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Vegetation analysis and population of tarsier (*Tarsius spectrumgurskyae*) at Batuputih Nature Tourism Park, North Sulawesi, Indonesia

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Abstract. *Arrijani, Rizki M. 2019. Vegetation analysis and population of tarsier (Tarsius spectrumgurskyae) at Batuputih Nature Tourism Park, North Sulawesi, Indonesia. Biodiversitas 20: 530-537.* Tangkasi or *Tarsius* (*Tarsius spectrumgurskyae*) is a world's smallest primate, which categorized as an endemic and protected species inhabited Sulawesi Island. Batuputih Nature Tourism Park (Batuputih NTP) at Tangkoko Batuangus Nature Reserve, Bitung City, North Sulawesi, Indonesia is one of the habitats of the primate. The research aimed to characterize the habitats of *Tarsius* that include physical and vegetation characteristics and to figuring out the nest distribution and estimation of the population of this species. The vegetation data were sampled using a quadrat sampling technique around *Tarsius* nests. The *Tarsius* population was estimated along a 2 km transect line with the distance 50 m to the left and right across the line (the total width 100 m (0.1 km). Meanwhile, to calculate population abundance (Overall estimate of population size/abundance) can be obtained by multiplying population densities with the total area of all observations. The result revealed that the vegetation types of *Tarsius* habitats were dominated by tree species which associated with Liana from the family Araliaceae, among them include *Spathodea campanulata*, *Ailanthus integrifolia*, *Kleinhovia hospital*, *Alstonia scholaris*, *Garuga floribunda*, *Arenga pinnata*, and two sleeping trees without accosiated from the species of *Ficus tinctoria* and *Ficus variegata*. *Tarsius* life in groups with 2-8 individuals per group. The estimation of population density was found that there were 270 individuals/km or 2.7 individuals/ha and their total abundance around 1660 individuals of *Tarsius* lived in Batuputih NTP.

Keywords: Batuputih NTP, habitat characteristics, population, *Tarsius*

INTRODUCTION

Tarsius is a genus of the smallest primates in the world, and the members live in several islands in Indonesia, such as Sulawesi, Kalimantan, and Sumatra, also in the Philippines (Sussman 1999). These primates are endemic throughout the northern tip of Sulawesi in the Sangihe Islands to the southern tip of Sulawesi in the Selayar Islands. Local people call them by various names such as tangkasi, monkey ghosts, and small monkeys, while in the international world know them as *Tarsius* sp. This genus comes from the family of Tarsiidae, the only family that survived from the order Tarsiiformes. *Tarsius* has a crepuscular nature (active at dusk or dark situations) and nocturnal and is very active throughout the night (Gursky-Doyen and Supriatna 2010).

Tarsius is protected under Indonesian Law No. 5/1990 and Government Regulation No. 7/1999; and according to IUCN (2008), *Tarsius* listed in the IUCN Red Data Book in the category of vulnerable. Recently released publications stated that two new *Tarsius* species were found in Sulawesi. One of them was named *Tarsius spectrumgurskyae*, which replaces the *Tarsius* Manado form according to the results of the latest genetic studies. The name was given to honor a scientist who has dedicated and played a pivotal role in conservation efforts in Indonesia. He is Dr. Sharon Gursky who has studied *Tarsius* in the Tangkoko conservation area, Bitung, North Sulawesi for more than 20 years and made him the world-famous *Tarsius* expert (Shekelle et al. 2017).

Tarsius are frequently captured from wild because of their uniqueness, possibly for exotic pet and public consumption. These hunting activities together with habitat loss due to shifting cultivation, development, mining, and logging, present a serious threat to the existence of this species. Therefore, conservation efforts addressing the presence of *Tarsius* in nature are critical. Such efforts, like researches on ecological aspects of their population and habitat characteristics, not only will save the *Tarsius* population in nature but also, it would directly link to maintaining a sustainable source of biodiversity.

Tarsius can be found in lowland forest, Batuputih Nature Tourism Park in Batuputih Village, Bitung City, North Sulawesi, hereinafter referred to as Batuputih NTP. The habitat that Tarsiers favor is tropical rain forests which have abundant water sources that support their food. They can also be found in secondary forests, mostly in small and medium trees (Yasuma and Alikodra 1990) tropical rain forests that have an abundant water source that supports their food. They also can be found in secondary forests, mostly in small and medium-sized trees (Yasuma and Alikodra 1990).

