RANGING PATTERN AND POPULATION ESTIMATES OF TUPAIA AND CALOSCIURUS IN PEATSWAMP FOREST IN UNIMAS

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ABSTRACT

The home range of Tupaia and Callosciurus at UNIMAS peat swamp forest were studied using mark recapture method. Two sampling period of 20 days each was done to gather all the data on the home range. The first sampling time was from 5th July 2003 to 24th July 2003 and continued with the second sampling on the 13th September 2003 until 2nd October 2003. The purpose of this study is to make baseline information for the study of ranging pattern made by small mammals. A population estimates was also done as supplementary information in the research. Minimum Convex Polygon (MCP) is used in calculating the home range size. Three models of estimating the population were applied in this study, namely the Lincoln-Petersen, the Schnabel, and the Schumacher and Eschmeyer methods. Throughout the research, 22 totals of individuals of 11 males and 11 females were captured using cage trap. Species captured are the Callosciurus notatus, Callosciurus prevostii borneensis, Callosciurus prevostii sanggaus, Tupaia tana and Tupaia picta. Banana is the most favorable baits use for capturing small mammals.

Keyword: home range, peat swamp, Tupaia, Callosciurus.

ABSTRAK


Kata kekunci: kawasan kelieran, Hutan paya gambut, Tupaia, Callosciurus.
1.0 INTRODUCTION

Sarawak is an area of 124 449.5 square kilometers. It is situated in Borneo Island, bordering with the Brunei and Kalimantan. Borneo is the third largest island after Greenland and New Guinea (Payne, 2000). The island is regarded as heaven of nature with high variety of biological diversity in the area.

1.1 Home range

Home range is considered as the space use by the animals for movement and nest site. According to Hanski et.al. (2000), home range is not a static, well-defined area. The borders may change depending on season and reproductive status. In general, Hanski et. al. (2000) also stated that the home range size also depends on body mass and energy requirement. There maybe a significant difference in home range size between sexes. When a female density was high, the home ranges of males are small, Hanski et.al. (2001). In studying on the home range of Tupaia and Callosciurus, we need to know the home range size and location, activities and movements of the occupants.

1.2 Callosciurus

According to Yasuma and Andau (2000), Callosciurus means ‘beautiful squirrel’. Callosciurus made up from the combination of the word ‘calli’ or ‘calo’, which means ‘beautiful’ and ‘sciurus’ that means ‘squirrels’. Collusciurus belong to the family of Sciuridae. The Sciuridae classified as the Rodentia. Callosciurus are mainly found in the Indomalayan Region.
The Rodents have four long, clawed digits on each foot, and a short thumb with a nail. There are the tree squirrel and the ground squirrel. The squirrels look likely the same. The differences can be seen in the coloration. Ground squirrel glimpsed in dim light as the tree squirrel often obscured by leaves and silhouetted against the sky, Payne et al. (1985). Most of them are very active animals and therefore, brightly coloured.

Based to Yasuma and Andau (2000), the *Callosciurus* are the recipient of the various type of forest. They occurs lowland dipterocarp forests and lower montane forests. Some of them inhibit the montane oak and lower moss forests such as the *Callosciurus baluensis*. The existence of the *Callosciurus* in coastal, riverine and swamp forest are also common. They are also occurring in limestone forests, heath forests, swamp forests, brackish-water forests and the beach forests. *Callosciurus* are also usually encountered in the gardens, plantations and sometimes along the road in tall and secondary forest mainly in the late afternoon (Yasuma and Andau, 2000).

The *Callosciurus* are the daylight animals of the rainforest (Harrisson, 1973). The peak time for this animals to be seen are early morning and late afternoon. As most of other mammals active at night, the *Callosciurus* face very little competition in their daily requirement. Result from this, the *Callosciurus* have developed canopy, tree trunk and ground forms, big, medium and little forms lowland and mountain forms (Harrisson, 1973).
This arboreal type of animal is active in small and medium-sized trees (Yasuma and Andau, 2000). They live in hollow trees and also build leaf and stick nests. According to Harrison (1973), the *Callosciurus* prefer the trunk than the canopy as their home, the middle zone. This is because it is easier for these animals to feed by ranging up and down, between the canopy and the ground, as food is available.

