the timberland of Loboc to determine the extent of the territory of a single individual of tarsier. Computation was based on the assumption that tarsiers are territorial and solitary; hence only one individual will occupy a single territory. Using the formula of the area of a circle $\pi r^2$, area of the territory was computed using the average shortest distance between positive roosting sites as $r$. The territory was 5,944.69 m$^2$ so the density would be 1.68 individuals per hectare (Table 2). The entire area of Loboc timberland is 184.39 has. So this means that it can support 310 number of individual tarsiers.

Table 2. Carrying Capacity of Tarsier in the Timberland of Loboc, Bohol.

<table>
<thead>
<tr>
<th>Shortest Distance Between Positive Roosting Sites (m)</th>
<th>Average Area of the Territory (m$^2$)</th>
<th>Density (Individuals per Hectare)</th>
<th>Area of Loboc Timberland (Hectare)</th>
<th>Total Carrying Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.5</td>
<td>5,944.69</td>
<td>1.68</td>
<td>184.39</td>
<td>310 individuals</td>
</tr>
</tbody>
</table>

Comparison of the Carrying Capacity Between the Corella-Sikatuna Timberland and the Loboc Timberland:

Results of the study conducted in the Corella-Sikatuna Timberland showed that the carrying capacity of the area is 2 individuals per hectare. The lower carrying capacity of Loboc Timberland could be due to habitat disturbance, particularly firewood collection and clearing activities for reforestation under the National Greening Program (NGP) of the DENR. These activities mean removal of saplings thus adversely affecting locomotive advantage and concealment ability of the species. Based on informal interviews conducted it was found out that the area is also the source of tarsiers that are sold to tourists and tarsier permitees who own the tarsier display area in the Municipality of Loboc.

CONCLUSIONS

Conclusions
Based from the results of the study the following conclusions are drawn:

- The total area of the timberland in Loboc, Bohol is approximately 184.39 hectares
- The entire 184.39 has. are suitable habitat for tarsier based on the vegetation type
- The total area of territory per single tarsier based on the sightings conducted is only about half a hectare (5,944.69 m$^2$) thus giving a carrying capacity of the entire Timberland of Loboc as 1.68 individual per ha. Or a total of 310 individuals for the entire timberland.
- One of the preferred roosting plants is Evodia pergamentacea (Tonggmos) of Family Rutaceae.
- The Timberland of Loboc is ideal for the promotion of biodiversity conservation, specifically the species of tarsier only found in Bohol, Tarsius syrichta L.= Carlito syrichta fraterculus Grooves and Shykelle 2010 and other wildlife species.
- The Loboc timberland is highly disturbed since there are farm lands in the area, and also it is the source of tarsier that is being sold to businessmen and tourists.

Recommendations:
The researchers would like to recommend the following:

- Since the entire Timberland of Loboc, is suitable as habitat for tarsier, it is suggested that the 184.39 has. be designated as the conservation area wherein it will be “NO ENTRY” and highly restricted zone. In other words, it will be classified as Protected Area.
- It is further recommended that there will be “habitat rehabilitation” by introducing plants like “sagisi” (Heterospathe elata) and” taguibun-e” (Thottea sp.) and other transitional species of plants which are considered favorite roosting/sleeping species of plants order to attract tarsiers in the area thereby increasing its potential to reproduce, grow and develop.
- Since most species of plants encountered in suitable habitats are transitional species it is suggested that there should be periodic disturbance to maintain species composition and stand structure as part of habitat rehabilitation strategies. This can be done by removing big trees, the removal of which must be scheduled in a manner that it will not bring about drastic changes in the structure.
- Introduction of exotic fast-growing species of plants in the area must also be avoided.
- Further studies on the following are recommended: Population density of tarsier in the area, Study on factors affecting tarsier’s distribution in the area, Study on mortality rate of tarsier in the area and Study on food preference of tarsier in the area.
- No permit be issued to hunt for tarsiers for commercial purpose.
• Issuance of Department Circulars and enactment of ordinances by the LGU of Loboc, Bohol in coordination with the DENR in the proper management and conservation of the Philippine Tarsier which are present in the Timberland

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REFERENCES