# DIVERSITY AND ABUNDANCE OF SQUIRREL USING CAGE TRAP AT UNIVERSITI MALAYSIA KELANTAN, JELI CAMPUS, KELANTAN, MALAYSIA.

by

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**DECLARATION**

I declare that this thesis entitled “Diversity and Abundance of Squirrel at Universiti Malaysia Kelantan, Jeli Campus, Kelantan, Malaysia is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 08 AUGUST 2024

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**Diversity and Abundance of Squirrels Using Cage Traps at Universiti Malaysia Kelantan, Jeli Campus, Kelantan, Malaysia.**



## ABSTRACT

At Jeli Campus, Universiti Malaysia Kelantan, Kelantan, informal study on squirrel variety and abundance was carried out. Using 'Pisang Emas' (*Musa acuminata*) as bait, six cage traps were set up to catch squirrels, and the species variety and abundance were noted. The findings show that just five squirrels in all, representing two species and two families the Tupaiidae and Sciuridae were found. With three recorded cases, *Tupaia Glis* was the species with the greatest squirrel catch rate. With regard to its non-endangered living forms, *Tupaia Glis* is classified as Least Concern. *Callosciurus Notatus*, which has two individuals is ranked similarly with regard to least concern. Thus, more research at Universiti Malaysia Kelantan, Jeli Campus is required to ensure that future studies on a wider variety of squirrel species are viable due to the surrounding squirrel population low diversity and abundance. Predators and local weather patterns have an impact on this.

**Kepelbagaian dan Kelimpahan Tupai Menggunakan Perangkap Sangkar di Universiti Malaysia Kelantan, Kampus Jeli, Kelantan, Malaysia.**

## ABSTRAK

Di Kampus Jeli, Universiti Malaysia Kelantan, Kelantan, kajian tidak formal mengenai kepelbagaian dan kelimpahan tupai telah dijalankan. Menggunakan 'Pisang Emas' (*Musa acuminata*) sebagai umpan, enam perangkap sangkar dipasang untuk menangkap tupai, serta kepelbagaian dan kelimpahan spesies itu diperhatikan. Penemuan menunjukkan hanya lima tupai kesemuanya, mewakili dua spesies dan dua keluarga Tupaiidae dan Sciuridae ditemui. Dengan tiga kes yang direkodkan, *Tupaia Glis* adalah spesies yang mempunyai kadar tangkapan tupai yang banyak. Berkenaan dengan bentuk hidupan yang tidak terancam, Tupaia Glis diklasifikasikan sebagai Least Concern. *Callosciurus Notatus* yang mempunyai dua individu, berada pada klasifikasi yang sama dengan bilangan tangkapan yang paling kurang. Oleh itu, lebih banyak penyelidikan di Universiti Malaysia Kelantan, Kampus Jeli diperlukan untuk memastikan kajian masa depan tentang kepelbagaian spesies tupai berdaya maju kerana populasi tupai di Kawasan itu mempunyai kadar kepelbagaian dan kelimpahan yang rendah. Pemangsa dan corak cuaca tempatan mempengaruhi ke atas kajian ini.

# TABLE OF CONTENTS

## LIST OF TABLE

## LIST OF FIGURES

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Study

The variety of living species on earth, including plants, animals, bacteria, and fungi referred to biodiversity. Biodiversity also had its own uniqueness in the genetic variation between populations and species (Adams, 2016). Biodiversity refers to various types of life on earth and refers to species or chains in the ecosystem.

Diversity could be divided into several different levels, including ecosystem diversity, species diversity, and genetic diversity. Species diversity was the number of different species in an ecosystem, and the current estimate of the totalnumber of Earth's living species ranges from 5 to 30 million (Amoeba Sisters, 2017) Genetic diversity refers to variation in genes within all of these species.

Mammals were a diverse group of animals found in various habitats worldwide, and they exhibit a wide range of sizes, shapes, and behaviors (David M, 2023). They were known for their well-developed brains and complex social behaviors, the number of "small" living mammals identified was approximately 90 percent of the 5416 species (Batelle, 2019). He has defined a small mammal as having a size or weight of 5 kilograms or 11 pounded or less. However, most appropriately he ignores this arbitrary

boundary whenever it seems sensible to did so (Wang Kelian, 2019). Examples of small mammals were rodents, tree shrews, moles, hedgehogs, rats, and solenodons. Rodentia was the largest order, consisting of four families: Sciuridae (squirrels), Spalacidae (bamboo rats), Muridae (rats and mice), and Hystricdae (porcuoines). Meanwhile, Erinaceidae (gymnures), Talpidae (moles), and Soricidae (shrews) were families from the Order Insectivora. Spalacidae (bamboo rats), Muridae (rats and mice), and Hystricdae (porcuoines). Meanwhile, the order Scandentia consists of Ptilocercidae (pentail tree shrews) and Tupaiidae (tree shrews). Small mammals often serve as prey for larger predators and were important components of various food webs (Joseph, 2015). They could also be significant contributors to ecological processes, such as seed dispersal and insect control (Njaka et al., 2014). Due to their size, small mammals were often less conspicuous than their larger counterparts, but they played essential roles in maintaining ecosystem balance and function. The study aims to determine the diversity and abundance of squirrels at a specific location.

