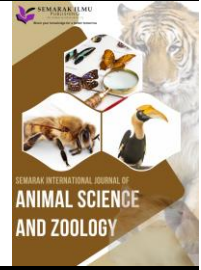




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# Toward a Greener UUM: A Study of Stray Cat Population Dynamics at Universiti Utara Malaysia

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### ABSTRACT

Cats have a tremendous impact on human health and societal well-being in many nations throughout the world. This work focuses on creating models to employ difference equations to examine the population of stray cats living in the Universiti Utara Malaysia's (UUM) residence hall. These models' main goal is to make it easier to determine the best strategy for controlling the stray cat population, in line with UUM's sustainable objectives. The examination of four different countermeasure strategies—catch-release, catch-neuter-release, catch-euthanize, and catch-release-neuter-euthanize—is covered by this inquiry. Our findings show that the stray cat population is dropping in three of the four successful techniques. The catch-release tactic, on the other hand, shows a rising tendency. Our analysis leads us to recommend the catch-neuter-release strategy as the most effective and sustainable way to control the stray cat population in the UUM residential hall, in line with the university's commitment to sustainability.

## 1. Introduction

Cats have a very important role in many countries in the world in terms of human health and social benefits. Malaysia has a cat population of about 795,000 cats as of 2018, with numbers steadily growing each year [1]. Meaning, we've easily got a million cats on our hands as of now. Mostly in Malaysia, people will take cats as their pets and as pet owners, it is their responsibility to take care of their cats. Having a pet means taking responsibility of another living being's life. Food, water, hygiene, health and so much more is our responsibility to provide to our pets.

As for stray cats, they are a familiar sight in public spaces, especially at restaurants, hospitals and universities where there is access to food waste. A stray cat is a cat who lived indoors and was socialized to people at some point of her life, but has left or lost her home, or was abandoned and no longer has regular human contact. A stray cat may be socialized enough to allow people to touch her, but she will become less socialized, even feral when spends too much time without positive interaction with humans.

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Cats who spend significant unsupervised time outdoors tend to survive to be about 7 years old, while indoor-only cats can be expected to live to around 14 years of age [2]. Cats have their first estrous (reproductive) cycle when they reach puberty. The estrous cycle is better known as a cat's heat cycle. On average, puberty or sexual maturity, first occurs in cats at about six months of age, but this can vary slightly by the time of year (length of daylight hours). Each heat generally lasts several days with the average length being seven days, although it can range from 1 to 21 days [3].

Female cats can become pregnant at five months and an average cat has 1-8 kittens per litter and 2-3 litters per year. During her reproductive life, a female cat can have more than 100 kittens. One female cat and her offspring can produce between 100 to 400 cats in 7 years [4]. As the presence of stray cats is significant in Universiti Utara Malaysia (UUM), the risk of an exploding population of these cats in campus can be expected in near future.

In UUM, there are 15 students' residential halls which divide by route A, route B, route C and Route D. In route A, there are 4 residential hall which are MAS, TNB, Proton and Tradewinds. While in route B, there are TM, MISC, BSN, Sime Darby, Grantt and Petronas. In route C, there 2 residential hall which are YAB and Muamalat. Last but not least, in route D there are SME Bank and Bank Rakyat. One more residential hall is known as Maybank where students with family will stay there. In each residential hall, there are a café for the students to buy food. Cats can live with access to food in residential hall because there are a lot of food waste from the café. Students usually spend their money to buy cats' food.

It is impossible to exaggerate how urgent our situation is, particularly in light of our goal of making UUM a green campus. The threat of an unchecked rise in the number of stray cats lurks menacingly across the expansive grounds of UUM. Without prompt action, we run the possibility of experiencing a severe overcrowding situation in our residence halls. Imagine there are only five female stray cats living in the residence hall right now. Over the course of seven years, if each of them reproduced and gave birth to just 100 kittens, we would be overrun by a startling 500 kittens. Furthermore, the quick maturity of these kittens within five months is not even taken into account in this worrisome prognosis. We must act immediately to develop and put into action the most sensible and humane solutions to this growing catastrophe. Until a serious intervention is made, the cycle continues unabated.