Diet includes a wide variety of fruits and insect. The *Callosciurus* feed on fruits, seed, nuts, buds and flower. This is the clear reason why the *Callosciurus* usually encountered in the garden and plantations areas. Insects that are eaten by the *Callosciurus* are the beetles and their larvae, which are gnawed out of dying wood or under part of the bark. Probably, the *Callosciurus* also feed on birds’ eggs (Yasuma and Andau, 2000).

1.3 **Tupaia**

*Tupaia*, from the family of Tupaiidae consist ten species are Asian mammals of the order Scandentia. Treeshrew, which was considered as 'primitive primates', was classified in the order of Primates by the biologist previously. *Tupaia* are endemic to Indomalayan Region. *Tupaia* are mainly found in Borneo, Sumatra, Peninsular Malaysia and South Thailand.

This group is commonly known as the treeshrew. Treeshrews are usually confused in the same group with the shrew by the names. The fact is that these two groups are completely unrelated as they are from two different orders. Grammatically, the two-word name treeshrew is a shrew that is misleading (Emmons *et. al.*, 1991).
Morphologically and ecologically, this group resembles the squirrel. However, it is anatomically and behaviorally different. These two groups can be distinguished by looking closely at the muzzle. The treeshrew have longer muzzle with complete set of thirty-eight teeth. The teeth are small and pointed kind. *Tupaia* have a complete ring of bone around the eye. The size is even smaller than the squirrel. Other than that, the treeshrew have five clawed on each foot. Looking at the coloration of the fur and the weight can identify Treeshrew.

Most of the treeshrew species are diurnal excluding Pentail treeshrew (*Dendrogale melanura*) and Smooth-tailed treeshrew (*Ptilocercus lowii*), Payne et al. (1985). According to Harrison (1973), *Ptilocercus lowii* is different from the other *Tupaia* because this species is nocturnal and entirely arboreal. *Tupaia* are active early morning and late afternoon. *Tupaia* mainly found in lowland dipterocarp forest. Other than lowland dipterocarp forest, the low woody vegetation of old and young secondary forests is also a preferable habitat of this family. Montane forest, lower montane forests and Kerangas forests (heath forests) are also the type of habitat where the *Tupaia* inhibit (Yasuma and Andau, 2000).

Emmons et al. (1991), described that *Tupaia* foraged on the ground, but usually nested in trees. The nests of the *Tupaia* are usually 0.5 to 15m above ground level. According to Yasuma and Andau (2000), some species of the *Tupaia* nested in burrows under big roots, fallen tree or rock. The nest was a layer of simply overlapped large leaves (not
woven), surrounding a ball of teased fibres with a chamber in the centre. The nest was wedged in a small, open chimney beside a solid core in the tree hollow, ~60cm below the cavity entrance (Emmons et al., 1991).

Most species are predominantly arboreal and omnivores. The *Tupaia* feeds on both fruits and invertebrates (Gorbet and Hills, 1992). According to Yasuma and Andau (2000), along lanais or branches of small trees are the travels tracks of this animal. They also travel on the ground as they feed there. The diet is a mixture of plant and animal material such as arthropods and earthworms with some fruit. Unlike the other species of the *Tupaia*, the Smooth-tailed treeshrew (*Ptilocercus lowii*) is strictly insectivorous and will not accept fruit at all (Harrison, 1973).

### 1.4 Peat swamp forest

Peat swamp forest is one of the wetlands. According to the Convention of Wetlands of International Importance, held in Ramsar, Iran, on the Caspian Sea in 1971, commonly known as the Ramsar Convention, wetlands are including all the areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters or twenty feet (Moore, 2001).

Peat swamp evolved from mangrove forest as the forest zone move seawards. As the zone shifts, it leaves an area of salty, sulphur-rich with acidic mud (Payne, 2000). Based on Moore (2001), he mentions that on the dome area of bog pail, the acidity is usually
less than pH4. The water draining from a peat swamp is low in inorganic ions and oxygen. According to Bennett and Gombek (1992), the high concentration of humic acid gives it a characteristic ‘blackwater’ appearance. This is one of the reasons of the very infertile soil in this area.

Surprisingly, this area support good stands of commercial timber. Many peat swamps have been heavily disturbed over the years (Payne, 2000). Sarawak Forest Department reported that the value of timber extracted from peat swamp forest in Sarawak in 1998 is RM41.821 million. Peat swamp play an important role as a reservoir, supplying water for communities and irrigation for crops as well as helping in reducing floods in surrounding areas. Other than that the peat swamp also important in global carbon balance (Bennett et. al., 1998).

