Feral Cat Population's Reactions to TNR(Trap, Spay_Neuter, and Release)-Focus on Lowell, MA

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Abstract:

The domestic cat (*Felis catus*) has played a vital role in human lives for centuries. Originally starting out as a form of rodent control, the domestic cat has evolved from a simple mouser to a vital role in many households as a companion animal, as well as remaining an important form of rodent control in many areas. Though, due to overbreeding and releasing cats into the outdoors with no form of contraceptive, many outdoor cats have become feral and skyrocketed in population and led to the development of dangerous diseases. Within the turn of the century, a newer form of population control has presented itself known as TNR (trap, neuter, release). TNR is more humane than more common forms of population control such as coil traps, pellet guns, and rat poison. This study investigates one population of feral cats' reaction to having a TNR program implemented. A Humane Society shelter in Lowell, Massachusetts tallied the number of feral cats brought in from 2009 to 2015 after the implementation of a TNR program in 2009. Three different populations were observed, adult cats over two months of age, kittens two months of age and younger, and the total combined population of all feral cats brought into the shelter. A linear regression was run on each data set to determine p-values of each group. From this data, it was able to be determined that TNR appears to have an affect on the population of each test group. The kitten population decrease by 80.1%, the adult cat population decreased by 50.2%, and the total combined population decreased by 65.7%. The adult cat population and total combined population appeared to stabilize towards the last several years of data collection, concluding that TNR not only appears to decrease the overall population

of feral cats, but leads to a healthy stable population that can be supported by the suburban/urban environment these cats were subjected to.

Introduction:

_____*Felis catus,* otherwise known as the domestic cat, is a species that was domesticated by the Egyptians around 4,000 years ago (National Geographic, 2016). Their avid rodent hunting ability being of use to humans, they became sacred beings worthy of godlike praise. Today, many homes keep these animals, still, as rodent hunters or even just as companions, though now they have become a nuisance to many. Humans have overbred cats, left them outside with no contraceptives in place, and created a massive population that in many places has become out of control. A stable population of feral cats can actually be beneficial to larger urban or suburban areas, the cats act as a natural pest eliminator by keeping the rat and mice populations in control, but, if there are no methods of population control in place, the cat population can explode exponentially. With an overabundance of cats in one given area, multiple negative outcomes can occur, for example, disease is spread far more quickly through outdoor populations of cats than cats raised indoors. Studies show that felines living in the outdoors stand a greater risk of contracting FeLV and FIV infections (Levy et al. 2006). Furthermore, sexually intact males were also found to be at a greater risk of infection than sexually intact females (Levy et al. 2006), this could be attributed to the behavior of intact male cats being more aggressive and territorial. Feline Leukemia (FeLV) can only be transmitted through direct contact, whether that be through saliva or blood of an infected animal to an uninfected animal, or through pregnancy, mother cats spreading it to the unborn fetuses (Lundgren. 2003). Since male cats tend to have a higher territorial instinct and behave more aggressively towards one another, they have a higher chance

of contracting FIV or FeLV (Natoli et al. 2005) because of the increased likelihood of exposure to an infected cat's blood or saliva through fighting.

Traditional methods of population control have come in different forms of inhumane euthanasia, some of the most common being; pellet guns, rat poisons, coil spring traps, etc. (Levy & Crawford. 2004). Since the turn of the century, a new form of population control has been introduced to many feral cat populations around the globe. This method- called TNR (or TSR in some places; trap, sterilize, and release) - is the humane trapping of feral cats, neutering them (or sterilizing them), then returning them to their place of origin. Statistically, female cats reproduce yearly at a one to three ratio (Nutter et al. 2004). This means that every female cat can have up to an average of 3 kittens every year, and each of these kittens reaches sexual maturity at around 9 months of age (Jemmet & Evans. 2008). Female cats have shown to have, on average, 1.5 litters of kittens per year, each litter containing approximately 2-3 kittens with a 75% survival rate (Nutter et al. 2004). By sterilizing the female, it leads to an inevitable elimination of an entire new generation of kittens. Studies have shown that, by implementing a form of TNR, the number of kittens produced each year decreases (Hughes & Slater. 2002)