Currently, there are few methods to manage stray cats. Examples include the traditional methods of catching and euthanizing them. This method can be considered the last option as it is inhuman and contrary to most of the religion's values and concepts. In this study we aim to find the most effective way in managing stray cats, without having to euthanize these cats. There are 4 approaches that we want to study on and do the prediction on the numbers on stray cats in the future (Table 1).

**Table 1**  
Literature concerning existing methodologies

No.	Approach	Description	Reference
1	Catch-release	Let the stray cats live in the residential hall without any action taken.	Not applicable
2	Catch-neuter-release	Castration all the male cats in residential hall.	[5-8]
3	Catch-euthanize	Euthanize all stray cats in residential hall.	[9-11]
4	Catch-release-neuter-euthanize	Some of the stray cats will be release, while some of them being castration and euthanize.	[12,13]

To date, there is a significant lack of studies focusing on managing stray cat populations in Malaysian universities, despite the growing presence of these animals on campuses like UUM. Existing methods, such as trapping and euthanasia, are often seen as inhumane and conflict with

cultural and ethical values. Universities face unique challenges due to abundant food waste and semi-contained environments, which support stray cat populations and threaten sustainability goals. This study aims to address this gap by exploring humane and effective strategies for managing stray cats, providing a solution that balances ethical considerations and campus sustainability.

## 2. Methodology

### 2.1 Data Collection

This research collected primary data through field visits to the residential hall to locate and identify stray cats. For each stray cat encountered, we tagged them by capturing a photograph for individual recognition purposes.