Sulawesi's forests have experienced a dramatic loss of native forest (Whitten et al. 2001) and a decline in primate population density (Gursky, 1998a;), so the quality of habitat plays a critical role in wildlife conservation

(Merker, 2006). A good habitat quality will support all activities of the *Tarsius*, including reproductive behavior so that it can live normally (Qiptiyah and Setiawan 2012).

The availability of food sources from the surrounding is one of the factors supporting the conservation of primates in the wild. In addition, the feed also influences the wide home range associated with primate movement behavior in addition to efforts to fulfill energy sources for growth and breeding (Bismark 2009).

Batuputih Nature Tourism Park, Bitung City, is part of the Tangkoko Batuangus Nature Reserve, which is managed by the North Sulawesi Natural Resources Conservation Agency, Indonesia. Batuputih NTP ecotourism offers several advantages, one of which is the ease access to flagship species such as yaki and *Tarsius* (Shekelle and Leksono 2004), Also, in Batuputih NTP there are camping ground and many lodgings outside the area. But, apart from its beneficial advantages, Batuputih NTP should be driven as a useful tool for conservation education that needs to be artificially divided by zones so that visitors coming to Batuputih NTP can be controlled. It is clearly understood that ecotourism is not a panacea for preserving biodiversity. There is no ecologically neutral tourism, and there will always be an impact.

Research concerning the ecological status and population of *Tarsius* in the Batuputih NTP remains unexplored. Considering the situation of this area as a tourist park, where human activity is complicated to avoid, it is critically important to initiate the research of their population and habitat characteristics.

MATERIALS AND METHODS

Study site

The study was conducted for three months in the Batuputih Nature Tourism Park (Batuputih NTP), part of Tangkoko Batuangus Nature Reserve, that geographically located at 0130'-0134 'N and 12514'39 "-12506'46" E, and included in Batuputih Village, North Bitung Sub-district, Bitung City, North Sulawesi Province, Indonesia. Batuputih NTP situated at an altitude between 0-200 m asl. with a gentle, flat, and slightly hilly field toward the border of the nature reserve area. The flat area is in the coastal, which covers 40% of the area. Climatic conditions in Batuputih NTP based on Schmidt and Ferguson classification type B climate with annual average rainfall around 2,279 mm and daily average temperatures of 23-24°C. The vegetation is dominated by coastal forest vegetation and secondary forest vegetation such as: bitung (*Barringtonia asiatica*), ketapang (*Terminalia catappa*), waru (*Hibiscus tiliaceus*), sea kale (*Ipomoea pescaprae*), pandan (*Pandanus tectorius*), gora forest (*Eugenia* spp.), egg wood (*Alstonia scholaris*), and red banyan (*Ficus benjamina*) (WCS 2000).

Vegetation analysis

Vegetation analysis in the *Tarsius* habitat was performed by the quadratic method (Mueller-Dumbois and Ellenberg 1974; Kusmana 1997). Determination of area and the minimum number of plots used a relieve method and species-area curve. Ropes and measuring tape were used to make the plots. Each plot was placed around the *Tarsius* habitat especially its sleeping habitat. the characters of their sleeping tree were observed.

The physical characteristics of the *Tarsius* habitat were determined by observing and measuring the parameters as follows: (i) *Altitude*. Measurement of the altitude at the study site was carried out using Garmin Etrex 10. (ii) *Temperature and humidity*. Daily air temperature and humidity were measured using a dry-wet thermometer. Measurement of temperature and humidity is carried out between 05.30-06.00 WITA.

Tarsius population

Tarsius population was sampling and estimated using a line transect method (Kurniawan 2009). This method is often used in collecting data on the types and numbers of individual wildlife. The length and width of the path are adjusted to the topographic conditions and stand density at the observation site. Data collected is based on direct counting with the primates shown along the sampling track (Kurniawan 2009).

In secondary forests, a transect line was made along a 2 km forest trail. The data recorded is the number of individuals or groups of *Tarsius* based on direct or indirect observation (voice) while the number of individuals in one group is determined by assuming that in each group there are at least two individual *Tarsius* (Merker 2006).

Distribution

The geographic distribution of *Tarsius* estimated according to the location of their sleeping tree, is done by marking the area that becomes the nest of the *Tarsius* using Garmin Etrex 10 and then analyzed using ArcMap GIS 10.1 software.

Habitat characteristics

Physical components

The physical components of the *Tarsius* habitat being analyzed consist of altitude, temperature and humidity, and distance from the settlement. All the components were analyzed descriptively from the results of identification, observation, and measurement as well as the actual conditions in the field.