This experiment observed one specific population's reaction to TNR over a seven year period, comparing the initial population present in 2009 to the latest available population count taken in 2015 with the assumption being that TNR has made a dramatic change to the overall population number, as well as the overall health of the population. The data used in this experiment was taken from a Lowell, Massachusetts Humane Society shelter, tallying the feral cat intake and measuring the population each year. The cats in this colony live in a suburban/urban area and are maintained by several different caretakers across the city. ___

Hypothesis:

This study aimed to prove that TNR is an effective form of population management of feral cats, and will hopefully be a paving way in implementing TNR programs into every locality with an overabundance of feral cats.

_____There are several hypotheses involved in this study. The first of which involves the combined population of cats and kittens brought into the shelter over the seven year span that TNR has been adopted.

The first **null hypothesis** states that the Combined Population (P) will not be affected by the TNR program implemented.

H_O: $P_I=P_F$ Where: I = Initial Population

F = Final Population

The first **alternate hypothesis** for the combined populations is that the final population will be less than the initial population with the TNR program implemented.

H_A: $P_F<P_I$

The second set of hypotheses involves the population of kittens under the age of two months that were brought into the shelter over the seven year span. The second **null hypothesis** states that the Kitten Population (P) will not be affected by the TNR program implemented.

H_O: $P_I=P_F$ Where: I = Initial Population

F = Final Population

The second **alternate hypothesis** for the population of kittens states that the final population will be less than the initial population.

H_A: $P_F<P_I$

The third, and final, set of hypotheses involves the population of adult cats, nine weeks and older that were brought into the shelter. The **null hypothesis** states that the Adult Cat Population (P) will not be affected by the implementation of TNR.

H_O: $P_I=P_F$ Where: I = Initial Population

F = Final Population

The **alternate hypothesis** for the adult cats is that the final adult cat population will be less than the initial population.

H_A: $P_F<P_I$

Materials and Methods:

The trapping, sterilizing, and releasing of feral cats in Lowell, Massachusetts has been ongoing since 2009, a population tally happening each year from 2009 to 2015, with a documentation of each cat's sex, weight, and approximate age. Traps were set and monitored until a feline made its way into the humane trap, cats trapped were then immediately taken to a local veterinary office to be sterilized, given rabies vaccinations, and dewormed. Any cat that was deemed suitable as a pet was tested for both FIV and FeLV and then put up for adoption. Cats sterilized were held overnight for observation and to allow the effects of anesthesia to wear

off before being released the next day. Any kitten trapped that was under the approximate age of nine weeks old was removed from the colony and taken into a caretaker's home to be acclimated to life as a domestic cat. The corner of the left ear on each cat was removed to identify them as sterilized before they were re-released. The environment the cats live in and the food offered remained constant throughout the whole process of data collection.

This experiment looks at the population of the feral cat colony with data collection beginning in 2009 and was completed in 2015. The independent variable of this experiment is the implementation of TNR on the colony residing in Lowell. The dependent variable is the population of the feral cats as they respond to the TNR efforts.