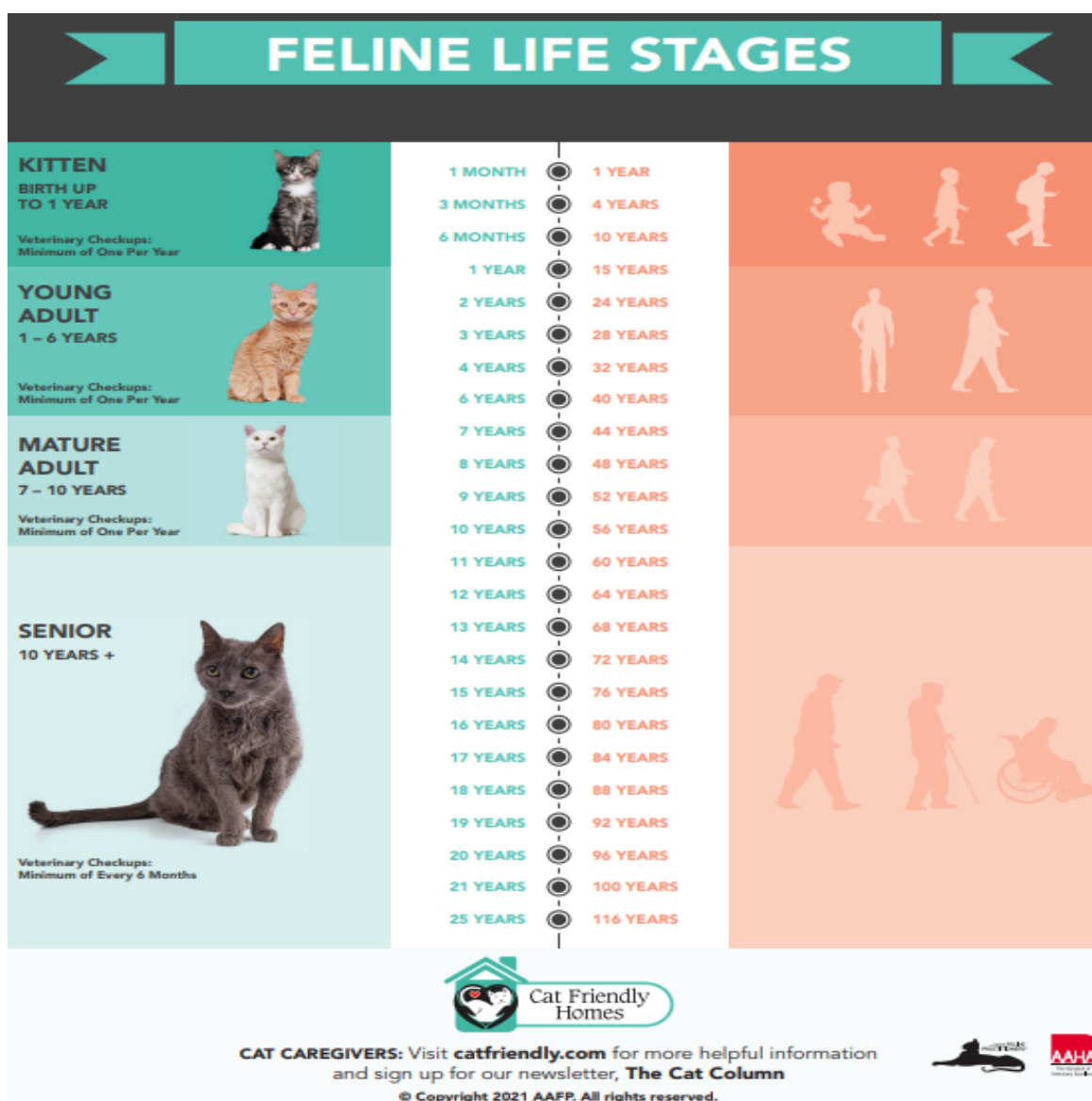


Fig. 1. Feline life stages

Data collection was initiated from the study area which included from SME Bank and Bank Rakyat Residential Hall. Each stray cat found, was tagged and by taking a picture so that each cat could be recognized. Data was recorded by looking at their gender and estimating their age.

## 2.2 Sample Size

The sample size of the study was from UUM residential hall that is located in route D which consisted of SME Bank and Bank Rakyat Residential Hall.

## 2.3 Hypothesis

There were four counter measure strategies in managing stray cat in UUM residential hall; thus, four hypotheses are available for each factor as following in Table 2.

**Table 2**  
 Hypotheses of the study

No.	Hypothesis	Description
1	Hypothesis 1	If we let the cats live in residential hall, it will increase number of stray cats there and indirectly will increase the health cases there.
2	Hypothesis 2	By castration the cats within 10 years UUM residential hall will be free from the stray cats.
3	Hypothesis 3	Killing the cats help in immediately decrease the stray cats in residential but this action will become an issue in UUM.
4	Hypothesis 4	By killing male cats, it will help to reduce the stray cats population without involve many costs.

## 2.4 Modelling Stray Cats Using Difference Equation

Table 3 depicts the tactics and measures associated with the four theoretical strategies.

**Table 3**  
 Four countermeasure strategies

No.	Approach	Strategy	Action
1	If we let the stray cats live in the residential hall	We'll simulate the number of stray cats if nothing is done. We can forecast what will happen to the stray cat population in the future using the model.	The cats will be allowed to live in the Residential Hall unattended. Every year, we'll keep track of and document the rise in stray cats.
2	If we castration the stray cat	The castration of male cats will serve as our example for how the stray cat population will develop. We can see what impact this move has on the number of stray cats.	With the assistance of a nearby veterinarian, we will castrate every male cat living in the residence. Within a specific time period, it will help to minimize the number of stray cats in UUM while also preventing female cats from becoming pregnant.
3	If we kill all the stray cat	We will model the stray cat population after the action been taken.	This will automatically decrease the number of stray cats in residential hall. This is considered as last approach that we will take.
4	If we kill all male cats and release female cats	We will model the population to know how this action affect the stray cats population.	It will help to reduce the population without castration all the cats. Within a certain year, the number of cats will be zero.