Analysis of vegetation

Vegetation data collected from the field is used to calculate the frequency, density, dominance and important value index of a plant species. These values can be expressed in the form of absolute values and relative values with the following equation:

$$\text{Density (D)} = \frac{Number\ individual\ of\ species}{total\ plot\ area}$$

$$\text{Relative Density (RD)} = \frac{Density\ of\ a\ species}{Total\ density\ of\ all\ species}$$

$$\text{Frequency (F)} = \frac{total\ number\ of\ plots\ species\ presented}{Total\ number\ of\ plots\ studied}$$

$$\text{Relative Frequency (RF)} = \frac{The\ frequency\ of\ a\ species}{Frequency\ of\ all\ species}$$

$$\text{Domination (D)} = \frac{Number\ of\ Basal\ area}{total\ plot\ area}$$

$$\text{Relative Domination (RD)} = \frac{Domination\ \ of\ a\ species}{Dominationn\ af\ all\ speceis}$$

Important Value index = RD + RF + RD (trees and poles)

Important Value index = RD + RF (stage and seedling)

$$\text{Basal area of-i} = \frac{1}{4}.\pi.d_i^2$$

The diversity and evenness of plant species in the population, the equation is used:

$$H' = -\sum_{i=1}^{s}\left(\frac{ni}{N}\right)\left(ln\frac{ni}{N}\right)$$

$E = H'/\log S$

Where: *H'* = Species diversity index Shannon-Wiener, ni = number of individual or species important value of the i-th, N = Total of the individual or total important value, S = Number of species (Southwood and Henderson 2000).

The similarity vegetation in the community was calculated by the Index of Similarity (IS) with the following equation:

$$IS = \frac{2w}{a+b} \times 100\%$$

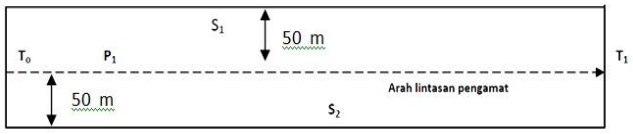
Where: IS = Similarity index of community, W = the number of the same value and the lowest value of species common to both the forest stands, a = the number of quantitative values for all species presented in the first stand, b = number of quantitative values for all species presented in the 2nd stand.

Nest characteristics

After analyzing the vegetation around the *Tarsius* nest, a descriptive analysis was also carried out on the plant species that were thought of as the *Tarsius*'s sleeping sites. A binocular device was used to facilitate observation of the trees.

Tarsius population

Estimation of the population using a transect method, where the length of the transect line (To-T1 distance = 2 km), the width of the transect by cutting contours, 50 m left and 50 m right = 100 m (0.1 km). So the area of the lane = 2 km x 0.1 km = 0.2 km2. Meanwhile, to calculate population abundance (Overall estimate of population size/abundance) can be obtained by multiplying population densities with the total area of all observations (Kyes et al. 2010).



Where: T_0 = starting point of transect line, T_1 = endpoint of transect line, P = position of observer, S = position of wildlife

Distribution

Tarsius distribution data based on their sleeping location that has been marked on GPS, then analyzed using ArcMap GIS 10.1 software.

RESULTS AND DISCUSSION

Habitat characteristics

Vegetation analysis was performed at each location of the *Tarsius* sleeping tree at Batuputih NTP of Tangkoko Batuangus Nature Reserve. The minimum plot size to be used in this study was 20 m x 20 m for trees, 10 x 10 m for poles and 5 x 5 m for stakes. The placement of sample plots is based on *Tarsius* nests (sleeping trees). A total of 21 randomized plots are placed on the research track along the 2 Km line transect path. The placement and number of plots considered the presence of the *Tarsius* nest and terrain traversed. Then all calculations on density, relative density, relative frequency, dominance, relative dominance, and important value index are in Table 1, 2, 3 and 4. The data shows the composition and structure of plants whose value varies in each type due to differences in the character of each tree. According to Kimmins (1987), variations in the structure and composition of plants in a community are influenced, among others, by plant phenology, dispersal, and natality.

Several types of plants around the sleeping habitats of *Tarsius* that have the highest IVI from the level of stakes is *Barringtonia acutangula* (21.12); poles is *Morinda bracteate* (45.31); and trees is *Spathodea campanulate* (66.62) respectively. This means, ecologically, the composition of these species shows characteristics of the habitat.