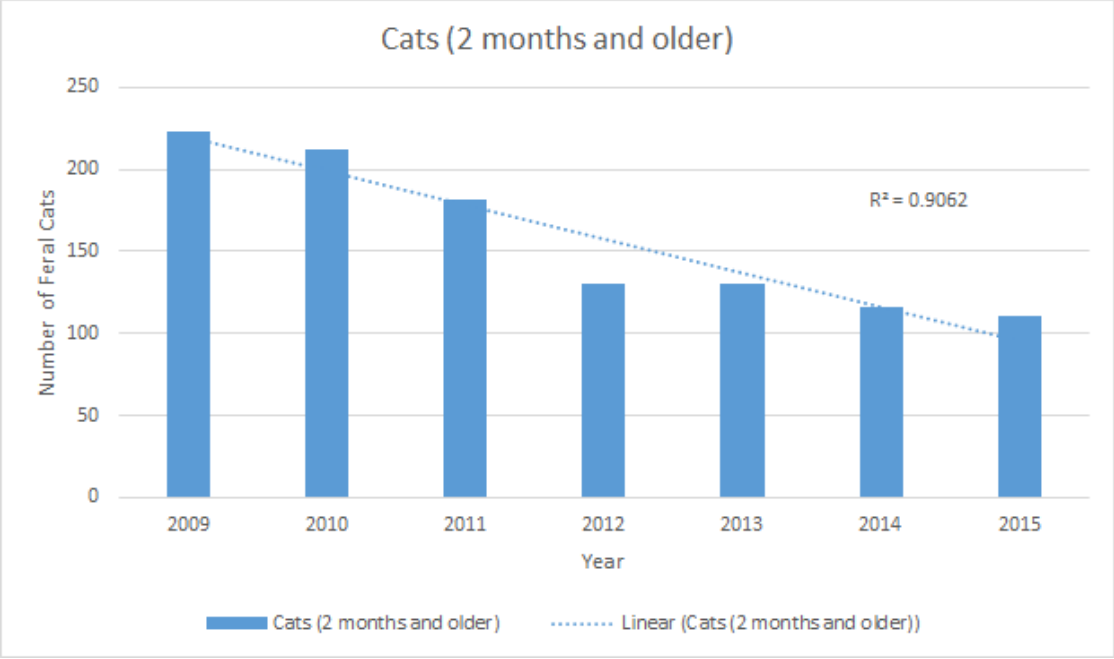
After data collection was complete a linear regression was run on the data to determine a p-value for the data to test its significance.

Results:

The results from this experiment show that over the 7 year period every population set had decreased by at least 50% (Chart 1). Adult cats decreased from an initial population of 223 to a population in 2015 of 111 felines, maintaining a constant population of 130 from 2012 to 2013 (Chart 1). The adult cat population showed an overall decrease by 50.2% (Graph 1). The kitten population began with a population of 222 in 2009 and in 2015 had decreased to an astonishing 42 felines (Chart 1) and showed a decrease in population by 80.1% (Graph 2). The combined population showed a decrease from 445 felines to 153 (Chart 1) with an overall decrease in the combined population by 65.7% (Graph 3).

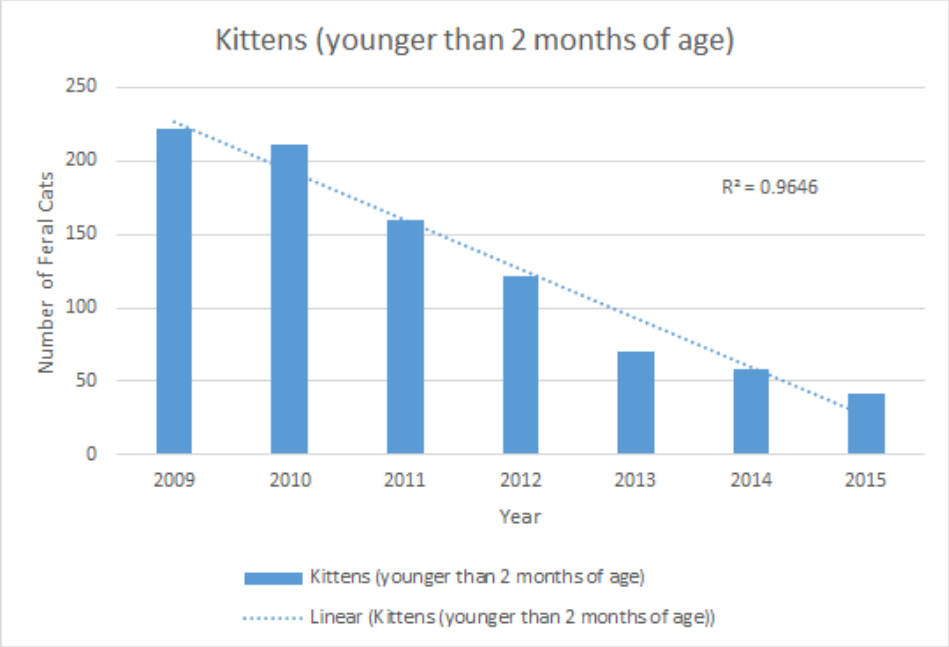
Year	Cats (2 months and older)	Kittens (younger than 2 months)	Total Combined Population
2009	223	222	445
2010	212	211	423
2011	182	160	342
2012	130	121	251
2013	130	70	200
2014	116	58	174
2015	111	42	153