Peat swamp forest covers extensive areas in the humid tropics and has been recorded from three principle regions in the rainforest belt: the Malay Archipelago, Tropical America and Tropical Africa. The process of peat buildup is most apparent in the forested mires of Southeast Asia, particularly Sarawak, Borneo, Papua New Guinea and Sumatra (Moore, 2001). Peat swamp consist 2.7 million ha or 8% of the nation’s total area (Phillips, 1998). In Sarawak, peat swamp forest consists about 12.5% of the state area (1.7 million ha), Anderson (1961). Lowland peatlands occurs mainly along the coast between the lower stretches of the main rivers draining into the South China Sea in the administrative divisions of Kuching, Samarahan, Sri Aman, Sibu, Sarakei, Bintulu, Miri and Limbang (Mutalib et. al, 1992: Phillips, 1998). Based on a report from Unit
Perancangan Negeri Sarawak (1998), the peat land occupies a large tract of Samarahan-Sadong, Lupar-Saribas, Rajang, Baram and Limbang river system. These areas are densely populated and relatively under developed.

The Samarahan peat swamp forest included in the Sadong swamp forest, which lies along the eastern side of Batang Sadong, south of Simunjan, north and east of Pasar Gedong, about 50km southeast from Kuching. The area is exposed to the northeast monsoon and received an annual rainfall of 3500-4000 mm. In the month of November –February 50-60% of rainfall occurs while June and July are driest month.

Fauna such as bats, primates, rodents, wild pigs and mouse deer can be found in Bornean peat swamp forest. Bennett and Gombek (1992) mentioned that treeshrews and tarsiers are also present in the peat swamp forest of Sarawak. According to Bennet and Gombek (1992), the area of peat swamp forest between Sadong River (Samarahan Administrative District) and Lupar River (Sri Aman Administrative Divisions) was once the home range of orang utan. The endangered species of Flat-headed Cat (*Felis planiceps*) and the Earless Monitor Lizard (*Lanthanotus borneensis*) may also occur in this area. Formerly, the peat swamp between the Sadong (Samarahan Administrative Division) and Saribas (Sri Aman Administrative Division) rivers also support the largest population of Proboscis monkeys (*Nasalis larvatus*) in Sarawak (Phillips, 1998).

The peat swamp area in Kota Samarahan is more than thirty years old regrowth forest (Tuen and Darub, 1999). Most of the area has been logged commercially through years.
Before that, hunting and extraction of forest product were the earliest activities done. This area of peat swamp has been extremely exploited and developed for infrastructure, housing, prawn and fish farming, agricultural and industrial development. These human activities have drawn a negative impact to the distribution of species of faunas. Samarahan IADP has developed 4300 ha of oil palm plantation on peat, and another 5217 ha have been planted in the Mid-Samarahan region (Unit Perancangan Negeri Sarawak, 1998).

According to Tuen et. al. (unpublished), about 20ha of forest across the road from the Unimas campus was cleared for a private housing project from the past 15 years. Later, in the year 2000 and 2002, more forest area were cleared for the extension to the present campus infrastructure and road which link the campus to the new one about 1km away (Tuen et. al., unpublished). From year 2002 until 2003, Unimas new campus project is still continue actively with more development within 5km radius for commercial centre and housing projects. (Tuen et. al., unpublished). believed that such activities disrupted the fauna community in the forest as the habitat that are used for foraging, refuge, and breeding are being destroyed. As the habitat is destroyed, the fauna tend to look for new home at the nearby-forested areas. Result from the declining of the resources, especially food.

My study is on the population estimates and home range of the non-volant small mammal, under the family of Tupaiidae and Sciuridae. The main aim will be based on the home range of these two families.
The objective of this research is to study the interpopulation estimates and the home range of the treeshrew (*Tupaia*) and squirrel (*Callosciurus*) in peat swamp forests UNIMAS.

### 2.0 STUDY SITES

The sampling area was done in the peat swamp forest in UNIMAS for forty days in two separate sampling times (twenty days each).