## 1.2 Problem Statement

There was a lack of data about the diversity and abundance of squirrels at Universiti Malaysia Kelantan, Jeli Campus, Kelantan. So, in this study, we had intended to identify the diversity and abundance of squirrels within the designated studied area to gained insights into their ecological roles and assess their conservation significance. The collected data aims to explore the diversity and abundance of squirrels, small mammals threatened by human activities liked urbanization and Eco-tourism. Thus, this contributes to broader ecological researched and supports evidence-based conservation efforts to protect these essential components of the local ecosystem. This study helps in conservation and planning for preserving squirrel species and would help future generations with the availability of basic data at the studied site.

## 1.3 Objectives

The research aims to assess the diversity and abundance of squirrels in Universiti Malaysia Kelantan, Jeli Campus, Kelantan.

## 1.4 Scope Of Study

The focus of the study is to identify the diversity and abundance of squirrels. The data collected for captured squirrel species around 6 capture nights using cage traps and analyses using the Shannon diversity index and Simpson diversityindex to find the species diversity of squirrel.

## 1.5 Significant Of Study

The studied aimed to assess the diversity and abundance of squirrels in Universiti Malaysia Kelantan, Jeli Campus, Kelantan. The result of the research could provide most information and knowledge for future researched and also provided the data that was sufficient for future research at Universiti Malaysia Kelantan, Jeli Campus, in managing the diversity of squirrels.

## 1.6 Study Area

The research will be conducted at the Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus, Kelantan which spans 279,000 hectares and was operational in January 2012. The temperature in Faculty of Earth Science Jeli Campus, Universiti Malaysia Kelantan, which was spread across a total areaof 5 square kilometers and fell between latitude 5 ° 4315 " and 5 ° 45'30 " N andlongitude 101 ° 51'15 101 ° 53'30 " to " E, was 28°C on average every year. Jeli Campus, Universiti Malaysia Kelantan had also

become a biodiversity conservation center to facilitate research, ecotourism, and biodiversity education.


**Figure 1.1** the map displays the Faculty of Earth Science Jeli Campus, Universiti Malaysia Kelantan, Kelantan.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction to Diversity of The Squirrel, Family Sciuridae

Squirrels belong to the family Sciuridae, the largest order of mammals and part of Rodentia, according to (Miriam L, 2015). As by the researcher's last update in September 2021, there were over 200 recognized species of squirrels. Types of squirrels and some of the major groups have different species like mountain squirrels, ground squirrels, tree squirrels, and flying squirrels, as described by (Rabosky et al., 2013). There are so many different types of species of squirrels, and there is a significant range of sizes. As known, the African pygmy squirrel isthe smallest species, measuring only 2.8 to 5 inches (about 7 to 13 cm) from head to tail and having weights of around 0.35 ounces (10 grams). Squirrels build their nests in branches or tree cavities during the summer, but in the winter, they will stay in tree cavities, which is known as warming the body structure and invading home.

### 2.1.2 Species

In Southeast Asia, there are several species of squirrels, about 91 species, which are divided into 30 nocturnal squirrel species and 61 diurnal species. Squirrels play a role in eating and dispersing seeds from some of the species diets. 30 species in the flying squirrel category, including Thomas's flying (*Aeromys thomasi*) and Large Black Flying (*Aeromys tephromelas*), Horsfield's Flying Squirrel (*Ioyms horsfieldii*), and others, (Tarvin Gill, 2018). In addition, for Sundasciurus tree squirrels like *Callosciurus notatus* (Plantain Squirrel), *Tupaia glis* (Common Treeshrew), and *Callosciurus caniceps* (Grey Bellied Squirrel), ( Lee Grismer, 2020). For the red-bellied tree squirrel known as *Callosciurus erythraeus* (Pallas Squirrel) and the Oriental Tree, which is *Callosciurus baluensis* (Kinabalu Squirrel), (Meijaard, 2016).

