Comparative Meta-Analysis of Feline Leukemia Virus and Feline Immunodeficiency Virus Disease Rates Among Cats in Mediterranean, Tropical, and Temperate Forest Habitats Around the Globe

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Abstract

Feline Leukemia Virus (FeLV) and Feline Immunodeficiency Virus (FIV) are two prevalent transmittable diseases for domestic cats. This paper reports the frequency of these two diseases in three separate biome habitats: Mediterranean forests, tropical forests, and temperate forests. Using information from 16 published articles, information around FeLV and FIV rates of infection in specific locations around the world was analyzed. Results show that the highest percentage of FeLV or FIV infected cats live in tropical forests (12.48%), and the results are statistically significant ($p = <0.001$ when tropical is compared to Mediterranean and temperate). While there are only theories on why, reasons for this could be that the lower income economies in this study were also in the tropical biome, there is a higher percentage of feral cats and cat colonies in tropical forests, and there is less emphasis on animal welfare and animal control programs in these countries. Additional research should be conducted to strengthen the study size in the tropical and Mediterranean forests before further conclusions can be drawn.

Keywords: Feline Leukemia Virus, Feline Immunodeficiency Virus, Feline infectious disease

Comparative Meta-Analysis of Feline Leukemia Virus and Feline Immunodeficiency Virus Disease Rates Among Cats in Mediterranean, Tropical, and Temperate Forest Habitats around the Globe

Feline Leukemia Virus (FeLV) and Feline Immunodeficiency Virus (FIV) are two widespread infectious diseases that impact domestic cats all over the globe. These diseases cause immunosuppressive infections in cats and are linked to lymphomas, leukopenia, and tumors (Normand, & Urbanek, 2017). Opportunistic infection rates increase in cats with these diseases, and kittens and cats living in colonies either in shelters or in the wild are the most susceptible. There is a direct association of virus infection to age, lifestyle, and health status (Oguzoglu, Muz, Timurkan, Maral, & Gurcan, 2013).

FeLV is a retrovirus that is transmitted via saliva, or nasal, rectal, or vaginal secretions. It can be transferred between cats through close contact, grooming, fighting (biting), shared litter boxes and food dishes, or from mother to offspring. Kittens and cats with suppressed immune systems are more likely to become infected (Lee, Levy, Forman, Crawford & Slater, 2002). The symptoms of FeLV are varied, but can include loss of appetite, lethargy, skin, bladder, and respiratory infections, weight loss, changes in behavior, gastrointestinal symptoms, oral diseases, seizures, and anemia (Green, 2012). Immunosuppression and anemia are typically the first signs of infection (Greene, 2012). Cats can be carriers of the virus without showing symptoms for several years before symptoms begin to show. A simple ELISA (enzyme-linked immunosorbent assay) blood test administered by a veterinarian can detect FeLV antibodies. FeLV is specific to cats, and is not zoonotic, but has been seen in large cats such as cheetahs, lions, and lynx. There is a vaccine for FeLV, but currently no cure for the disease (Normand & Urbanek, 2017).

FIV is a lentivirus which is transmitted through deep bite wounds and is not as easily transmitted between cats as FeLV. Transmission between mother and offspring is rare, but does occur (Normand, & Urbanek, 2017). Analogous to human immunodeficiency virus (HIV), FIV targets the immune system of cats. The disease stages for FIV are very similar to HIV, and go through declining stages of health. The initial state of FIV presents with lethargy, fever, and weight loss. An infected cat can stay in this stage for a variable length in time, some developing worse symptoms within months, while others will remain in this milder stage for years. Feline Acquired Immune Deficiency Syndrome (FAIDS) is the latter disease state. FAIDS occurs when the immune system of the animal is so repressed that the cat is very vulnerable to secondary infections. FAIDS is not what actually causes death, but the secondary infections due to the weakened immune system (Hartmann, 2011). Like FeLV, FIV is testable by a simple ELISA blood test in the veterinarian's office. There is no cure, but there are treatment options to reduce symptoms. While vaccines are available, the evolution of the virus makes it difficult to vaccinate against all potential strains of the virus (Richards, 2005).

Cats are exceedingly adaptable creatures and live on all continents excluding Antarctica. Therefore, cats can live in any biome except tundra (Randerson, 2006). This paper focuses on temperate, tropical, and Mediterranean forests, due to the amount of existing literature on cat populations and disease in these biomes.