The study area is within a peatswamp area in Unimas temporary campus site located at 01° 27' North and 110° 27' East in Kota Samarahan, Sarawak. According to Tuen and Darub (1999), it is a regrowth forest. They also stated that the forest is more than thirty years old. The sampling site will locate at around 30 to 200m from the edge of the campus with the canopy of about 15 to 20 meters height with the present of a few emergent trees. The dominant types of vegetation in this forest are from the families of Sapotaceae, Lauraceae and Euphorbiaceae (Mustaffa, 1997). The sampling area is about 1km².
3.0 MATERIAL AND METHOD

3.1 Technique of sampling

Capture-mark-recapture method was used to sample the animals. This method is complicated as the individual will be captured, marked, released, recaptured and checked for identification mark, then the animals re-released, recaptured and the same procedure will continuously done for a few times. However, this method is more precise as it needs a big number of samples in a long period of time (Slinsby and Cook, 1989). In this research, the animals were only marked once.

In this method, every individual in the population must have the same probability to be caught. It does not matter whether the individual had been caught or not. Every animal has the same probability to come back to the population. The mark can be seen and stay to the animal for long period of time (Slinsby and Cook, 1989).

One hundred cage traps were used in this survey in 10x10 grids of 10m traps intervals (Figure 1). According to Jones et al. (1996) they recommended a 10x10m array of points, with two points for each grid. Fifty traps were set on the ground and fifty traps will be set 1-2 meters above the ground. These will take a distance of 1 to 2 meters above the ground level. The traps were set ten lines transects of 100m. Compass bearing was used to set the grid.
The sampling took forty days with two different sampling periods of twenty days each. These twenty days of sampling made up two thousand trapping nights. The first sampling was done from the 5th July 2003 until 24th July 2003. The second sampling time started from the 13th September 2003 until 2nd October 2003.

The traps checked twice a day, in the morning between 7 and 8 a.m. and later in the evening between 5 and 6 p.m (Tuen et. al., 2002).

Bananas and sweet potatoes were used as baits were also checked every time trap checking was done. Rotten baits were replaced with new fresh ones. According to Tuen et al. (2002) banana is the most suitable bait for rodents. It is also reported that sweet potato was an effective bait use for non-volant small mammals in UNIMAS peat swamp (Hanifah, 2000). Beside the factor of bait that I used, the capture would be influenced by the location of the trap, the persistence of the trap itself, weather, the age and the gender of the animal (Rabinowitz, 1995).

Cloth bags were used to transfer the trapped animals from the cage trap. After transferring the animals into the cloth bags, the baits were replaced with new fresh ones before continue checking the other traps.
Figure 1: One hundred traps in 10x10 grids of 10m-trap interval in 1 ha plot.

The animals that were caught that day were brought back to wildlife lab anatomy to process and record of morphological measurement. The measurements recorded were
head and body length, tail length, hind foot length, ear width, and total length. The animals were weighed using Pesola spring balance. The animals' genders were also recorded. The animals were identified by referring to the book 'A field guide to the mammals of Borneo' (Payne et. al., 1985).

Numbered metal tags were fitted to a plastic necklace to the animals' neck before it was released back to its own habitat. Plot number is also recorded as well as the microhabitat and the type of bait. The line transect is used to estimate the general habitat composition and structure. The animals were then sent back to the area it was caught in the same day.

3.2 Home range analysis

The simplest method in identifying home range is by using the Minimum Convex Polygons (MCP) (Hanski, 1998). Each home range made by *Tupaia* or *Callosciurus* was determined by the area in a polygon based on three or more capture points (Figure 2). All of the outermost points are joining together to form a polygon. The polygons then represent the individual's home range. Minimum Convex Polygons (MCP) gives an estimate of the home range by enclosing all of the locations within the polygon.
Figure 2: Example of home range of T1 and C1 as determined by respective capture points.
3.3 Statistical methods

In this research, the population of study is assumed as a closed population. According to Krebs (1989), a closed population is one that does not change in size during the study period, that is, one in which the effects of births, deaths, and movements are negligible. Each dominance species from *Tupaia* and *Callosciurus* is estimated its population. Firstly, the population is tested to see whether the population is closed or not. This is done by plotting a graph of accumulated number of marked animals (*M*<sub>t</sub>) against the proportion of marked animals at each sample (*R*<sub>t</sub>/*C*<sub>t</sub>).

A linear graph shows that the assumptions are fulfilled, where a curvilinear graph shows that the assumptions are violated and either the population is not closed or catchability is not constant (Krebs, 1989). In order to get the most fit graph for each population by looking at the R-value. A larger R-value, the fitness of the graph is at the best.