There were eleven various kinds of squirrels which had been aimed in the process of capturing them in ordered to determine their species and data (Xundei Li, 2015). These consist of the plantain squirrel *(Callosciurus notatus)*, grey-bellied squirrel (*Callosciurus caniceps*), pallas's squirrel (*Callosciurus erythraeus*), sunda black-banded squirrel (*Callosciurus nigrovittatus*), western striped squirrel (*Tamiops mcclellandi*), low's squirrel (*Sundasciurus lowii*), slender squirrel (*Sundasciurustenuis*), horse-

tailed squirrel (*Sundasciurus hippurus*), red-cheeked squirrel (*Dremomys rufigenis*), three-striped ground squirrel (*Lariscus insignid*), and shrew-faced ground squirrel (*Rhinosciurus laticaudatus*). This particular sort of squirrel had been identified as a plant enemy causing destruction to fruit seeds.

### 2.1.3 Lifestyle

The red squirrel prefers to ate on the ground rather than trees. These squirrels were also very agile in trees, jumping from tree to tree and walking along slender branches. Diurnal squirrels that were active at dawn and in the morning by looking for available food were gray squirrels (Alina Bradford, 2014).

### 2.1.4 Diet

In general, the diversity of squirrels had a main meal or their favorite foods. Squirrels were herbivorous species that ate fruits, nuts, and seeds, while when the season was difficult, they would eat various types of small insects such as caterpillars, larvae, and crickets. The good resources of minerals and roughage for squirrels were bark, twigs, and soil, but they prefer dried corn on the cob (Baker N, 2021).

### 2.1.5 Wings Morphology

(Michael Kernan, 2020) suggests that squirrels possess a typed of wiglet, a small patagium flap. Scientists had conducted study indicating that wiggles curve upwards, resembling the wings of an airplane. A theory had been put forward that the tilted could reduce drag around the wing tip and acted to stabilize or reduce glide.

**Figure 2.1** The Siberian flying squirrels belongs to a species of *Pteromys volans*. (Source: Ecology Asia, 2020)

## 2.2 Echolocation Necessity for Squirrels

Firstly, ground squirrels used to emit ultrasounds to warned other animals that a predator was approaching. According to (Hazel Muir, 2014), the ground squirrels (*spermophilus richardsonii*) communicate with themselves, and a burrowing rodent responds to the approached of humans.

Thus, according to the (Muul and Alley, 2013) studies, flying squirrels emit sound at high frequencies in a more detailed vocalization studied, including the southern flying squirrel (*glaucomys volans*). Scientists had conducted studied indicating that wiggles curve upwards, resembling the wings of an airplane. But these squirrels used high frequencies in various contexts, (Gilley lm, 2013). Then, the term echolocation refers to special animals with specialized aquatic adaptations that used their ability to regularly searched for prey and evade or navigate predators. Therefore, squirrels could also made sounded and listened to echoed, even from large obstacles (Schnitzler et al., 2015).

## 2.3 Frequency Usually Used for Echolocation

Ultrasound was a signal with a frequency above 20 kHZ, the upper limit of human hearing. As the frequency of a sounded increases, its wavelength became shorter, and ultrasonic frequencies reflect more easily from smaller objects. However, they were more readily absorbed by watered molecules in the atmosphere, resulting in a more rapid attenuation rate in the air. A spectrometer was used to measured temporal and spectral parameters of vocalizations in recorded files, with a resolution of 0. 016 Ms and 976 Hz. The studied aimed to achieve higher temporal resolution by sacrificing lowered frequency resolution due to the short duration of observed sounded with large bandwidths. Temporal measures included called duration and inter-pulse interval (IPI), which was used to measure the sequence of successive vocalizations.

## 2.4 Technique and Method

The fundamental method is the technique followed by other researchers on the variety and abundance of squirrels. This approach entails walking survey lines across a forest, pausing periodically to note any sightings of squirrels. Although it offers a relative measure of numbers, it is not reliable for projecting how abundance will change over time. Then, this approach's distance sampling is comparable to the basic method but makes use of methods for determining the survey area's size, which makes it possible to estimate the squirrel density. Transect surveys, such as the line transect technique, entail walking transect lines through the research area and documenting signals, vocalizations, and sightings of squirrels (Len Thomas, 2023). It is employed to calculate the variety and abundance of species. Subsequently, the intense search approach entails focused searches in particular regions, such tree branches, the forest canopy, and the forest floor, in order to detect and document squirrel activity and presence.