Temperate Forests. Temperate forests are found in countries such as Turkey, South Korea, the Midwest United States, Northern Italy, Germany, and the east coast of Australia. These forests can contain coniferous, broadleaf, or mixed tree species, based on the latitude of the biome. Generally, winters are mild and rainfall is moderate in temperate forests. Most of these forests have several season changes (Woodword, 2003). Since cats can adapt to rapidly changing temperatures and climates, cats thrive in these locations and prey off small rodents and human garbage (Krauss et al., 2010).

Tropical Forests. Tropical forests contain the highest variety of tree species in all the forests, and are in locations such as Brazil, Thailand, St. Kitts, Peninsular Malaysia, and Merida, Mexico. There is the greatest diversity of animals and plants found in this forest (Bowes, 2010) and these forests are in regions of year-round warmth, and receive the highest amount of rain of all forests. Because of this diversity, there are numerous resources for cats for habitat, food, and water needs. There are typically two seasons in tropical forests, the rainy season, and the dry season (Woodward, 2003).

Mediterranean Forests. Mediterranean forests are also known as scrublands, because the temperatures in this biome allow for short trees to grow. These forests are in areas like the west coast of Australia, Israel, and Portugal. Cats thrive in these environments due to the large diversity of insects and therefore insect eating birds (Woodward, 2003).

The mission of this paper is to explore the incidence of FeLV and FIV in cats in the three separate forest types, temperate, tropical, and Mediterranean, and draw conclusions from existing literature. The hypothesis is that there will be the highest prevalence of infectious disease rates between cats in tropical forests, as these forests are more frequently in areas with less governing bodies, capital, and financial reserves. It is hypothesized that the lack of finances, and increased poverty and crime in these areas leave less resources for shelter, feral, and domestic cats to be treated and populations controlled.

Methods

Articles were found at the Cincinnati Library and online using Google Scholar and the Miami University online database on the incidence of FeLV and FIV in various forest biomes. Searches were conducted using the keywords "feline infectious disease" or "feline virus" and articles chosen based on abstracts and topics discussed in articles. The main criteria for acceptance of study was that the study looked specifically at FeLV and FIV rates of infection in specific locations around the world. After locations were established, biomes were assigned to each location/article using a map of the world's biomes by Blij and Mueller (1995). A total of 4 articles were found discussing disease prevalence in Mediterranean forests, 6 articles for tropical forests, and 6 articles for temperate forests. There were very few articles found on boreal forests and all the other biomes in relation to cat disease prevalence. The chosen articles were analyzed, and data extruded and entered into an Excel spreadsheet (Appendix 1, Table 1). The data points that were extracted were the sample size of the study, the number positive for FeLV and FIV, and the number of co-infections if listed. Additional data was extruded if mentioned in the article on the percentage of indoor versus outdoor cat infection rates, male versus female infection rates, and hypothesized risks for infection. Binary logistic regression statistics were conducted on the incidence of FeLV and FIV in the various countries, as well as different forest biomes. The prevalence of FeLV and FIV in each biome were compared to one another. These findings were compared among forest types and conclusions were drawn.

Results

Information regarding FeLV and FIV infection rates was found in 14 countries (Figure 1). A total of 4 articles were found discussing disease prevalence in Mediterranean forests (Israel, Portugal, and two locations in Australia), 6 articles for tropical forests (Rio de Janeiro, Thailand, Peninsular Malaysia, Merida, Mexico, and two locations in the West Indies), and 6 articles for temperate forests (South Korea, the United States, Italy, Turkey, Germany, and Australia).

Figure 1. Map of Countries Researched.