(Chart 1) This chart contains all the data collected in this experiment, the yearly counts of each population.



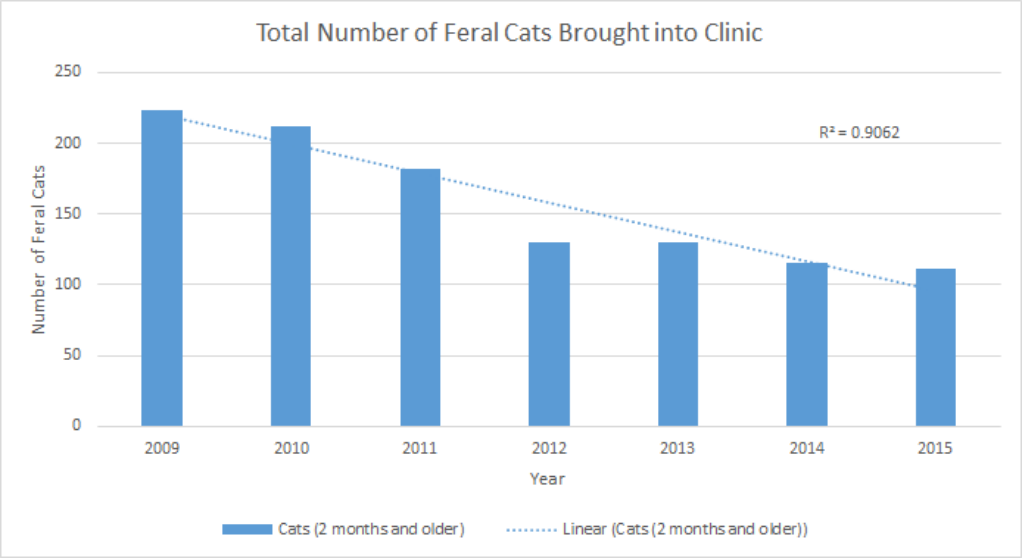
(Graph 1) This graph shows the population of adult felines from the years of 2009 to 2015.

The total population of adult cats brought into the shelter contains an R^2 value of 0.9062, . The results of the linear regression also show that this data has a p-value of 0.000154. (Appendix, Table 1).



Graph 2: This graph shows the population of kittens between 2009 and 2015.

The population of kittens two months and younger brought into the shelter contains an R^2 value of 0.9646, suggesting a strong decreasing trend since the implementation of TNR. The results of the linear regression also show that this set of data has a p-value of 8.11E-05. (Appendix, Table 2).



Graph 3: This graph contains data from the combined population of adult cats and kittens from the population.

The total combined population of adult feral cats and kittens brought into the shelter contains an R^2 value of 0.9062, suggesting a strong decreasing trend since the implementation of TNR. The results of the linear regression also show that this data set has a p-value of 0.000947. (Appendix, Table 3).