Plants have important roles in the daily activities of the *Tarsius*. During its movement, the *Tarsius* needs a branch with a small diameter (< 4 cm) mainly for hunting and exploring, medium diameter (4-8 cm) for resting and marking the home range, while diameter > 8 cm is also used for resting and marking home range although not as much as moderate diameter (MacKinnon and MacKinnon 1980). Aside from being a means of mobilization, the presence of various types of plants also plays a critical role in creating microclimates for the life of insects and insects are the main feed source of *Tarsius*.

The important value index can be used for calculating the Shannon-Wiener diversity index (*H '*) (formula 3a). The results show that the species diversity index in all the plots being studied was 3.31. Based on the category by Barbour et al. (1987), the species diversity index of 3.31 is included in the medium category. The diversity index value

illustrates the richness of tree species in the Batuputih NTP area. Because only 21 plots were scattered in determining the diversity index, the value of species diversity at the research location was actually higher than the results reported in this study. Therefore the level of vegetation biodiversity at the research location is actually very high. This condition illustrates that the ecosystem in Tangkoko Batuputih is actually a stable ecosystem and has approached a climax. This conclusion is supported by the fact that the species that dominate almost the entire research area are some typical tree species with relatively uniform strata.

Table 1. IVI Value of tree species on a 20 x 20 m plot found in Batuputih NTP, Bitung City, North Sulawesi, Indonesia

Species name	KM	KR	FM	FR	DM	DR	INP
Spathodea campanulata	57	12.2137	57.14	5.714286	2621424.87	48.69088	66.62
Morinda citrifolia	64	13.7404	85.71	8.571429	570993.163	10.60574	32.92
Arenga pinnata	40	8.65135	28.57	2.857143	1079105.79	20.04353	31.55
Barringtonia acutangula	22	4.83458	66.67	6.666667	39542.4628	0.73447	12.24
Kleinhovia hospital	19	4.07122	42.86	4.285714	184219.459	3.42173	11.78
Cocos nucifera	14	3.05342	47.62	4.761905	108535.098	2.015953	9.83
Alstonia scholaris	11	2.54451	47.62	4.761905	68785.2468	1.277631	8.58
Morinda bracteata	17	3.81677	38.1	3.809524	19497.9041	0.362158	7.98
Dracontamelon dao	14	3.05342	28.57	2.857143	108535.098	2.015953	7.92
Macaranga sp.	13	2.79897	42.86	4.285714	36597.8828	0.679777	7.76
Caryota mitis	17	3.81677	33.33	3.333333	28118.4315	0.522277	7.67
Garuga floribunda	4	1.01781	19.05	1.904762	181114.971	3.364066	6.28
Alstonia sumatrana	11	2.54451	19.05	1.904762	49689.302	0.922939	5.37