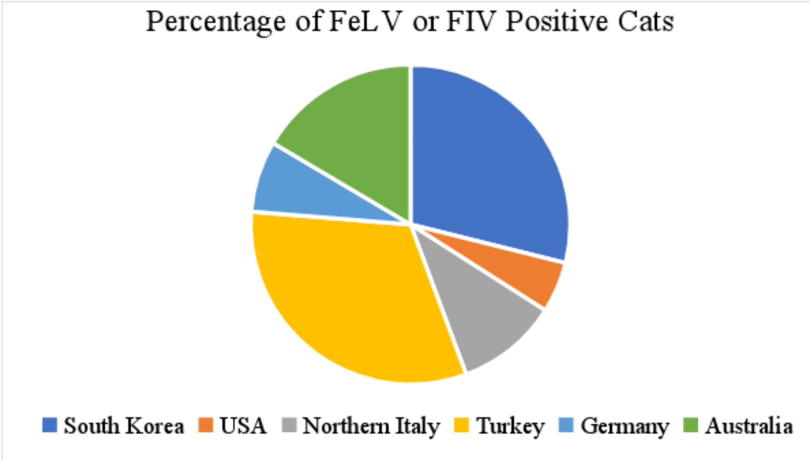
Temperate Forests

Turkey. FeLV and FIV was diagnosed using PCR in 200 domestic cats living in Ankara between February 2007 and August 2009. A total 31% of the cats tested were positive for at least one virus, the highest percentage of the temperate forest regions (Figure 2). The most common single infection was FeLV (20.5%) and then FIV (9.5%). There was no statistical significance between male or female cats surveyed and infection rates, as well as no statistical significance between breeds. Statistical significance was noted between indoor (n = 157) and outdoor (n = 43), as outdoor cats were 2.15 times more likely to be infected with FIV than indoor cats (Oguzoglu, Muz, Timurkan, Maral, & Gurcan, 2013).

South Korea. 72 feral cats were analyzed for this article, with 22.2% verified positive for FeLV and 5.56% positive for FIV in the summer of 2013. This is the highest percentage of positive FeLV cats in the temperate forest region. Cats were live-trapped in 7 different areas around Seoul and tested in this study via ELISA test. Of the cats tested, two female and zero males tested positive for FIV and 5 females and 3 males tested positive for FeLV (Hwang, Gottdenker, Min, Lee, & Chun, 2016). These are interesting results as in every other study where there was a statistical significance between genders, males tested higher for FIV than females except in Portugal.

North America. With a sample size of 18038, this is the largest study researched. A total of 2.27% of the cats tested were positive for FeLV and 2.47% positive for FIV, making a total of 5% of all cats surveyed positive for one of the two diseases from late summer to the end of fall in 2004. Blood samples were analyzed using ELISA tests, and were a mix of owned and feral cats. 1.88% of female and 2.67% of male cats tested positive for FeLV, and 1.37% of females and 3.62% of males tested positive for FIV. Outdoor cats were 2.5 times more likely to acquire FIV or FeLV than indoor cats in this study (Levy, Scott, Lachtara, & Crawford, 2006).

Figure 2. Percentage of FeLV or FIV Positive Cats in Temperate Forests.



Northern Italy. Between January 2008 and January 2010, a total of 316 feral cats were tested in this article, with 3.8% positive for FeLV and 6.65% positive for FIV via ELISA. For FIV infections, male cats had a statistical significantly higher chance of acquiring the disease than female cats (p = 0.002) but infection rates were not significant between genders for FeLV. Adult cats were almost ten times more likely to have FIV in this study than young felines (Spada et al., 2012).

Germany. 17462 cats were analyzed in this article between 1993 and 2002, the second largest sample size in this paper. Only 7% of the total population tested positive for FeLV (3.65%) or FIV (3.22%). Male cats were statistically significantly higher to contract FIV (p = <0.001) or FeLV (p = 0.004) compared to females. Indoor and outdoor comparisons also showed a statistical significance, as outdoor cats were 6.7 times more likely to contract FIV than indoor cats and two times more likely to contract FeLV than indoor cats (Gleich, Krieger, & Hartmann, 2009).

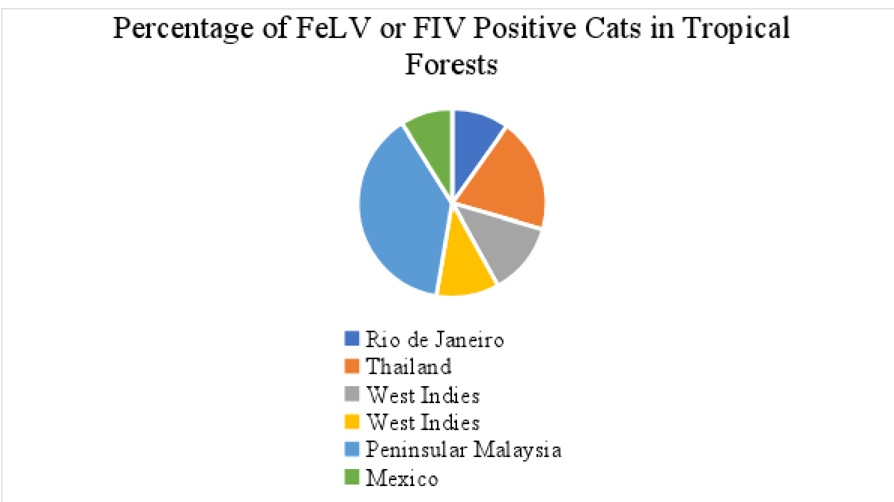
Australia. Cats on the eastern coast of Australia were tested in this study, between January 2012 and December 2012. A total of 2083 felines were tested, with 16% of the sample size positive for FeLV (1.54%) or FIV (14.64%). In the temperate forest region, this is the highest percentage of FIV positive cats. Female cats were statistically less likely to contract FIV than male cats (p = <0.001) and unneutered males were statistically more likely to have FIV than castrated males (p = <0.001). No statistical significance was seen between cats testing positive for FeLV (Westman et al., 2016).

