# THE DIVERSITY AND ABUNDANCE OF STRAY CAT IN JOHOR BAHRU, JOHOR

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## Abstract

Cats (*Felis catus*) are one of the world's invasive species due to their close relations with human beings. Generally, stray cats are cats that were abandoned by their previous owners while feral cats are the ones that usually live in a colony away from human contact. The distribution and profile of the stray cats in Johor Bahru are unknown and need to be investigated. Thus, this study was conducted to determine the composition and abundance of stray cats in Taman Daya, Adda Heights, Taman Setia Indah, and Ulu Tiram. As well as to assess and compare the health conditions of the stray cats between localities. The stray cats' data were collected by using the mark-recapture technique and by counting and calculating the stray cats at the animal shelters visited. The stray cats were examined by the veterinarian to obtain their sex, breed, age, weight, temperature, reproduction status, and medical conditions. A total of 42 stray cats were caught and six breeds were identified, with Domestic Short Hair having the highest number of individuals. Then, the data were analyzed using PAST version 4.04 software indicated that Taman Daya has the highest diversity of stray cats with (H'=1.437) and breed richness with (R'=1.477) while Adda Heights has the highest evenness of stray cat breeds amongst the four locations with (E'=0.9806). Overall, this study shows the diversity (H') =1.504, richness (R') =1.355 and evenness (E') = 0.7500 of stray cats in these four locations, respectively which may acknowledge society about the diversity and abundance of stray cats and contribute towards controlling the number of stray cats. However, further in-depth studies are required to record more data of stray cats within this area.

## Introduction

Cats (*Felis catus*) have been known as one of the world's invasive species due to their relations with human beings (Duffy and Capece, 2012). Still, it is a very common animal that humans chose as pets in their households. As a result, populations of *Felis catus* whether as pets or astray are usually linked spatially with human populations (Ferreira *et al.*, 2011). Stray cats, cats that are abandoned by their owners or born astray can be found around restaurants, alleyways, on the streets, or even in residential areas. These cats can be found in those areas because they may have been introduced in order to control pests such as rats according to Robertson (2008). Otherwise, the high food availability areas can easily result in an increase in the overall abundance of stray cats (Hwang *et al.*, 2018, Seo *et al.*, 2021).

An increasing number of stray cats is quite alarming, especially with regard to zoonotic diseases. A study by Goni (2017) reported that the occurrence of *Campylobacter* cases in Selangor was recorded at 32.6% in stray cats higher than in pet cats, 12.5%. The cases could occur in an environment with improper hygiene practiced or a higher chance when coming in contact with the affected animals. Jones *et al.* (2018) reported a relatively low prevalence of *Toxoplasma gondii* infections in the United States (11.14% of seropositive for *T. gondii* IgG antibody) but it could cause around 400 to 4000 infants born

with congenital infection with *T. gondii* annually. On the contrary, *T. gondii* infections in Malaysia were not relatively low. The seroprevalence rate of *T. gondii* which can reflect the infections was 44.2% in immunocompetent patients (Mohamed and Hajissa, 2016), 57.4% among migrant workers (Sahimin et al., 2017), and 34% among pregnant women (Chemoh *et al.*, 2019). *Toxoplasma gondii* can infect humans by consuming food or water that is contaminated with *T. gondii* oocyst. Felid being the definitive host of these parasites can excrete millions of oocysts in the environment. Bawm *et al.* (2020) stated that the spread of *T. gondii* was higher among stray cats compared to pet cats and the female cats have a higher risk to be infected with *T. gondii*.

Moreover, there were evidence of stray cats gives a profound impact on local fauna and biodiversity. Loss et al. (2013) claimed that free-ranging cats including the stray cats in America cause significantly higher bird and mammals' mortality, with approximately 1.3-4.0 billion and 6.3-22.3 billion killed annually, respectively. The high death tolls among local fauna were also reported in China which estimated the minimum annual amount involve billions of invertebrates, fishes, amphibians, reptiles, birds, and mammals (Li *et al.,* 2021). Other than that, Robertson (2008) stated that stray cats could lead to emotional suffering as well as become a public nuisance. As well as Amirul Shakir (2017) noted in his study that the people of Kuching faced some problems with the stray animals, the remains of the stray cats that have been rotting on the streets after being run over by vehicles were such an upsetting sight. A survey conducted in Japan mentioned that the residents complained that stray cats caused the bad smell from the stray cats' feces Uetake *et al.* (2014).