It was discovered that the Common Tree-shrew (Tupaia glis) was the most prevalent small mammal in this part of Malaysia, while the Malaysian Fruit Bat (Cynopterus briachyotis) was the most numerous. Data on the variety, distribution, and habitat of flying squirrels were to be recorded through a detailed study conducted in Malaysia's Royal Belum State Park (Jayaraj, 2019). The preferred habitat of flying squirrels observed at Royal Belum State Park includes the types of trees, their height, and their

breast-height diameter. Data Deficient, Vulnerable, and Endangered Flying Squirrel Distribution and Ecology in Royal Belum State Park an activity for a night transect survey that involves community participation in data collecting and sampling.

# CHAPTER 3

# MATERIAL & METHOD

## 3.1 Materials

The materials that had been used were divided into two categories. The first was catching squirrels used equipment is cage trap while the second was using 'Pisang Emas' (*Musa acuminata*) and Groundnut (*Arachis hypogaea*) as a bait.

### 3.1.1 Cage Traps

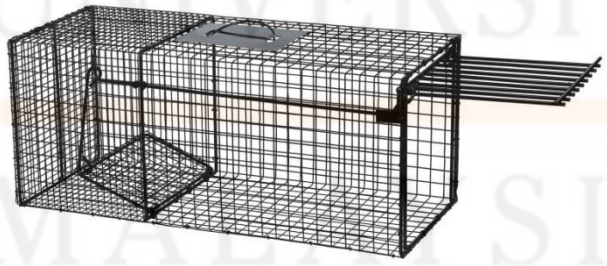


**Figure 3.1.1**: Image of cage trap (Source: Google image, 2024)

### 3.1.2 Baits

**Figure 3.1.2**: Image of Pisang Emas (*Musa acuminata*) and Groundnut (*Arachis hypogaea)*

There 6 cage traps had been used to caught squirrels used groundnut (*Arachis hypogaea*) and 'Pisang Emas' (*Musa acuminata*) baits. The species identificationprocess was done when the squirrel was in the cage. One of the pioneer plant species, 'Pisang Emas' (*Musa acuminata*) are commonly used in wildlife research and conservation initiatives. They offer important insights on wildlife ecology and conservation tactics and are used as bait in research on wildlife behavior, population growth, and habitat usage. Grown primarily for its edible seeds, the peanut, which is also referred to as the groundnuts (*Arachis hypogaea*), goober, goober pea, pindar, or monkey nut, is a legume crop. Both big and small commercial farmers grow it extensively in the tropics and subtropics as an oil crop and as a grain legume. By giving food and habitat, as well as by influencingbiological processes in natural habitats, groundnuts sustain animals. Their presence supports the viability and well-being of animal populations as well as the enhancement of biodiversity in their habitats.

## 3.2 Method

### 3.2.1 Trapping Method

Due to their role as food for certain predators, squirrels are a fundamentally elusive species, which makes their genetics difficult to understand. To get precise and objective predictions of the composition and organization of squirrel communities, a combination of direct and indirect methodologies must be employed. The most important method for tracking the variety and richness ofsquirrel populations has been thought to be live trapping. In any case, live trapping involves several techniques that differ in their level of skill and can even reveal differences in the population structure of a single species (Daniel U, 2016).One of the most popular types of traps for catching squirrels is the cage trap.

Humans have certain difficulties while employing cage traps for capture. Stress and physical injury are common during squirrel capture. Squirrels that arecaptured may also suffer from exposure to harsh weather conditions and dehydration. Squirrels may die in the days following release due to these wounds, stress, and bewilderment. To prevent the animal from getting into touch with or spreading possibly harmful organisms, ensure sure cage traps are ideal before using them. When utilizing cage traps to catch squirrels, there are certain procedures that must be followed (Maria

Vittoria Mazzato, 2016). The cage trapmust be set first. Place the cage trap on the animal's path as near to its course as possible. Ensure that the cage is stable and operating properly by setting the cage trap and tripping it a few times. To trip the trap, use the hanger that is provided above its surface, insert the end through the cage's side, and press downward on the treadle.

The animal and cage trap are being observed in the second stage. Move the trap to a safe, quiet area as soon as the squirrels are caught, cover it with a tarp, and wait for the appropriate moment to release them. Every morning at 8:00 AM, thetrap was baited, set, and examined every hour until 6:00 PM. The squirrels that are caught might not stay in the trap for as long as is required. If after three days it still doesn't produce a catch, move the trap.

Thirdly, squirrels need to be released from their cages. Release both nocturnal and diurnal species during the day. Point the opening of the trap toward an escape hatch so the animal may notice it and come closer. Open the front door, step back from the opposite end of the trap, and tap the bait (Kevin Carrilo, 2024). The final thing to do is clean the cage traps. It is necessary to clean the cage traps after every catch to stop the spread of diseases and illnesses since some creatures are unwell or polluted.