Overall. South Korea had the highest percentage of cats infected with FeLV at 22.22% of the study population infected. This is the highest percent of FeLV cats in any of the countries researched across all locations. The east coast of Australia had the highest percentage of FIV positive cats, at 14.64%. Overall, Turkey had the highest percentage of FeLV or FIV infected cats in the temperate forest locations researched, at 31% of the study population positive for either disease.

Tropical Forests

Rio de Janeiro. A total of 1094 cats were tested between July 2007 and November 2008, with 11% being positive for FeLV. FIV was not tested in this study. Gender did not show any significance with infection, but outdoor cats were statistically more likely to contract FeLV than indoor cats. Cats who lived in colonies were statistically more likely to contract FeLV than cats who lived alone or in groups of less than 5 cats (de Almeida, Danelli, da Silva, Hagiwara, & Mazur, 2012).

Figure 3. Percentage of FeLV or FIV Positive Cats in Tropical Forests.



Thailand. Between April 2013 and March 2014, 777 cats were sampled for FeLV and FIV around Bangkok via ELISA tests. The highest percentage of FeLV positive cats in tropical forests was seen in this study, with 16.47% of cats testing positive. Only 5.41% of cats tested positive for FIV. There was not data recorded on gender or habitats (indoor vs outdoor) in this study (Nedumpun et al., 2015).

West Indies. In 2006 - 2007, 99 stray cats were trapped in the capital of St. Kitts. These cats were tested using ELISA tests and 12.12% of animals tested positive for FIV. Surprisingly, no felines tested positive for FeLV. The same study was conducted again in 2009, with 72 stray cats evaluated for FeLV or FIV. Of this sample size, 13.89% tested positive for FIV, but again, no felines tested positive for FeLV. Due to the geographic separation of St Kitts, the lack of FeLV positive cats could mean that there is no FeLV present on this island (Kelly et al., 2010).

Peninsular Malaysia. 368 felines were tested in this article between January to December 2010, with the highest rate of infection (43%) of the tropical forest habitats researched (Figure 3). 12.23% of cats tested positive for FeLV and 31.25% tested positive for FIV. This is the highest percentage of FIV infected cats in the tropical forest habitats researched in this paper. Male cats were statistically more likely to acquire FeLV when compared to females cats ($p = 0.011$) and young cats were statistically more likely to contract FeLV than adult cats ($p = 0.022$). Male cats again were statistically more likely to contract FIV than females ($p = 0.024$) and young cats were at greater risk to contract FIV than adult cats ($p = 0.039$) (Bande et al., 2012).

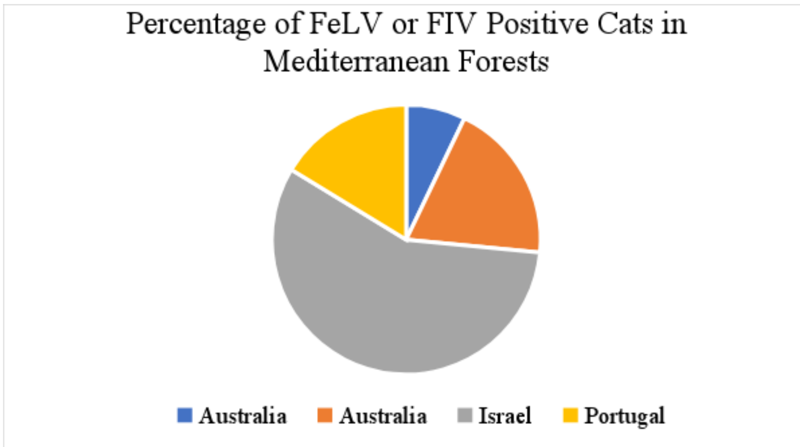
Mexico. Study was conducted in Merida on 227 owned cats using blood ELISA tests. A total of 7.49% of cats tested positive for FeLV and 2.64% tested positive for FIV. Adult cats in this study were more likely to present with FeLV than younger cats (16.4% adult, vs. 2.7% young tested positive). There was no statistical significance between male ($n = 104$) or female cats ($n = 123$) (7.8% vs. 7.3%) for contracting FeLV. Outdoor cats ($n = 159$) were 1.4 times more likely to have FeLV than indoor cats ($n = 68$) in this study (Ortega-Pacheco et al., 2014).