Despite cats being one of the favorite human companions, stray cats can cause many concerns – transmission of zoonotic diseases, impact on biodiversity, and public nuisance. Their apparent abundance, which typically they can be found in places where the food sources are in excess like urban areas such as Johor Bahru, yet their present status is unknown. Due to insufficient study about the density and the profile of the stray cats in that area, the composition and abundance of stray cats were investigated and compared among the localities in Johor Bahru. In addition, the health conditions of these cats were examined in order to accurately profile these stray cats. The obtained data will determine the population size of stray cats in Johor Bahru which may provide preliminary information to facilitate future population management plans and further control the concerning issues relating to stray cats.

## Methods

**Study Area**

This study was conducted in Johor Bahru, one of the cities situated in the third most populous state in Malaysia (Department of Statistics Malaysia, 2021). There were four areas selected based on the area of shelters and veterinary clinics Johor, Taman Daya (1°33'08.0"N 103°45'37.4"E), Adda Heights (1°33'18.8"N 103°44'58.0"E), Taman Setia Indah (1°34'20.3"N 103°45'22.0"E) and Ulu Tiram (1°35'50.1"N 103°48'52.2"E) with Ulu Tiram being the area that has a stray cat shelter named Cat Tiram Shelter (Figure 1).
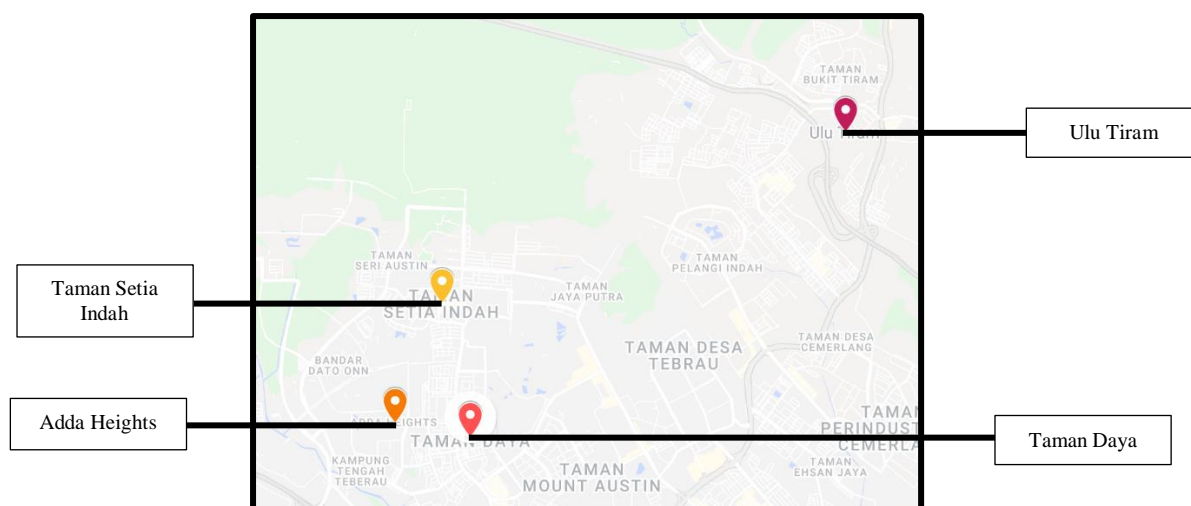
Figure 1. Map of Johor Bahru with four locations pinned (Google Map, 2021)

**Field sampling, data collection, and data analysis**

The stray cats' data were obtained by employing the mark-recapture technique which this technique required setting up traps to capture the subject of study, mark them for future recognition and release them back into the population (Henderson, 2002). A total of three traps were set up around the selected locations with cat foods placed in the traps to attract the stray cats that were roaming around the location. Then, the trap will be left to let the cats come near to the trap. Once the cat was captured, photos of the stray cats were taken to avoid data redundancy. The recaptured stray cats will be released from the trap. Additionally, any unintentionally trapped pet cats (collared, neutered, ear-tipped, or had signs of prior medical attention) or other species were released straight away for accurate data collection (Zito, 2018). The successfully trapped stray cats were brought to a veterinary clinic for their sex, species, breed, age, weight, temperature, and reproduction status examinations. The health condition of the cats was noted as well for supplementary data (Table 1). Then, the cats were released back to their place of origin.

The second data collection method was by visiting the stray cat shelters and the veterinary clinics that conducted a campaign for stray cats in which both places have numbers of stray cats to be included in this study. The data collected were analyzed for the Shannon-Wiener diversity index (H'), richness (R'), and evenness (E') of stray cats using PAST version 4.04. The relative abundance for each stray cat breed was estimated by the total number of individuals per breed divided by the total number of individuals.