Homalium celebicum	17	3.81677	9.524	0.952381	28421.593	0.527908	5.29
Eugenia sp 2	10	2.29006	23.81	2.380952	17624.5462	0.327362	4.99
Cananga odorata	10	2.29006	23.81	2.380952	6930.61571	0.128731	4.8
Palaquium obovatum	7	1.52671	28.57	2.857143	9058.5357	0.168255	4.55
Polyscias nodosa	7	1.52671	28.57	2.857143	3956.58439	0.07349	4.45
Piper aduncum	7	1.52671	23.81	2.380952	26922.0409	0.500055	4.40
Crateva nurlava	8	1.78116	19.05	1.904762	18651.2765	0.346433	4.03
Melanolepis multiglandulosa	7	1.52671	19.05	1.904762	2984.76712	0.05544	3.48
Canarium asperum	3	0.76335	14.29	1.428571	58077.7176	1.078747	3.27
Koordersiodendron pinnatum	5	1.27226	19.05	1.904762	2471.40393	0.045904	3.22
Clerodendrum minahassae	4	1.01781	19.05	1.904762	1594.01539	0.029608	2.95
Eugenia sp 1	4	1.01781	14.29	1.428571	10642.2671	0.197672	2.64
Ailanthus integrifolia	7	1.52671	9.524	0.952381	7129.30202	0.132421	2.61
Artocarpus dadah	4	1.01781	14.29	1.428571	6400.76699	0.118889	2.56
Albizia saponaria	4	1.01781	14.29	1.428571	2656.5824	0.049344	2.49
Ficus tinctoria	4	1.01781	9.524	0.952381	25619.5568	0.475863	2.44
Ficus variegata	2	0.5089	9.524	0.952381	30697.4549	0.570181	2.03
Pisonia umbellifera	3	0.76335	9.524	0.952381	3335.0345	0.061946	1.77
Tectona grandis	3	0.76335	9.524	0.952381	2862.21404	0.053163	1.76
Pongamia pinnata	3	0.76335	9.524	0.952381	438.541003	0.008146	1.72
Vittex quinata	2	0.5089	9.524	0.952381	10958.1316	0.203539	1.66
Pterospermum celebicum	2	0.5089	9.524	0.952381	703.888004	0.013074	1.47
Sterculia comosa	2	0.5089	9.524	0.952381	614.015393	0.011405	1.47
Cryptocarya bicolor	2	0.5089	9.524	0.952381	586.252654	0.010889	1.47
Ardisia myristicaefolia	2	0.5089	9.524	0.952381	246.07285	0.004571	1.46
Diospyros pilosanthera	2	0.5089	9.524	0.952381	240.448514	0.004466	1.46
Pterospermum diversifolium	1	0.25445	4.762	0.47619	3636.06754	0.067537	0.79
Ficus sp 1	1	0.25445	4.762	0.47619	1506.80003	0.027988	0.75
Ficus septica	1	0.25445	4.762	0.47619	926.966561	0.017218	0.74
Ceiba pentandra	1	0.25445	4.762	0.47619	517.309581	0.009609	0.74
Cordia myxa	1	0.25445	4.762	0.47619	457.072718	0.00849	0.73
Memecylon sp	1	0.25445	4.762	0.47619	363.322718	0.006748	0.73
Cassia fistula	1	0.25445	4.762	0.47619	141.003848	0.002619	0.73
Eugenia littorale	1	0.25445	4.762	0.47619	72.2531847	0.001342	0.73
Mangifera kweni	1	0.25445	4.762	0.47619	68.3658439	0.00127	0.73
Buchanania arborescens	1	0.25445	4.762	0.47619	60.5122081	0.001124	0.73
Garcinia sp.	1	0.25445	4.762	0.47619	39.5010616	0.000734	0.73
Gnetum gnemon	1	0.25445	4.762	0.47619	38.8561571	0.000722	0.73
Amount	467	100	1000	100	5383811.34	100	300