Overall. Thailand had the largest percentage of FeLV positive cats in this biome, at 16.47% of the study population testing positive for the disease. Peninsular Malaysia had the highest percentage of FIV positive cats, at 31.25% of the study population. This is the highest percentage of FIV positive cats across any of the biomes researched. Peninsular Malaysia also had the highest percentage of infected cats with either FeLV or FIV, with 43% of the total study population testing positive for either disease.

Mediterranean Forests

Australia. A study conducted between January 2011 and March 2013 was performed in two locations along the coasts of western Australia. The first study tested 2241 cats, which had a positive 0.98% of the population for FeLV and 5.76% for FIV. The second study had a sample size of 166, with 4.22% of cats testing positive for FeLV and 14.20% positive for FIV (Westman et al., 2016).

Figure 4. Percentage of FeLV or FIV Positive Cats in Mediterranean Forests.



Israel. This study looked at 102 cats, with a mix of feral and owned cats. Using ELISA blood tests, a total of 11.7% of the cats tested positive for FIV and 3.9% tested positive for FeLV. Male cats were 2.8 times more likely to contract FIV than female cats, with intact males having the greatest risk (Baneth, Kass, Steinfeld, & Besser, 1999).

Portugal. 231 stray felines were tested for FeLV or FIV between November 2003 and July 2005. 7.07% of cats tested positive for FeLV and 10.18% tested positive for FIV in this study. An unusual result is that females were 1.6 times more likely to contract FIV and had a 1.4 times greater risk to contract FeLV than males (Duarte et al., 2010).

Overall. Portugal had the highest percentage of FeLV positive cats in this biome, at 7.07% of the cats researched testing positive for the disease. Israel had the highest percentage of FIV positive cats, at 11.76% of the study population testing positive. Overall, the west coast of Australia had the highest percentage of FeLV or FIV infected cats, at 19% of the study population positive for infectious disease.

Binary Logistic Regression

When FeLV prevalence was compared across the biomes, there is a statistical significance (tropical versus temperate ($p = <0.001$) and tropical versus Mediterranean ($p =$

<0.001) (Figure 5). When FIV prevalence was compared across the biomes, there is a statistical significance (tropical versus temperate (p = <0.001) and tropical versus Mediterranean (p = <0.001)(Figure 6). Statistical analysis data can be found in Appendix II.

Figure 5. Prevalence of FeLV Across Biomes.

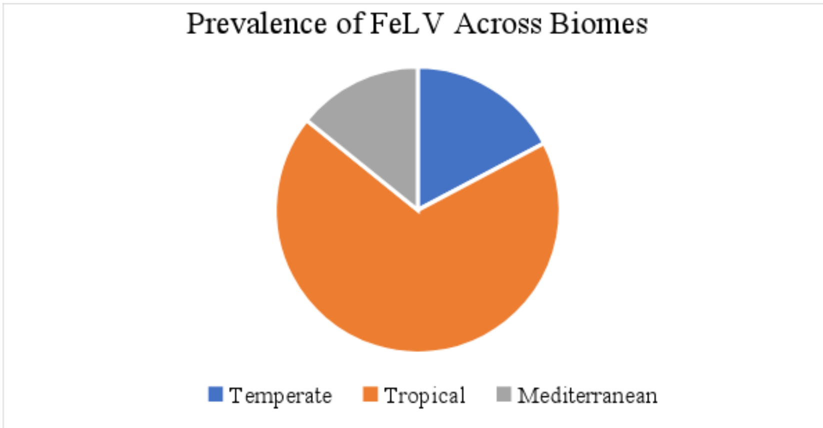
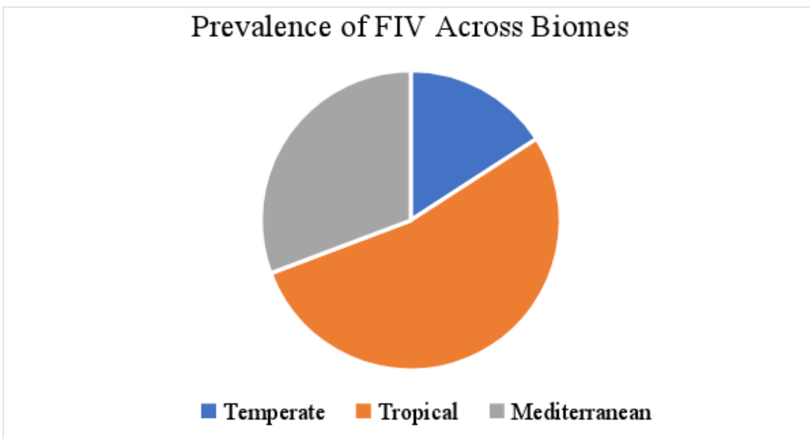


Figure 6. Prevalence of FIV Across Biomes.