Table 1. Parameters that were collected for this study.

| Main Data | Description |
| --- | --- |
| Sex | Female/Male |
| Species | Follow the standard scientific name (provided by a veterinarian) |
| Breed | Follow the standard breed grouping |
| Age | Juvenile (<6 months) or Adult (>6 months) |
| Weight | Weight of cats in kg |
| Temperature | The temperature of cats in °C |
| Reproduction status | Active or Neuter/Spay |

| Supplementary data | Description |
| --- | --- |
| Medical conditions | Mite infection |
| | Fungus infection |
| | Open wound |
| | Eye infection |

**Stray cats' health examination**

The stray cats were examined by the veterinarian to obtain their health conditions. The medical conditions that were noted were fever condition, reproduction status, mite infection, fungus infection, open wound, and eye infection. In order to determine whether the cats were fever or not, the temperature of the stray cats was taken using a thermometer. The thermometer with gel applied at the end of the thermometer was inserted into the anus of the cat (Figure 2).



Figure 2. The body temperature of the cat is being taken

### Result and Discussion

**General result**

A total of 42 individuals of only a single cat species *Felis catus*, were successfully collected in this study (Table 2). The highest number of stray cats collected were from Taman Daya with 15 cats, followed by 11 cats from Taman Setia Indah and 9 cats from Ulu Tiram. The lowest number of cats were from Adda Height, with seven cats in total. Additionally, there are five different breeds collected amongst the 42 individual stray cats. To begin with, the Domestic Short-Hair breed was the highest breed collected with 18 cats, followed by the Domestic Long-Hair breed with eight cats, and the lowest breed with two cats, the Tonkinese breed. The other cat breeds collected were Bombay, Siamese, and Scottish Fold with six and three cats each for later breeds mentioned, respectively.

Table 2. The collected stray cats for each area of study in Johor Bahru Johor.

| Breed | Taman Daya | Adda Heights | Taman Setia Indah | Ulu Tiram | Total Individuals |
|---|---|---|---|---|---|
| Bombay | 1 | 2 | 1 | 2 | 6 |
| Domestic Short Hair | 6 | 3 | 6 | 3 | 18 |
| Domestic Long Hair | 4 | 2 | 3 | 1 | 10 |
| Siamese | 2 | 0 | 1 | 0 | 3 |
| Scottish Fold | 0 | 0 | 0 | 3 | 3 |
| Tonkinese | 2 | 0 | 1 | 0 | 2 |
| Total individuals | 15 | 7 | 11 | 9 | 42 |
| Relative abundance (E') | 0.8415 | 0.9806 | 0.7669 | 0.9273 | |

The Domestic Short-Hair cat breed is the highest breed collected amongst the four locations. There are approximately six individuals of Domestic Short-Hair breeds in both Taman Daya and Taman Setia Indah. The high number of Domestic Short-Hair breeds is because it is one of the common breeds that

could be seen in the streets of Malaysia (Figure 2). Compared to the Tonkinese breed, which has the lowest count of cats collected, the Tonkinese cats are an uncommon stray cat breed in Malaysia.

**Composition of the stray cat**

The breed diversity of stray cats was calculated using Shannon-Weiner Index (H'). The H' values for Johor Bahru represented by Taman Daya, Adda Heights, Taman Setia Indah, and Ulu Tiram were (H') = 1.504, which indicates that these four areas have low species diversity of stray cats. This is also reflected in Margalef Index, the Richness (R') index = 1.355, which describes the abundance of species per unit area is low in Johor Bahru. Moreover, the Evenness (E') index showed a lower value with E' = 0.7500 which indicates that the distribution of stray cats in Johor Bahru was sparse.

The outcome of calculated biological indices specified Taman Daya has the highest diversity of stray cats and highest breed richness with (H'=1.437) and (R'=1.477) while Adda Heights has the highest evenness of stray cat breeds with (E'=0.9806) amongst the four areas (Table 3). On the other hand, Ulu Tiram has the second highest diversity of stray cats, breed richness, and evenness of stray cat breeds with (H'=1.311), (R'=1.365), and (E'=0.9273) respectively. Next, the location that has the third highest diversity of stray cats and breed richness was Taman Setia Indah with (H'=1.121) and (R'=1.251) while Taman Daya has the third highest evenness of stray cat breeds with (E'=0.8415). Lastly, Adda Heights has the lowest diversity of stray cats and breed richness in its area with (H'=1.079) and (R'=1.028) while Taman Setia Indah has the lowest evenness of stray cats breeds compared to the other four areas with (E'=0.7669).