### 3.3 Data Collection

The initial sample site for this study is located on Faculty of Earth Science, Jeli Campus included 21 days of squirrel capture using 6 cage traps installed at designated located in sunny, frequently wet weather between 8:00 AM and 6:00 AM. There are around 8 meters separating one cage from the next.

Within the cages, peanuts and 'Pisang Emas' were stored as bait to catch the squirrels. After capturing them for a picture, the squirrels were released. The species squirrels had been determined based on the data obtained from the squirrels that were caught a basic overview of the species richness and abundance in the region was provided by a species cumulative graph that displayed the number of species against the number of days (Kathleen M. Zelman, 2022). It shows that there are not enough squirrels in the sample region to represent the entire number of squirrels if the line graph has not yet reached its asymptotic.

### 3.4 Data Analysis

Relative abundance (%) is to identify the percentage of each species or classification in a population or sample, one can utilize relative abundance calculations. It determines a species' frequency or rarity in relation to various species in a particular area or community. Relative species abundance is calculated using squirrels caught in the first day of capture (number of species/6cage trap) (Fadhlyemen, 2019)

$$\text{Relative Abundance} = \frac{\text{Total number of individuals per species}}{\text{Total number of individuals}} \quad (3.1)$$

Squirrel diversity and abundance are measured using the Simpson and Shannon diversity indices. An index used to condense the many characteristics of a population when each species is part of a distinct group is the Shannon diversity index (H). Richness and evenness diversity are measured using the Simpson Diversity Index (D). Number of species over sample is used to quantify richness(Levine D, 2014). In the meanwhile, the sample area's richness is determined by measuring evenness the relative abundance of each unique species (Tucker CM, 2017).

$$(H') = -\sum_{i=1}^{S} pi \ln(pi) \quad (3.2)$$

Thus: s = number of species

pi = proportion of total sample belongs to the species

$$(D) = \frac{n(n-1)}{\sum N(N-1)} \quad (3.3)$$

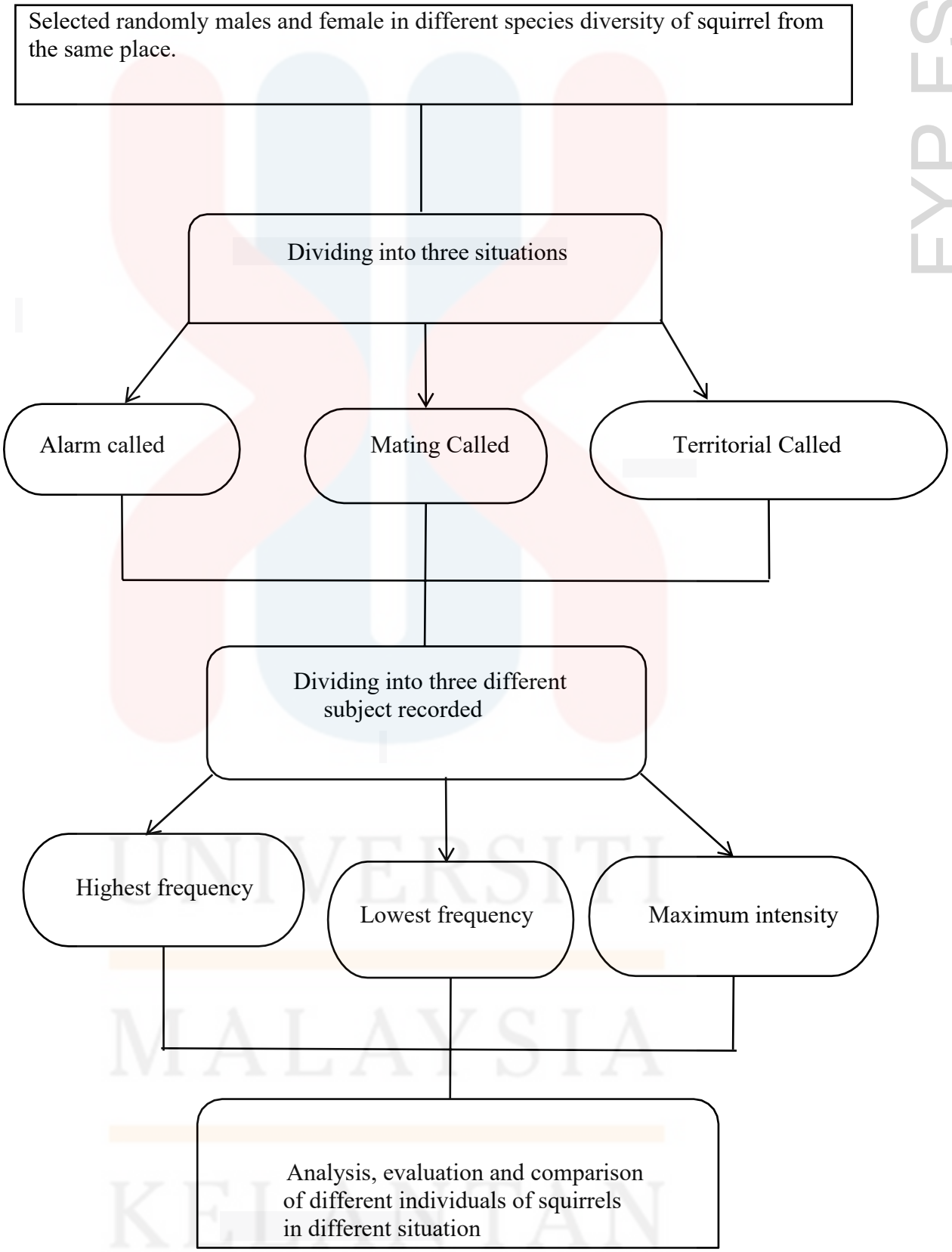
Thus: n = total number of individuals of the specified species foundN = total number of species' animals identified