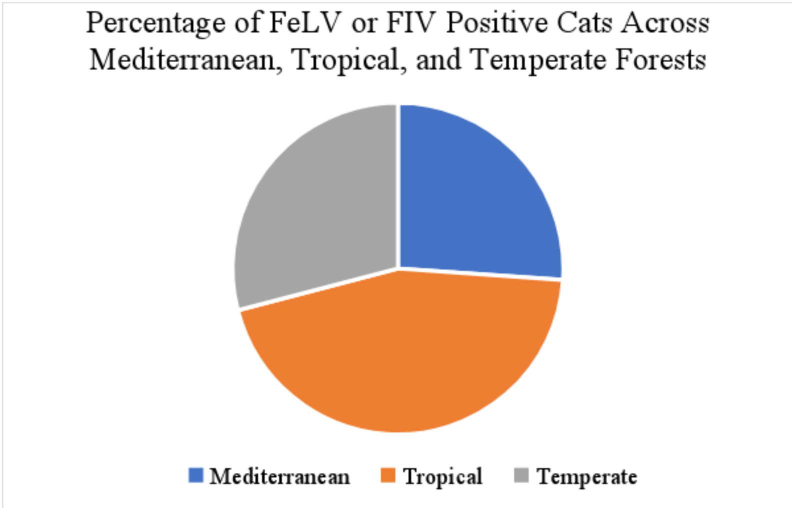


Discussion

The habitat with the highest percentage of FeLV or FIV was the tropical forest, at 12.48% (Figure 7) which supported the hypothesis. There are several theories as to why tropical forests in this analysis could have the highest prevalence of FeLV and FIV infections. Using information regarding the gross national income (GNI) per capita for the current 2018 fiscal year, all the countries in the tropical forest areas were upper middle-income countries except the West Indies which is a high-income country, whereas the countries in the temperate and Mediterranean forests in this paper were all in the high-income category with the exception of Turkey (upper middle) (World Bank, n.d.). High income countries have a GNI of at least

$12,236 per capita, where upper middle-income economies have a GNI of $3,956 to $12,235 per capita. Conclusions can be drawn from this information, as upper middle-income economies have limited flexibility with finances to spend on animal control or spay and neuter programs for cats, compared to high income economies.

Figure 7. Percentage of FeLV or FIV Positive Cats Across Mediterranean, Tropical, and Temperate Forests.



In locations where there are larger colonies and more feral cats, there are going to be higher rates of disease. The study in Rio de Janeiro showed that colonies of five or more cats had a statistically significant higher chance of FeLV or FIV infection within the colony. Therefore, the more colonies of feral cats there are in a country, the higher the risk of infectious disease spread. Higher populations of feral cats mean there are more colonies than locations with fewer feral cats. While accurate estimates of feral cat populations are difficult to assess, there is evidence that there are more feral cats in tropical climates than in climates with more seasonal changes. The increase in feral cats in any area will increase the chances of disease spread between colonies and to owned cats.

Statistics on cat ownership and feral cat populations are lacking for much of the globe, due to lax rules and regulations in regards to companion animals and animal control. The World Society for the Protection of Animals (WSPA) states that countries in Europe and nations like the United States place far more emphasis on animal welfare and sterilization of cats than other countries around the world (de Boo & Knight, 2002). The tropical habitats researched in this study are on the WSPA list of locations where animal care resources are low compared to the resources of the locations in Mediterranean and temperate forests.

The habitat with the least prevalence of FeLV or FIV infections is the temperate forest, at 8.08% (Figure 5). Locations in this study that were categorized as temperate forests are South Korea, the United States, Northern Italy, Turkey, Germany, and Australia. All of these countries are high income economies according to their GNI except Turkey, which is an upper middle economy. Being mostly high-income economies, these countries have funding and resourcing available for shelters, veterinary care, and sterilization programs for feral cats. Overall, there are more resources and better programs in place for owned and feral cats in these locations (de Boo & Knight, 2002).