Note: KM = absolute density, KR = relative density, FM = absolute frequency, FR = relative frequency, DM = absolute dominance, DR = relative dominance, INP = important value index

Table 2. IVI Value of Poles species on a 10 x 10 m plot found in Batuputih NTP, Bitung City, North Sulawesi, Indonesia

Species name	KM	KR	FM	FR	DM	DR	INP
Morinda bracteata	57	10.5042	95.238	9.3462	54487.72	25.45977	45.31
Barringtonia acutangula	57	10.5042	71.429	7.0097	40602.276	18.9717	36.48
Eugenia sp.2	55	10.0665	52.381	5.1404	31468.612	14.70393	29.91
Palaquium obovatum	41	7.87815	71.429	7.0097	21584.001	10.08527	24.97
Spathodea campanulata	39	7.22164	52.381	5.1404	20371.262	9.518614	21.88
Canarium asperum	29	5.47094	42.857	4.2058	9291.7434	4.341632	14.02
Clerodendrum minahassae	20	3.72024	57.143	5.6077	4849.7157	2.266063	11.59
Ailanthus integrifolia	23	4.37675	38.095	3.7385	7251.6265	3.388373	11.50
Gnetum gnemon	23	4.37675	38.095	3.7385	6211.7076	2.902464	11.02
Melanolepis multiglandulosa	13	2.40721	42.857	4.2058	2144.0097	1.001803	7.61
Canarium asperum	14	2.62605	19.048	1.8692	2781.287	1.299576	5.79
Mahangbahu*	14	2.62605	14.286	1.4019	2605.5543	1.217463	5.24
Alstonia scholaris	9	1.7507	28.571	2.8039	1017.3036	0.475342	5.03
Morinda citrifolia	14	2.62605	9.5238	0.9346	2172.6153	1.01517	4.57
Koodersiodendron pinnatum	7	1.31303	23.81	2.3366	560.5105	0.261902	3.91
Pongamia pinnata	9	1.7507	14.286	1.4019	652.96103	0.305101	3.45
Maranthes corymbosa	7	1.31303	19.048	1.8692	480.49742	0.224516	3.41
Glochidion philippicum	5	1.09419	19.048	1.8692	415.38141	0.19409	3.16
Dracontamelon dao	5	1.09419	19.048	1.8692	318.85047	0.148985	3.11
Pterospermum celebicum	7	1.31303	14.286	1.4019	697.75933	0.326033	3.04
Terminalia catappa	4	0.87535	19.048	1.8692	307.95041	0.143892	2.88
Crateva nurlava	4	0.87535	19.048	1.8692	232.24238	0.108517	2.85
Diospyros maritime	5	1.09419	14.286	1.4019	519.03245	0.242522	2.74
Arenga pinnata	5	1.09419	14.286	1.4019	340.08284	0.158906	2.65
Leea indica	7	1.31303	9.5238	0.9346	803.98942	0.37567	2.62
Polyscias nodosa	3	0.65651	14.286	1.4019	187.69431	0.087701	2.15
Vittex quinata	3	0.65651	14.286	1.4019	107.00637	0.049999	2.11
Homalium celebicum	4	0.87535	9.5238	0.9346	181.00641	0.084577	1.89
Sterculia comosa	3	0.65651	9.5238	0.9346	247.49867	0.115645	1.71
Buchanania arborescens	3	0.65651	9.5238	0.9346	101.97149	0.047647	1.62
Piper aduncum	2	0.43768	9.5238	0.9346	107.00637	0.049999	1.42
Szysigium littorale	2	0.43768	9.5238	0.9346	98.886298	0.046205	1.42
Caryota mitis	2	0.43768	9.5238	0.9346	89.332158	0.041741	1.41
Garuga floribunda	2	0.43768	9.5238	0.9346	84.737072	0.039594	1.41
Polyalthia glauca	2	0.43768	9.5238	0.9346	75.910866	0.03547	1.41
Mangifera sp.	2	0.43768	9.5238	0.9346	67.064756	0.031336	1.40
Dendrognide microstigma	2	0.43768	9.5238	0.9346	48.411435	0.022621	1.39
Mallotus columnaris	2	0.43768	9.5238	0.9346	47.134706	0.022024	1.39
Cryptocarya bicolor	2	0.43768	9.5238	0.9346	46.293032	0.021631	1.39
Saraca sp.	3	0.65651	4.7619	0.4673	100.73173	0.047068	1.17
Eugenia sp.1	2	0.43768	4.7619	0.4673	44.632431	0.020855	0.93
Diospyros hebecarpa	1	0.21884	4.7619	0.4673	63.091447	0.02948	0.72
Ficus tinctoria	1	0.21884	4.7619	0.4673	36.041288	0.016841	0.70
*Buru-buru**	1	0.21884	4.7619	0.4673	21.898696	0.010232	0.69
*Mata Ikan**	1	0.21884	4.7619	0.4673	16.515014	0.007717	0.69
Garcinia tetrandra	1	0.21884	4.7619	0.4673	15.287572	0.007143	0.69
Macaranga sp.	1	0.21884	4.7619	0.4673	12.974864	0.006063	0.69
Garcinia sp.	1	0.21884	4.7619	0.4673	12.53507	0.005857	0.69
Alstonia sumatrana	1	0.21884	4.7619	0.4673	11.889597	0.005555	0.69
Kleinhovia hospital	1	0.21884	4.7619	0.4673	10.449841	0.004883	0.69
Ardicia rumphii	1	0.21884	4.7619	0.4673	10.449841	0.004883	0.69
Amount	544	100	1019	100	214015.14	100	300

Note: KM = absolute density, KR = relative density, FM = absolute frequency, FR = relative frequency, DM = absolute dominance, DR = relative dominance, INP = important value index. *) Local name (unidentified)

The evenness value of species in the community is then determined based on the value of the species diversity index. The result showed that the evenness value (E) is 1.27 (formula 3b.) Which means that the similarity of species in the community is high. The evenness value of species is determined by the distribution of each species in each plot equally. The more evenly distributed a species in all research sites, the higher the evenness value. And vice versa if certain species are dominant while other types are not dominant or have a lower density, then the value of evenness of the community will be lower. If in a community, there are one or several dominant tree species,

the value of evenness of the trees in the community concerned will be lower than that of communities that are not dominated by certain tree species (Arrijani 2008).