Table 3. Diversity (H'), species richness (R') and evenness (E') of stray cats for four areas in Johor Bahru.

| Location | Total Number of Individuals | Shannon-Weiner Index (H') | Richness Index (R') | Evenness Index (E') |
|---|---|---|---|---|
| Taman Daya | 15 | 1.437 | 1.477 | 0.8415 |
| Adda Heights | 7 | 1.079 | 1.028 | 0.9806 |
| Taman Setia Indah | 11 | 1.121 | 1.251 | 0.7669 |
| Ulu Tiram | 9 | 1.311 | 1.365 | 0.9273 |
| All locations | 42 | 1.504 | 1.355 | 0.7500 |

Taman Daya has the highest diversity of stray cats due to the vast human population there. Compared to the other locations, Taman Daya has a bigger residential area that is filled with shop lots and supermarkets. Due to that, the diversity of stray cats is higher there as stray cats seek shelter where they can find food resources easily (Robertson, 2008). Other than that, Robertson (2008) also said that stray cats usually come from humans who abandoned them or are introduced to the environment to combat pests like rats. Next, Taman Daya has a richness index of 1.477 which is higher than Adda Heights with 1.028 because the abundance and diversity of stray cats were evenly distributed among all the breeds in the population. After that, Taman Daya has an evenness index of 0.8415 which is lower than Adda Heights with 0.9806. This occurs due to Adda Heights having a location that has an equal amount of stray cats' breed distribution compared to Taman Daya. Hence, it is plausible to assume that the diversity of stray cats in these four areas is slightly diverse. This is probably due to the stray cat breeds that are abundant in the four locations are not as much. Although there were around 40 breeds in Malaysia according to Malaysia Cat Club, only 7 breeds were found in these four locations. Moreover, the breeds that were found in these locations were Bombay, Domestic Short Hair, Domestic Long Hair, Siamese, Scottish Fold, and Tonkinese where Domestic Short Hair and Domestic Long Hair are the most common stray cat breeds globally according to American Humane Association (2012).

**Health condition of Stray Cats**

A total number of 14 juveniles and 10 adult stray cats that has a body temperature that exceeds 39°C (Table 4). The veterinarian that examined the stray cats informed us that if the cats' body temperature exceeds 39°C, it means that the cat has a fever. Based on the data obtained, there were a lot more juveniles that were diagnosed with fever compared to adult ones. Since juvenile cats have lower immune systems compared to adult ones. Hence, they are more prone to viruses and diseases (Wilson, 2019).

Table 4. The number of stray cats diagnosed with fever by age.

| Temperature | Total Number of Adult Individuals (>6 months) | Total Number of Juvenile Individuals (<6 months) |
|---|---|---|
| Less than 39°C | 7 | 21 |
| More than 39°C | 10 | 14 |

The reproduction status of stray cats was noted as well. There were three stray cats neutered upon examinations which these three neutered cats were caught from Adda Heights, Taman Setia Indah, and Ulu Tiram. Conversely, there was an absence of neutered cats caught in Taman Daya hence explaining the abundance of stray cats in the area. Taman Daya also has the highest number of stray cats compared to the other locations. Based on several studies, it has been proven that neutering stray cats are very effective in decreasing the size of cat colonies throughout the years (Levy *et al*., 2014).

Table 5. The health condition of stray cats examined

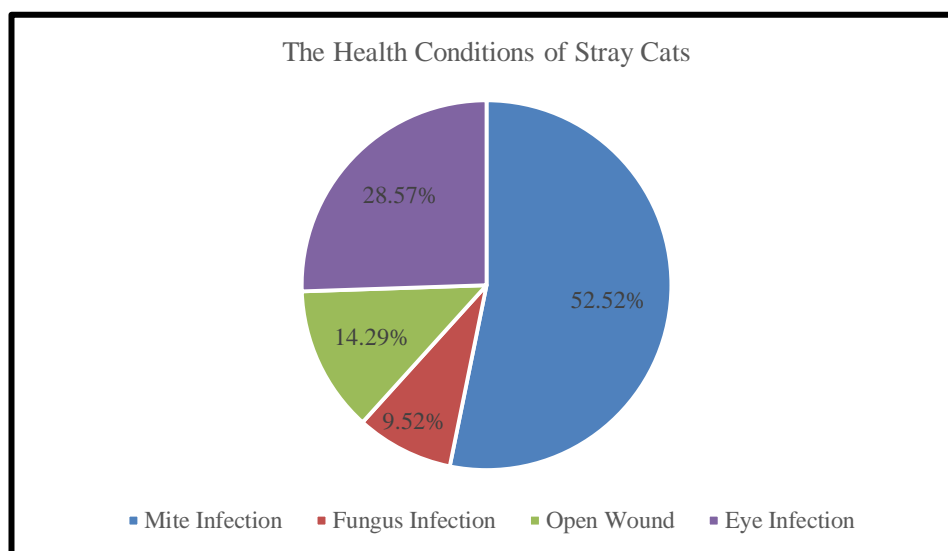| Health condition | Total Number of Individuals Infected | Percentage (%) |
|---|---|---|
| Mite infection | 25 | 52.52 |
| Fungus infection | 4 | 9.52 |
| Open wound | 6 | 14.29 |
| Eye infection | 12 | 28.57 |