Conclusion:

_____In conclusion, for the adult cat test group, the initial population began as 223 cats and the final population was 111, with a decrease in population by 50.2% (Graph 1). The kitten population began with 222 felines and the final population came out to be 42, an overwhelming decrease in population by 80.1% (Graph 2). The total combined population began with 445 cats and ended in 2015 with a population of 153, meaning the whole population decreased by 65.7% (Graph 3). When a linear regression was run on each population, the p-values produced were less than 0.05 and all showed that the data was statistically significant. The linear regression run on the population of adult cats produced a p-value of 0.000154 (Appendix, Table 1), the population of kittens produced a p-value of 8.11E-05 (Appendix, Table 2), and the combined population of

both adult cats and kittens produced a p-value of 0.000947 (Appendix, Table 3). For all portions of this study, the null hypothesis was able to be rejected. The final population of each test group proved to be less than the initial population and was deemed statistically significant with the linear regression. These major population declines could be attributed to the TNR efforts being put forth in Lowell, Massachusetts. The kitten population especially appeared to make the sharpest decline as the sterilization is preventing from kittens being born each season. The population of the combined count and the adult cat count also seem to level out and stabilize themselves towards the last three years of the study, helping to support that TNR is an efficient form of population control by maintaining a healthy population of feral cats.

This data supports the notion that TNR is an effective form of feral cat population control, and could potentially lead to the implementation of TNR in a multitude of different localities with an overabundance of feral cats. Further study should be put into how feral cat health is affected by TNR, whether or not this form of population control provides adequate means in reducing the number of FeLV and FIV cases, as well as parasites and other diseases spread by cat-on-cat contact and impregnation. Further study should also be conducted in less invasive contraceptive methods to reduce possibility of complications related to the surgeries required to sterilize cats, as anesthesia and such invasive procedures could potentially be harmful to the animal.

Scholarly Citations:

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Appendix:

Regression Statistics								
Multiple R	0.95196138							
R Square	0.906230469							
Adjusted R Square	0.887476563							
Standard Error	0.724644308							
Observations	7							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	25.37445314	25.37445	48.32222	0.000946588			
Residual	5	2.625546863	0.525109					
Total	6	28						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2018.899851	1.02967669	1960.712	6.55E-16	2016.252983	2021.546719	2016.252983	2021.546719
Cats (2 months and older)	-0.043749057	0.006293543	-6.95142	0.000947	-0.059927126	-0.02757099	-0.059927126	-0.027570989

Table 1: Linear regression comparing adult feral cat population from 2009 to 2015.

Regression Statistics								
Multiple R	0.982140508							
R Square	0.964599977							
Adjusted R Square	0.957519973							
Standard Error	0.445241652							
Observations	7							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	27.00879936	27.0088	136.2428	8.10884E-05			
Residual	5	0.991200641	0.19824					
Total	6	28						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2015.644044	0.354663391	5683.259	3.2E-18	2014.732353	2016.555736	2014.732353	2016.555736
Kittens (younger than 2 months)	-0.028855555	0.002472137	-11.6723	8.11E-05	-0.035210386	-0.02250072	-0.035210386	-0.022500724

Table 2: Linear regression comparing the population of kittens two months of age and younger from 2009 to 2015.

Regression Statistics								
Multiple R	0.97687875							
R Square	0.954292092							
Adjusted R Square	0.945150511							
Standard Error	0.505929129							
Observations	7							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	26.72017858	26.72018	104.3903	0.000154199			
Residual	5	1.27982142	0.255964					
Total	6	28						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2017.005627	0.525919782	3835.196	2.29E-17	2015.653707	2018.357547	2015.65371	2018.357547
Total Combined Population	-0.017625448	0.001725084	-10.2172	0.000154	-0.022059916	-0.01319098	-0.02205992	-0.013190979

Table 3: Linear regression comparing the total combined population from 2009 to 2015.