$$E = \frac{H'}{Hmax} \quad (3.4)$$

$$Hmax = \ln(S) \quad (3.5)$$

Data collected in the field is analyzed to calculate caught rates and analyzed data released to trapping operations. A cumulative species curves was created to assess species adequacy from the data obtained and the data Shannon Index was used toquantify the diversity and abundance of squirrel in Universiti Malaysia Kelantan, Jeli Campus, Kelantan.

## Research Flow Chart



# CHAPTER 4

# RESULT AND DISCUSSION

## 4.1 Results

5 individuals from 2 different kinds of small mammals one under the order Rodentia and the other under the Families Tupaiidae and Sciuridae were caught for this investigation. Table 4.1 makes it abundantly evident that when it comes to the number of individuals, *Tupaia glis* is the most numerous species (3 individuals), followed by *Callosciurus notatus* (2 individuals). Sciuridae family has two species in this investigation.

Table 4.1: Diversity and abundance of squirrels in Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus, Kelantan.

| Species | Number of Individuals | IUCN Status | DWNP Status |
|---|---|---|---|
| **Rodentia** **Sciuridae** | | | |
| *Tupaia glis* | 3 | Least concern | Least concern |
| *Callosciurus notatus* | 2 | Least concern | Least concern |
| Total number of individuals | 5 | | |
| Total number of species | 2 | | |
| Number of families | 2 | | |
| Total traps | 6 | | |
| Capture rates | 0.83% | | |

The Shannon-Weiner diversity index for squirrels caught at the Faculty Earth Science Jeli Campus, is displayed in Table 4.2. The Shannon index value should fall between 1.5 - 3.5 in the majority of research of 0.673, the result of this investigation came inside that range the squirrel diversity and abundance are low in the Faculty of Earth Science, Jeli Campus. For squirrels caught at the Faculty of Earth Science, Jeli Campus, the Species Evenness index value was determined to be 0.971. Since the Species Evenness index value is approaching 1, the value shows that the species is approaching total evenness.

Table 4.2 shows the Shannon- Wiener Diversity Index and Evenness for Squirrels at Faculty of Earth Science, Jeli Campus.

| **Species** | **No of individuals** | **(pi)** | **In (pi)** | **(pi)In (pi)** | **Evenness** |
|---|---|---|---|---|---|
| *Tupaia glis* | 3 | 0.6 | 0.51 | 0.306 | |
| *Callosciurus notatus* | 2 | 0.4 | 0.91 | 0.366 | |
| **Total** | **5** | **1** | | **0.672** | **0.971** |