For this study, we use difference equation to model the stray cats population. A difference equation is any equation that contains a difference of a variable. The following variables affect how difference equations are categorised; 1) Order of the equation. The order of the equation is the highest order of difference contained in the equation; 2) Autonomous vs. non-autonomous; 3) Linear vs. nonlinear.

Then, we assume that during a small unit time interval, a percentage  $b$  of the population is newly born. Similarly, a percentage  $c$  of the population dies. The percentage of newly born will only involving population of female cat,  $Pf(t)$ . In other words, the new population,  $P(t + \Delta t)$  is the old population,  $P(t)$  plus (+) the number of births minus (-) the number of deaths during the time period,  $\Delta t$  as in Eq. (1),

$$P(t + \Delta t) = P(t) + bPf(t)\Delta t - cP(t)\Delta t \quad (1)$$

Female cats can become pregnant at five months and an average cat has 1-8 kittens per litter and 2-3 litters per year.

Assumptions:

- The female cats in the residential hall will have 2 litters per year (Which is the minimum litters for cats).
- A time interval of every 6 months for cats to reproduce was referred.
- Each cat will reproduce 4 kittens each litter (Which is the average number of kitten that cat reproduce).
- From the kittens produced, 50 % are female and another 50 % are male.
- The average cat lifespan outdoors is 5.625 years [13].

Using this assumption, we predicted the stray cat population every half year (1 litters). We also used Microsoft Excel to model the graph for each measure taken.

### 3. Results

#### 3.1 Cat Population

In this study, we used the sample size in UUM Residential Hall route D which are from SME Bank and Bank Rakyat residential hall. The total of cats that were found was 17 with 7 female and 10 male (Table 4).

Female	7
Male	10
Total	17

##### 3.1.1 Catch-release approach

The first approach that we take is catch release approach (Table 5). In this approach we will let the cats to live in the Residential Hall without doing anything to them and we will monitor and record the increase of stray cats each year. From the Figure 2, we do a prediction on the number of cats if we apply catch release approach. The population start with the total of 17 cats. The number is increasing after 6 month (0.5 years) or 1 litter to 45 cats. For the next litter which is 6 month after

that (1 year), the population increase to 72 cats. As we can see from the Figure 2, the number of cats keep increasing to a bigger number. After 5.5 years, the numbers of cats is increase to 36,436 which is a really big number. From this Figure 2, we can see that if we let the stray cats live in the residential hall without any action taken, its only takes a short few years for the number of cats to drastically increase.

**Table 5**  
 Catch-release calculation

years	b	Pf(t)	bPf(t)Δt	P(t)	cP(t)Δt	P(t+Δt)
0	0	7	0	17	0	17
0.5	4	7	28	17	0	45
1	4	7	28	45	1	72
1.5	4	21	84	72	0	156
2	4	33	132	156	6	282
2.5	4	75	300	282	0	582
3	4	139	556	582	4	1134
3.5	4	289	1156	1134	0	2290
4	4	565	2260	2290	3	4547
4.5	4	1143	4572	4547	0	9119
5	4	2272	9088	9119	3	18204
5.5	4	4558	18232	18204	0	36436

### 3.1.2 Catch-neuter-release approach

The second approach that we take is catch neuter release approach (Table 6). In this approach, we will castration all the male cats in residential hall with the help of veterinarian near us. It will help to avoid female cats from getting pregnant and at the same time will reduce the stray cats in UUM within a certain year. From the Figure 3, we do a prediction on the number of cats if we apply catch release approach. The population start with the total of 17 cats. For the next six months (0.5 years), we still do not see any changes in the numbers of cats. It means that, there are no birth or death of the cats. But for the next litter, we can see that the graph shown a decreasing pattern. It either the number keep decrease or there are no changes. After 5 years, the numbers of cat is 0. It means that by using this approach, its take 5 years for the residential hall to be free from stray cats.