The results also revealed that *Tarsius* inhabited secondary forest areas and Saccharum spontaneum grasslands. In this study, 19 *Tarsius* families were found, in which two families lived in dense bushes from S. spontaneum grass. A similar finding was also stated by MacKinnon and MacKinnon (1980) that *Tarsius* in the Tangkoko Batuangus Nature Reserve forest could be in very diverse sleeping locations. These locations include in dense bushes of *S. spontaneum* grass or tangling of vines or epiphytic ferns, in cracks or holes in the tree with more than one opening (Figure 2). As stated by Gursky (1998) and Wirdateti-Dahruddin (2006) that the Ficus species is often used as a sleeping tree in CA Tangkoko (*Tarsius* Figure 3).

Table 3. IVI Value of Stakes species on a 5 x 5 m plot found in Batuputih NTP, Bitung City, North Sulawesi, Indonesia

Species name	KM	KR	FM	FR	DM	DR	INP
Barringtonia acutangula	66	14.77	57.14286	6.349206	54.15908	12.74092	21.125
Palaquium obovatum	35	7.91	100	11.11111	36.64316	8.620297	19.027
Eugenia sp.2	48	10.81	71.42857	7.936508	44.79451	10.5379	18.754
Morinda bracteata	33	7.38	80.95238	8.994709	33.38262	7.853256	16.383
Ailanthus integrifolia	44	9.76	28.57143	3.174603	42.57658	10.01613	12.937
Spathodea campanulata	15	3.43	57.14286	6.349206	16.98514	3.995751	9.7793
Melanolepis multiglandulosa	17	3.95	33.33333	3.703704	16.85244	3.964534	7.6615
Saraca sp.	19	4.22	19.04762	2.116402	17.09888	4.022508	6.338
Mangifera sp.	13	2.90	28.57143	3.174603	12.05641	2.83627	6.077
Diospyros cauliflora	11	2.63	23.80952	2.645503	11.92372	2.805053	5.284
Clerodendrum minahassae	11	2.63	19.04762	2.116402	13.06112	3.072625	4.7549
Pterospermum celebicum	7	1.58	28.57143	3.174603	7.336215	1.725843	4.7577
Dracontamelon dao	5	1.31	28.57143	3.174603	1.137398	0.267573	4.4939
Pongamia pinnata	8	1.84	19.04762	2.116402	7.791174	1.832872	3.9634
Homalium celebicum	5	1.31	23.80952	2.645503	5.345769	1.257591	3.9648
Pongamia sp.	9	2.11	14.28571	1.587302	8.720049	2.05139	3.6981
Eugenia sp.1	9	2.11	14.28571	1.587302	8.454656	1.988956	3.6981
Cananga odorata	7	1.58	19.04762	2.116402	6.274644	1.476109	3.6995
Koordersiodendron pinnatum	5	1.31	19.04762	2.116402	5.213072	1.226374	3.4357
Gnetum gnemon	7	1.58	14.28571	1.587302	7.108735	1.672329	3.1704
Kleinhovia hospita	4	1.05	19.04762	2.116402	5.023506	1.181779	3.1718
Mata ikan*	5	1.31	14.28571	1.587302	6.388383	1.502866	2.9066
Morinda citrifolia	7	1.58	9.52381	1.058201	6.938126	1.632193	2.6413
Vittex quinata	3	0.79	14.28571	1.587302	3.31741	0.78042	2.3789
Sterculia comosa	3	0.79	14.28571	1.587302	3.20367	0.753663	2.3789
Leea indica	4	1.05	9.52381	1.058201	4.473764	1.052452	2.1136
Crateva nurlava	3	0.79	9.52381	1.058201	3.506976	0.825016	1.8498
Diospyros maritima	4	1.05	4.761905	0.529101	4.189415	0.985559	1.5845
Polyalthia glauca	2	0.52	9.52381	1.058201	6.028207	1.418135	1.5859
Piper aduncum	2	0.52	9.52381	1.058201	2.217925	0.521767	1.5859
Albizia saponaria	2	0.52	9.52381	1.058201	2.142099	0.503928	1.5859
Syzigium polianthum	2	0.52	9.52381	1.058201	2.047316	0.481631	1.5859
Alstonia scholaris	3	0.79	4.761905	0.529101	3.108887	0.731365	1.3207
Ficus septica	1	0.26	4.761905	0.529101	1.63027	0.383521	0.793
Buchanania arborescens	1	0.26	4.761905	0.529101	1.535487	0.361223	0.793
Maranthes corymbosa	1	0.26	4.761905	0.529101	1.289051	0.303249	0.793
Horsfieldia brachiata	1	0.26	4.761905	0.529101	1.270094	0.298789	0.793
Glochidion philippicum	1	0.26	4.761905	0.529101	1.232181	0.28987	0.793
Polyscias nodosa	1	0.26	4.761905	0.529101	1.232181	0.28987	0.793
Planchonia valida	1	0.26	4.761905	0.529101	1.118441	0.263113	0.793
Macaranga sp	1	0.26	4.761905	0.529101	1.080528	0.254194	0.793
Alstonia sumatrana	1	0.26	4.761905	0.529101	1.080528	0.254194	0.793
Mallotus columnaris	1	0.26	4.761905	0.529101	1.080528	0.254194	0.793
Cryptocrya bicolor	1	0.26	4.761905	0.529101	1.061571	0.249734	0.793
Garcinia sp.	1	0.26	4.761905	0.529101	0.985745	0.231896	0.793
Calophyllum soulattri	1	0.26	4.761905	0.529101	0.985745	0.231896	0.793
Amount	451	100	900	100	425.0834	100	200