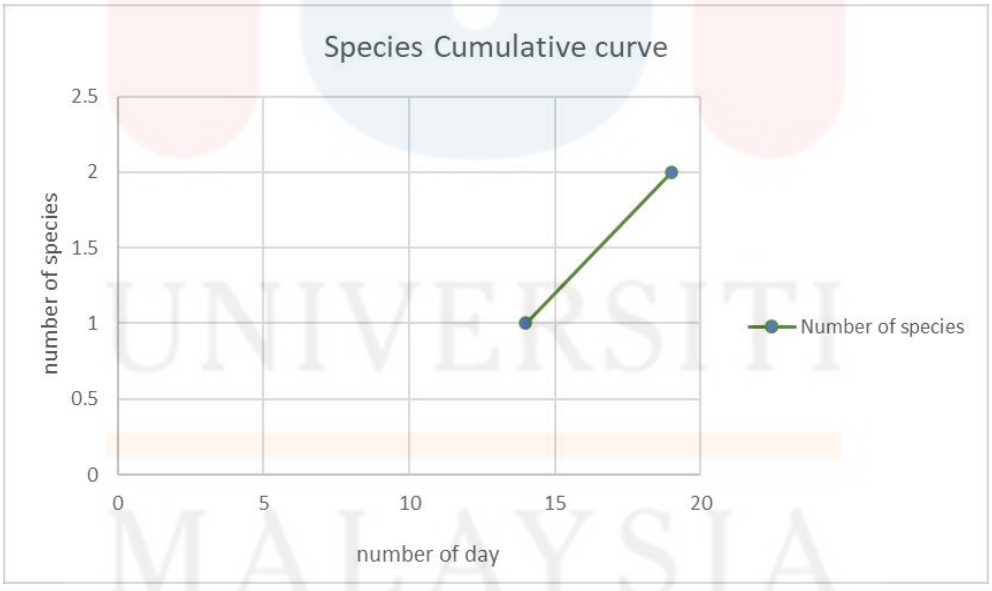
The Simpson's index and the Simpson's index of diversity for squirrels at the Faculty of Earth Science, Jeli Campus, are displayed in Table 4.3. Simpson's index, D had a value of 0.52. A Simpson index value ranges from 0 to 1, where 0 represents the maximum variety and 1 the lowest. The value obtained is trending towards increasing, showing that the Faculty of Earth Science, Jeli Campus has the lowest diversity of squirrels. The outcome for the Simpson's index of diversity was 0.48. Simpson's index of diversity has a range that is nearly identical to Simpson's index. However, when the value hits 1, it indicates the maximum diversity, and 0 indicates the lowest diversity. The diversity abundance of squirrels at the Faculty of Earth Science, Jeli Campus has the lowest diversity, according to the value of Simpson's Index of Diversity.

Table 4.3 shows the Simpson's index and Simpson's index of Diversity for squirrels at Faculty of Earth Science, Jeli Campus.

| **Species** | **n (number of individuals** | **n-1** | **n(n-1)** | **Total** |
|---|---|---|---|---|
| *Tupaia glis* | 3 | 2 | 6 | |
| *Callosciurus notatus* | 2 | 1 | 2 | |
| **Total** | **5** | | **∑n (n-1)= 8** | |
| **Simpson's index(D)** | **0.52** | | | |
| **Simpson's Index of Diversity** | **0.48** | | | |

The graph in Figure 4.1 indicates that no squirrels were caught on the first, second, or third day. Only one species of squirrel *Tupaia glis* was caught on the sixth day. On days 11 and 13, there are further captures of the same species, and on day 17 and 19, there is an additional species of *Callosciurus notatus*. On day 21, the graph approaches the asymptotic level. This asymptotic level demonstrates that the entire number of squirrels trapped at the Faculty of Earth Science, Jeli Campus, was sufficient to record all species.

## 4.2 Species Cumulative Curve



## 4.3 Species account

### 4.3.1 Treeshrews (*Tupaia glis*)

The largest of the treeshrews is the Tupai Muncung Besar, *Tupaia glis*, was caught mostly with a total of 3 individuals at Faculty of Earth Science, Jeli Campus. It belongs to the Tupaiidae family of small, flightless mammals. This little animal is 13 to 20 cm long, weighs around 190 grams on average, and treeshrew can be identified because has different-colored fur on its body, with white fur on the belly and gray or black fur on the top half of the body. It has a reddish-browncoloration overall. This species is almost as long as it is in the body, with a fluffy, gray-brown tail that measures 12–19 cm. Both sexes of these little creatures have the same appearance, with smooth hands that have sharp claws and smooth skin above the nose (Syuhada, S, 2020). Tupaia glis is listed as Least Concern in IUCN Red List of Threatened species (Sargis, E. & Kennerley, 2017).

### 4.3.2 Plaintain Squirrel (*Callosciurus notatus*)

Meanwhile, a species of rodent belonging to the Sciuridae family is called Tupai Pinang (*Callosciurus notatus*) was caught in mostly with sum 2 individuals recorded at Faculty of Earth Science, Jeli Campus. It may be found in Thailand, Singapore, Malaysia, and Indonesia. It may be found in a variety of environments, including gardens, parks, woodlands, and agricultural regions. Fruit farmers consider them to be vermin, (Jo Leen Yap 2022). Its length ranges from 20 to 30 centimetres on average, and its tail is the same size. The colour of this animal is grey/brown, with a black and white stripe running between it and its brown belly. The definition of "beautiful squirrel" refers to the genus *Callosciurus*. *Callosciurus notatus* is listed as Least Concern in IUCN Red List of Threatened species (Darkworth, J.W. 2016).