**Table 6**  
 Catch-neuter-release calculation

years	b	Pf(t)	bPf(t)Δt	P(t)	cP(t)Δt	P(t+Δt)
0	0	7	0	17	0	17
0.5	0	7	0	17	0	17
1	0	7	0	17	1	16
1.5	0	7	0	16	0	16
2	0	5	0	16	6	10
2.5	0	5	0	10	0	10
3	0	3	0	10	4	6
3.5	0	3	0	6	0	6
4	0	1	0	6	3	3
4.5	0	1	0	3	0	3
5	0	0	0	3	3	0
5.5	0	0	0	0	0	0

### 3.1.3 Catch-euthanize approach

The third approach is catch euthanize approach (Table 7). This will automatically decrease the number of stray cats in residential hall. From Figure 4, it shown that the numbers of cats drop to 0 for the next litter. The population of cat can be control using this approach but this is considered as last approach that we will take as it is not humane.

**Table 7**  
 Catch-euthanize calculation

years	b	Pf(t)	bPf(t)Δt	P(t)	cP(t)Δt	P(t+Δt)
0	0	7	0	17	0	17
0.5	4	0	0	17	17	0
1	4	0	0	0	0	0
1.5	4	0	0	0	0	0
2	4	0	0	0	0	0
2.5	4	0	0	0	0	0
3	4	0	0	0	0	0
3.5	4	0	0	0	0	0
4	4	0	0	0	0	0
4.5	4	0	0	0	0	0
5	4	0	0	0	0	0
5.5	4	0	0	0	0	0

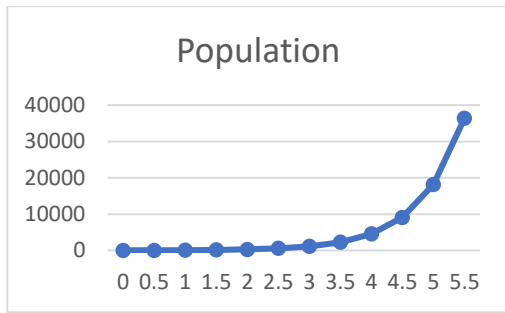
### 3.1.4 Catch-release-neuter-euthanize approach

The last approach is catch release neuter euthanize approach (Table 8). In this approach we combine all method in managing stray cats, where we kill all male cats and release female cats. It will help to reduce the population without castration all the cats. Within a certain year, the number of cats will be zero. From the Figure 5, we can see that the number of stray cats population start with 17 cats. After 6 months, the number of cats reduce to 7 cats. The big drop of number is because we euthanize the male cats. The numbers of cats are maintain for the next 2 litters (1 year) and begin to decrease again after that. Within five years, we can free from stray cats in the residential hall without has to pay for the castration cost, but this method is also not humane.

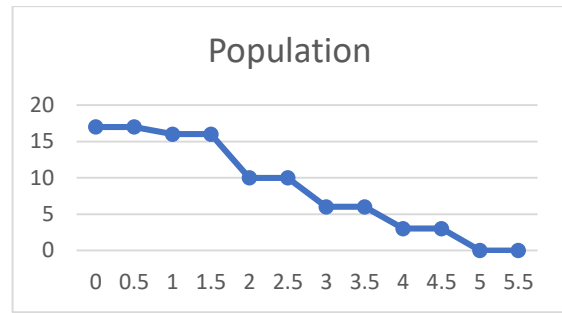
**Table 8**  
 Catch-release-neuter-euthanize calculation

years	b	Pf(t)	bPf(t)Δt	P(t)	cP(t)Δt	P(t+Δt)
0	0	7	0	17	0	17
0.5	0	7	0	17	10	7
1	0	7	0	7	0	7
1.5	0	7	0	7	0	7
2	0	5	0	7	2	5
2.5	0	5	0	5	0	5
3	0	3	0	5	2	3
3.5	0	3	0	3	0	3
4	0	1	0	3	2	1
4.5	0	1	0	1	0	1
5	0	0	0	1	1	0
5.5	0	0	0	0	0	0