Note: KM = absolute density, KR = relative density, FM = absolute frequency, FR = relative frequency, DM = absolute dominance, DR = relative dominance, INP = important value index. *) Local name (unidentified)

Table 4. Importing Value Index in Batuputih NTP, Bitung City, North Sulawesi, Indonesia

Level	Local name	Species name	Density (ind/ha)	IVI (%)
Stakes	Salense	*Barringtonia acutangula*	66	21.12
Poles	Mengkudu	*Morinda bracteata*	57	45.31
Trees	Kayu bunga	*Spathodea campanulata*	57	66.62

Furthermore, 17 other *Tarsius* families live in secondary forests and they inhabit trees and poles with a height of 1-17 m from ground level. Their sleeping trees include *Spathodea campanulata*, *Ailanthus integrifolia*, *Kleinhovia hospital*, *Alstonia scholaris*, *Arenga pinnata*, *Terminalia catappa*, *Garuga floribunda*, *Ficus tinctoria*, and *Ficus variegata*. All of these trees exclude *F. variegata* (dead plant), *F. tinctoria* (hollow tree) and *Arenga pinnata* are associated with liana forming a grove of sleeping trees as in Figure 2. The temperature of the habitat of the sleeping tree around 24°C-27°C with humidity 81% up to 99%.

Estimation of population abundance

During the study, *Tarsius* were found in various locations along the transect line at altitudes ranging from 9-46 m asl. The results showed that in one family constitute two to six individuals could be found. The estimated population density of *Tarsius* is 270 per km^2 or 2.7 individuals per ha with a total of 1660 individuals found in the Tangkuputih Tangkoko Nature Park. Shekelle and Salim (2008), said the population of *Tarsius*, primates living in the forests of Sulawesi declined dramatically in the last ten years. It is estimated that the number of *Tarsius* in the Batuputih NTP in North Sulawesi, only 1,800 individuals remains. In fact, in 1998, the number of *Tarsius* was still around 3,500 individuals. This is due to the area of Batuputih Nature Tourism Park experiencing damage and habitat change due to forest fires, hunting, logging and making the area by local residents into agricultural land.

Distribution

Tarsius are most commonly found in secondary forests with a total of 50 individuals from 17 families compared to the number of *Tarsius* found in dense bushes of *S. spontaneum* grass which only has one family with three members, and two other families found around community settlements totaling four individuals (Figure 3). This is in accordance with the research of Mustari et al (2013) which states that *Tarsius* are generally found around secondary forests and fields with dense vegetation. This is closely related to the presence of abundant food sources in secondary forest areas compared to S. spontaneum fields.

In conclusion, the *Tarsius* observed in Batuputih NTP inhabited the holes situated in trees of fig (*F. tinctoria*) and coro (*F. variegata*); seho tree (*A. pinnata*) and trees associated with liana i.e. nusu (*T. catappa*), kayu kambing (*G. floribunda*), kayu telur (*A. scholaris*), bintangar (*K. hospital*), kayu bunga (*S. campanulata*) and wariu (*A. integrifolia*). The estimated population density of *Tarsius* during the research in the Batuputih NTP 270 individuals/km² and its total abundance reaches 1660 individuals with the largest *Tarsius* population is found in secondary forests.

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A **B** **C**

Figure 1. *Tarsius* as sleeping tree: A. Wariu tree (*Ailanthus integrifolia*), B. Ficus tree (*Ficus tinctoria*), C. *Tarsius* in ficus tree (arrow)

Figure 3. Distribution map of *Tarsius* location found in Batuputih Nature Tourism Park, Bitung City, North Sulawesi, Indonesia

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