While not all studies analyzed infection risk between genders, South Korea and Portugal showed a higher chance of FeLV and FIV contraction for female cats than male cats. This is an unusual result because it is theorized that males are more likely to contract infectious diseases due to their propensity for being territorial and engaging in behaviors like fighting which would increase their risk of coming in contact with infected blood or mucous compared to female cats (Mendes-de-Almeida et al., 2011). Male cats had a significantly greater chance to become infected with FeLV in Malaysia and Germany, and FIV in Malaysia, Italy, Germany, and Australia. There were no significant differences between genders for either virus in Rio de Janeiro, Mexico, or Turkey, and no difference for FeLV in Italy.

No studies conducted in Mediterranean forests compared the risk for infection between indoor and outdoor cats. However, the risk for FeLV was statistically higher in Rio de Janeiro (2.96 times higher) and Mexico (1.4 times higher) for outdoor cats than indoor cats. Outdoor cats were also at a statistically significant risk for FIV in Turkey (2.15 times more likely) and for both FeLV and FIV in the United States (2.5 times more likely for both diseases) and Germany (6.7 times more likely for FIV and 2 times more likely for FeLV). Cats which are kept indoors are at a lesser risk for contracting FeLV and FIV according to these studies.

The potential issues with this study are the lack of data in tropical and Mediterranean forests compared to the data available in temperate forest habitats. A total of 38,171 cats were analyzed in the six studies that took place in the temperate forest habitat, where only 2,637 cats were tested in all five of the tropical and only 2,709 cats were tested in the three studies in the Mediterranean forests. A lack of data from the tropical and Mediterranean forest regions could have impacted the results of this study. However, GNI could play into the availability of resources to research and conduct studies on cat infectious diseases in the different biomes of the world.

Conclusion

In conclusion, the hypothesis was supported by the data. There is a higher prevalence of infectious disease in tropical forests compared to Mediterranean and temperate forests. While there are only theories on why, reasons for this could be that the lower income economies in this study were also in the tropical biome, there is a higher percentage of feral cats and cat colonies in tropical forests, and there is less emphasis on animal welfare and animal control programs in these countries. Additional research should be conducted to strengthen the study size in the tropical and Mediterranean forests before further conclusions can be drawn.

Action Component & Reflection

Reflecting back on this IAP, I learned a lot about how little clinics in Cincinnati record data on feral cats. My original plan was to call local shelters and clinics to see if male or female feral cats had the greater prevalence of infectious disease. However, after calls to 21 different organizations and clinics, I realized that most places do not keep detailed records on feral cats. Most of the funding and resources for feral cat programs are limited and work is done by volunteers swamped for time. Most facilities do not have the option to slow down and take solid data, like I was looking for. So, while it makes sense, I was surprised that there was a lack of data in regards to infectious disease rates in strictly feral cats. Once I changed the scope of my paper to looking at biomes across the world, I was also surprised at the lack of information in other biomes, since cats occupy every biome except tundra and aquatic habitats. It is interesting to me that there is little information out there about cats and cat diseases in the desert, grasslands, and savannahs. The overwhelming majority of data I found was from temperate forest habitats. I was also thinking that FIV would not be as much of an issue as I know now it is, since FIV is much harder to contract that FeLV. This also took me by surprise.

The information in this report is important because it encourages people to keep pets indoors or at least smaller outdoor colonies to reduce the risk of infectious disease. There is little research comparing biomes and habitats across the world for cats, and this paper helps strengthen this research. My whole Master Plan is around increasing awareness of the feral cat problem and by conducting this research, I now know a lot more about infectious disease rates that impact cats. Using this information, I will present the poster at the Cincinnati Veterinary Technician meeting the first quarter of 2018.

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Appendix I – Raw Data

Table 1. Raw Data

Location	Biome	Sample size	Positive for FeLV or FIV		Co-Infection Rate	FeLV		FIV	
			Count	Percent	Percent	Count	Percent	Count	Percent
Turkey	Temperate	200	62	31%	0.05%	42	21.00%	20	10.00%
Northern Italy	Temperate	316	33	10%		12	3.80%	21	6.65%
Germany	Temperate	17462	1201	7%	0.24%	638	3.65%	563	3.22%
South Korea	Temperate	72	20	28%		16	22.22%	4	5.56%
Australia	Temperate	2083	337	16%	0.53%	32	1.54%	305	14.64%
USA	Temperate	18038	855	5%	0.32%	409	2.27%	446	2.47%
Peninsular Malaysia	Tropical	368	160	43%	4.35%	45	12.23%	115	31.25%
Thailand	Tropical	777	170	22%		128	16.47%	42	5.41%
Merida, Mexico	Tropical	227	23	10%		17	7.49%	6	2.64%
Rio de Janeiro	Tropical	1094	125	11%		125	11.43%		
West Indies	Tropical	72	10	14%		0	0.00%	10	13.89%
West Indies	Tropical	99	12	12%		0	0.00%	12	12.12%
Australia	Mediterranean	2241	146	7%		22	0.98%	124	5.76%
Australia	Mediterranean	166	31	19%	2.41%	7	4.22%	24	14.20%
Israel	Mediterranean	102	16	16%		4	3.92%	12	11.76%
Portugal	Mediterranean	231	37	16%		14	7.07%	23	10.18%