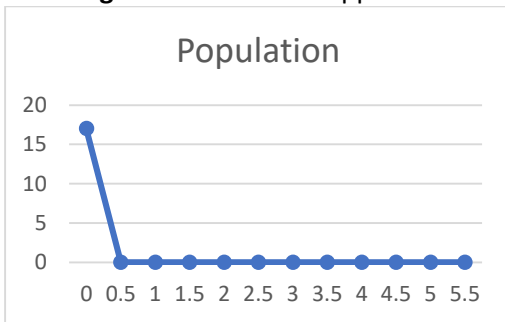
Figures 2 through 5 depict the trends in stray cat populations for each of the four approaches.



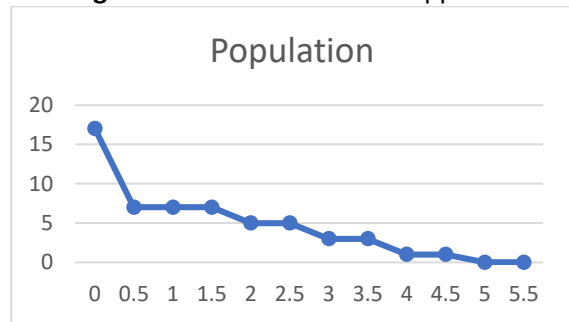
**Fig. 2.** Catch-release approach



**Fig. 3.** Catch-neuter-release approach

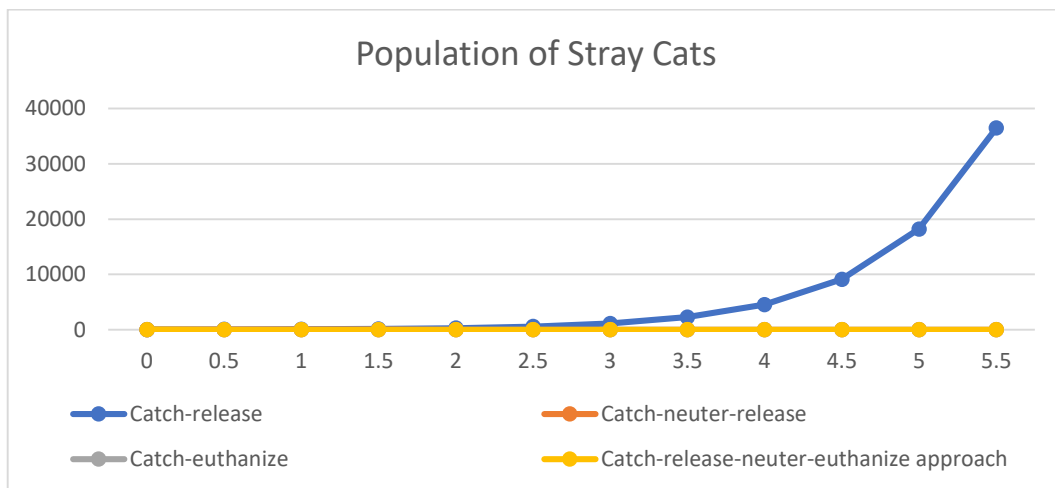


**Fig. 4.** Catch-euthanize approach



**Fig. 5.** Catch-release-neuter-euthanize approach

A comparison of all four approaches is shown in Figure 6. The only strategy that keeps strays cats from multiplying is catch-release. All three approaches—catch-neuter-release, catch-euthanize and catch-release-neuter-euthanize—succeed in reducing the number of stray cats within five years.