When the assumption is violated or the curvilinear is present, the population estimates are still can be obtained by using the Tanaka’s model by using log value. If it is a closed population or a linear graph is present, three closed mark and recapture methods will be used in estimating the data. The population estimates were determined using the Lincoln-Petersen method, the Schnabel method and the Schumacher -Eschmeyer method.
3.3.1 The first estimates was by Lincoln-Peterson Method

The numbers of individuals were marked over a short time, releasing them, and then recapture individuals to check for marks. For this method to be valid, the second sample must be a random sample where the marked and unmarked individuals must have the same chance of being captured in the second sample.

The data obtained are:

- \( n_1 \) = number of individuals marked in the first sample
- \( n_2 \) = total number of individuals captured in the second sample
- \( m \) = number of individuals in second sample that are marked

From these three variables, we need to obtain an estimate of

\[ \hat{N} = \text{estimate of population size of population at time of marking} \]

The appropriate estimator is:

\[ \hat{N} = \frac{n_1(n_2 + 1)}{m + 1} \quad (1) \]

This is the appropriate estimator from Bailey (1952) in estimating a population where the second sample is taken with replacement. The equation was used so that a given individual can be counted more than one. Assuming that, the chances of sighting a marked animal are on the average equal to the chances of sighting an unmarked animal (Krebs, 1989).
The estimate of standard error for the unbiased $\hat{N}$ (for equations 1) is:

$$SE(\hat{N}) = \sqrt{\left[(n_1 + 1)(n_2 + 1)(n_1 - m)(n_2 - m)/((n + 1)^2(n + 2))\right]}$$  \hspace{1cm} (2)$$

Approximate 95% confidence limits for the true population size are:

$$\hat{N} \pm 2SE(\hat{N}) \hspace{1cm} (3)$$

If the total number of recapture ($\sum R_t$) is less than 50, confidence limit for the population estimate should be obtained from the Poisson distribution (Appendix 2) (Krebs,1989).

3.3.2 The second estimates was by Schnabel Method, where,

The Schnabel method (1938) extended the Petersen method that applied to a series of samples in which there is a 2, 3, 4, . . . , nth sample. Individuals caught at each sample are first examined for marks, then marked and released. A single type of mark is used to distinguish between two types of individuals: marked (caught in one or more prior samples) and unmarked (never caught before).

We determined for each sample $t$:

- $C_t =$ total number of individuals caught in sample $t$
- $R_t =$ number of individuals already marked when caught in sample $t$
- $M_t =$ number of marked individuals in the population just before the $t$-th sample is taken

Given these counts of marked and unmarked individuals, an estimate of population size $\hat{N}$ for a closed population is needed in the estimation.
\[ \hat{N} = \frac{\sum (C_i, M_i)}{\sum R_i} \]  

(4)

\[ \text{Variance} \quad \frac{1}{N} = \frac{\sum R_i}{\left( \sum C_i M_i \right)^2} \]  

(5)

\[ \text{Standard error} \quad \frac{1}{N} = \sqrt{\text{Variance}} \frac{1}{N} \]  

(6)

Poisson distribution (Appendix 2) is also used in getting the confidence limit for the population if the total number of recapture (∑R₀) is less than 50 (Krebs, 1989).

\[ \hat{N} \pm t_\alpha (S.E.) \]  

(7)

3.3.3 The third estimates was by Schumacher-Eschmeyer Method, where,

A linear regression technique by Schumacher-Eschmeyer (1943) is the extension of Schnabel method in estimating the population size. The appropriate formula of estimation is:

\[ \hat{N} = \frac{\sum (C_i, M_i^2)}{\sum (R_i, M_i)} \]  

(8)

Where \( s = \text{total number of samples} \)

\[ \text{Variance} \quad \frac{1}{N} = \frac{\sum R_i^2 \left( \sum R_i M_i \right)^2}{s - 2} \]  

(9)
Standard error of $\frac{1}{N} = \sqrt{\frac{\text{Variance}}{N} \sum (C_i M_i^2)}$ (10)

The t-table (Appendix 3) is used to obtain confidence limit for the population estimate if the total number of recapture ($\sum R_i$) is less than 30 (Krebs, 1989).

$$\hat{N} \pm t_{\alpha} (S.E.)$$ (11)

All the data analysing that was done for the research is referring to Ecological Biology by Krebs (1989). The calculations were calculated using Microsoft Excel.