### 4.3.3 Factor That Affect the Capture Rate of Diversity and Abundance of Squirrels at Faculty of Earth Science, Jeli Campus.

#### 4.3.1 Availability and Habitat Quality

Food resources were influenced by habitat quality and availability since squirrel populations may be greatly impacted by the diversity and availability of food items, such as fruits, nuts, and seeds. More squirrels are probably drawn to areaswith plenty of food (James M. Hassell (2017). Since squirrels require water to stay hydrated, their dispersal may be impacted by water supplies that are not close by. For squirrels, the existence of trees, bushes, and other vegetation serves bothcover and a place to build their nests. Higher squirrel variety and abundance maybe sustained by dense vegetation.

Changes in land cover and use can have a big effect on how many squirrels are captured. For instance, alterations in farming methods and the division of forestsmight impact the accessibility of food supplies and living spaces for squirrels, thus influencing their population size and variety (Bret R, 2016). Based on this investigation, it can be concluded that *Tupaia glis* and *Callosciurius notatus* are not very diverse due to a variety of factors.

### 4.3.2 Human Activities and Disturbance at Faculty of Earth Science, Jeli Campus

Hunting, logging, and deforestation are just a few examples of how human activity may negatively affect squirrel populations. These actions may result in habitat degradation and fragmentation, which would lower the number of squirrels that are captured (Amy Haigh, 2017). Construction and human activity on campuses can disturb squirrel habitats, changing the distribution and number of these animals. Squirrel behavior can be impacted by pollution and noise, which might lower their visibility and decrease the likelihood that they will be captured.

### 4.3.3 Weather

The frequency at which squirrel variety and abundance were captured was impacted by continuous rain (Hugh J, 2017). Because the squirrels were withdrawn and inactive during this investigation, there was minimal to no catch rate on wet days.

### 4.3.4 *Musa acuminata*) as bait

'Pisang Emas' (*Musa acuminata*) was used as bait in this study in order to catch both diversity and abundance of squirrels (Amirtham, 2018). The study's squirrel catch rate was significantly impacted by the use of "Pisang Emas" (*Musa acuminata*) as bait. To maximize squirrel capture rates, local banana varieties like 'Pisang Emas' (*Musa acuminata*) are the preferred bait.

### 4.3.5 Competition and Predation

The behavior and population of squirrels can be affected by the presence of predators like snakes and birds of prey, which can make them more elusive and challenging to catch at Faculty of Earth Science, Jeli Campus. Competition between monkeys and other species, such as birds and other rodents, for food and habitat might impact squirrel abundance and distribution (Broughton, R. K, (2019). This is why data collection is necessary since monkeys can disrupt cage traps.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATION

## 5.1 Conclusion

All things considered, this study offers current information on the variety and number of squirrels at the Faculty of Earth Science, Jeli Campus as such, it may be contributed to the existing body of guidelines. This has to do with the speciesconsideration and the variables influencing the capture rate. According to this survey, the most prevalent species in the Faculty of Earth Science is *Tupaia glis*.The IUCN Red List of Threatened Species classifies the majority of the animal species that have been identified in this study as Least Concern. In 2017, the Department of Wildlife and National Parks Peninsular Malaysia (DWNP) listed *Callosciurus notatus* and *Tupaia glis* as Least Concern.

The species that were found in the Faculty of Earth Science, Jeli Campus, had the lowest diversity, according to the diversity and abundance index that was produced in this study using Simpson's index and Shannon-Weiner diversity index. After reaching its asymptotic level, the species accumulation graph recorded the overall amount of trapping effort. This was insufficient to include all species of squirrel found in this research region.

## 5.2 Recommendation

With lacking previous data, this study focuses on the species variety and numberof squirrels in the Faculty of Earth Science, Jeli Campus. New guidelines for future research have been generated by this study. Additionally, this informationis highly useful for planning the conservation efforts at the Faculty of Earth Science, Jeli Campus. Squirrels at both high and ground levels were the kind of squirrel that were caught for this investigation. To get fresh information, more surveys on squirrels across species are required.

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# APPENDIX

List species captured in Faculty of Earth Science, Jeli Campus.

| | | |
|---|---|---|
| Common treeshrew | *Tupaia glis* |  |
| Plantain squirrels | *Callosciurus notatus* |  |