**Fig. 6.** Comparative analysis for four approaches



**Table 9**  
 Comparative analysis of four approaches

Years	Catch-release	Catch-neuter-release	Catch-euthanize	Catch-release-neuter-euthanize approach
0	17	17	17	17
0.5	45	17	0	7
1	72	16	0	7
1.5	156	16	0	7
2	282	10	0	5
2.5	582	10	0	5
3	1134	6	0	3
3.5	2290	6	0	3
4	4547	3	0	1
4.5	9119	3	0	1
5	18204	0	0	0
5.5	36436	0	0	0

### 3.2 Ethical Implications of Stray Cats Management Strategies

The management of stray cats presents significant ethical challenges, particularly in university settings where the interests of various stakeholders must be balanced. Traditional strategies, such as trapping and euthanizing stray cats, are often criticized for being inhumane and ethically questionable. Animal welfare organizations strongly oppose such practices, emphasizing that they contradict the principles of compassion and respect for animal life. These organizations advocate for more humane approaches, such as Trap-Neuter-Return (TNR) programs, which aim to control population growth while ensuring the well-being of stray cats. TNR programs align with the ethical principle of minimizing harm, offering a sustainable solution without resorting to lethal methods.

Community stakeholders, including students and staff, also play a critical role in shaping the ethical considerations of stray cat management. Many individuals on campus develop emotional bonds with stray cats, viewing them as part of the community. These sentiments underscore the importance of inclusive strategies that respect the values of the campus population. Ethical management must also address the potential risks stray cats pose, such as health concerns and environmental impacts, ensuring that solutions protect both human and animal welfare.

By adopting humane and community-supported approaches, universities can align their strategies with broader ethical frameworks. Collaborations with animal welfare organizations and active engagement with campus stakeholders are essential to developing solutions that are not only effective but also ethically sound. This approach strengthens the moral legitimacy of management practices, fostering a sense of shared responsibility and support within the campus community.

## 4. Conclusions

Our findings highlight the urgent need for swift action and long-term strategies to manage the rapidly increasing stray cat population at UUM. Three of the four countermeasures evaluated have shown success in fewer stray cats inside the residential hall. However, the catch-release approach has shown to be incredibly unproductive, leading to a sharp rise in the number of stray cats in just five years. This unsustainable trend not only jeopardizes the hygiene of our campus but also puts our goals for a green and environmentally conscientious UUM in jeopardy.

Contrarily, the catch-neuter-release, catch-euthanize and catch-release-neuter-euthanize methods have shown effective in drastically reducing the number of stray cats in the residential hall, with the possibility of reaching zero within five years. But it's important to take into account how

compassionate these practices are, especially for a facility like UUM, which keeps high standards as a higher education center. Adopting cruel practices like catch-euthanize and catch-release-neuter-euthanize can damage UUM's reputation as the second-best university in Malaysia and result in bad public perception and feedback.

Catch-neuter-release appears to be the most practical method for controlling the stray cat population at UUM, but it is important to consider the fees and expenses the university would spend. In parallel with these efforts, it is noteworthy that the university's initiatives to provide shelter and homes for stray cats also play a pivotal role in managing this issue. These commendable efforts should continue and expand, ensuring the welfare of these animals while harmonizing with UUM's commitment to becoming a greener and more environmentally responsible institution by 2030. Urgent action is required to strike a balance between sustainability, campus cleanliness, and the compassionate treatment of stray cats, aligning our endeavors with UUM's vision for a more ecologically conscious future.

## 5. Future Directions

Future research should focus on developing and evaluating long-term, humane strategies for stray cat management that can be implemented in diverse university settings. This includes studying the effectiveness of community engagement programs, such as student-led feeding and sterilization initiatives, in reducing stray populations sustainably. Additionally, further investigation into the environmental and behavioral impacts of stray cats on campus ecosystems can provide a more comprehensive understanding of their role in urban biodiversity. Comparative studies between different campuses and urban areas could also yield valuable insights into best practices for managing stray animals in various contexts. Lastly, integrating technological advancements, such as data-driven monitoring systems or predictive modelling, could enhance the precision and efficiency of stray cat population management efforts.

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