Figure 3. Pie chart of the health conditions of stray cats

A total of 32 stray cats have at least one type of infection or injury while ten of them are free of any infections and injuries (Table 5). The highest percentage of infections the stray cats have been mite infections (Figure 3). Mite infections can be observed by looking at the cat's ears. After that, the lowest percentage of infections the stray cats have been fungus infections. To identify whether the cat has a fungus infection or not, an apparatus called Wood's lamp was used. The veterinarian used Wood's lamp on the stray cats and only four out of 42 individuals have a fungus infection.

Mange is a very common problem that stray cats or feral cats have. Mange is a condition that cats have when they are infected with mites. The most common mange affected by stray cats is the otodectic mange (Fanelli *et al*., 2020, Dryden, 2018). *Otodectes cynotis*, ear mite is the mite species that causes otodectic mange on stray cats or dogs and is commonly known as ear mite (Figure 4). These mites are usually found deep in the external ear canal of the cats. Sometimes it infests other parts of the body including the feet, head, tip of the tail, and head. It usually lives as a surface parasite and does not burrow into the skin. These mites feed on blood, lymph and serum as they may pierce the skin of the mammal (Mullen and OConnor, 2019).
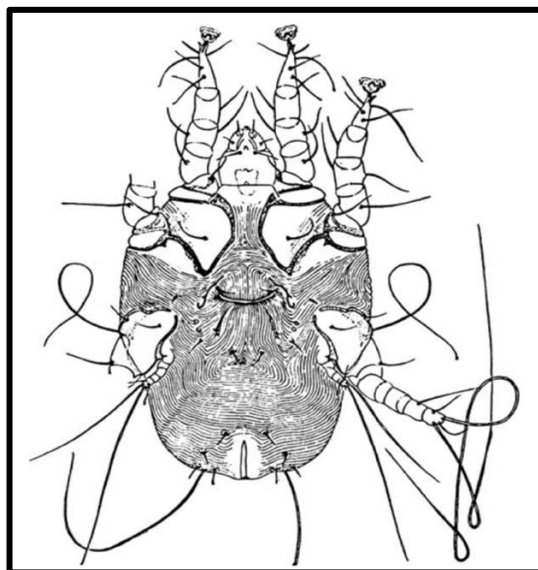
Figure 4. *Otodectes cynotis*, ear mite of cats and dogs

Moreover, antigenic substances are produced when the mites are feeding on the skin of the animal which resulted in clinical signs that reflect allergic hypersensitivity (Mullen and OConnor, 2019). The clinical signs can lead to varying responses ranging from asymptomatic, mild cases to convulsive seizures and severe otitis.

The prevalence of *Otodectes cynotis* according to a study by Lefkaditis *et al.* (2021) conducted during the summer in north-central of Florida, it appears that 74 out of 200 (35%) cats caught and examined by swabbing the specimen from both ear canals were infected by *Otodectes cynotis*. On the other hand, fleas which is another type of ectoparasite that commonly infects stray cats have a higher prevalence compared to ear mites. *Ctenocephalides felis* (cat flea) which was the most common flea has infected 185 out of 200 cats (92.5%) according to the study found by Lefkaditis *et al.* (2021). Next, a study conducted by Lefkaditis *et al.* (2009) found that the prevalence of *O. cynotis* was higher in cats age ranging between three and six months with 17.58% prevalence compared to cats aged below three months with 11.38% prevalence.

## Conclusion

In conclusion, Taman Daya has the highest diversity of stray cats and breed richness while Adda Heights has the highest evenness of stray cats. Then, Taman Daya was determined as having the highest individual of stray cats found in Johor Bahru. Moreover, the medical conditions of the caught stray cats showed that the juvenile stray cats were more likely to catch fever than the adult cats, and the mite infection was more prevalent among stray cats compared to other infections such as fungus and eye infections. The number of juvenile cats that has a fever was more than the number of adult cats. Lastly, it is recommended to expand the area of study for in depth and breadth of the stray cat's distribution and population dynamic which will be helpful to reflect the composition and abundance of stray cats in Johor Bahru more realistically.

## Acknowledgment

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