Appendix II – Statistical Calculations

Binary Logistic Regression: FeLV versus Biome

Method

Link function	Logit
Categorical predictor coding	(1, 0)
Rows used	16

Response Information

Variable	Value	Count	Event Name
FeLV	Event	1531	FeLV
	Non-event	41986	
n	Total	43517	

Deviance Table

Source	DF	Seq Dev	Contribution	Adj Dev	Adj Mean	Chi-Square	P-Value
Regression	2	385.8	48.71%	385.8	192.92	385.84	0.000
Biome	2	385.8	48.71%	385.8	192.92	385.84	0.000
Error	13	406.2	51.29%	406.2	31.25		
Total	15	792.1	100.00%				

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC
48.71%	48.46%	12876.88

Coefficients

Term	Coef	SE Coef	95% CI	Z-Value	P-Value	VIF
Constant	-1.9976	0.0600	(-2.1153, -1.8799)	-33.27	0.000	
Biome Tropical vs.						
Temperate	-1.4750	0.0671	(-1.6065, -1.3435)	-21.98	0.000	1.18
Mediterranean	-1.677	0.138	(-1.947, -1.407)	-12.20	0.000	1.18

Odds Ratios for Categorical Predictors

Level A	Level B	Odds Ratio	95% CI
Biome			
Tropical	Temperate	4.3711	(3.8324, 4.9855)
Mediterranean	Temperate	0.8171	(0.6367, 1.0486)
Mediterranean	Tropical	0.1869	(0.1428, 0.2448)

Odds ratio for level A relative to level B

Regression Equation

P(FeLV) = exp(Y')/(1 + exp(Y'))

Y' = -1.9976 - 1.4750 Biome_Temperate + 0.0 Biome_Tropical - 1.677 Biome_Mediterranean

=================================

Test and CI for Two Proportions

```
Sample  X    N  Sample p
1       4  200  0.020000
2       0  200  0.000000


Difference = p (1) - p (2)
Estimate for difference:  0.02
95% CI for difference:  (0.000597346, 0.0394027)
Test for difference = 0 (vs ≠ 0):  Z = 2.02  P-Value = 0.043


* NOTE * The normal approximation may be inaccurate for small samples.

Fisher's exact test: P-Value = 0.123
```

Test and CI for Two Proportions

```
Sample   X      N  Sample p
1       21  17462  0.001203
2       42  17462  0.002405


Difference = p (1) - p (2)
Estimate for difference:  -0.00120261
95% CI for difference:  (-0.00209261, -0.000312614)
Test for difference = 0 (vs ≠ 0):  Z = -2.65  P-Value = 0.008

Fisher's exact test: P-Value = 0.011
```

Test and CI for Two Proportions

```
Sample   X     N  Sample p
1        5  2083  0.002400
2       11  2083  0.005281


Difference = p (1) - p (2)
Estimate for difference:  -0.00288046
95% CI for difference:  (-0.00663594, 0.000875019)
Test for difference = 0 (vs ≠ 0):  Z = -1.50  P-Value = 0.133

Fisher's exact test: P-Value = 0.209
```

Test and CI for Two Proportions

```
Sample   X      N  Sample p
1       10  18038  0.000554
2       58  18038  0.003215
```

```
Difference = p (1) - p (2)
Estimate for difference:  -0.00266105
95% CI for difference:  (-0.00355580, -0.00176630)
Test for difference = 0 (vs ≠ 0):  Z = −5.83  P−Value = 0.000

Fisher's exact test: P-Value = 0.000
```

Test and CI for Two Proportions

```
Sample   X    N  Sample p
1       14  368  0.038043
2       16  368  0.043478


Difference = p (1) - p (2)
Estimate for difference:  -0.00543478
95% CI for difference:  (-0.0340030, 0.0231334)
Test for difference = 0 (vs ≠ 0):  Z = −0.37  P−Value = 0.709

Fisher's exact test: P-Value = 0.853
```

Test and CI for Two Proportions

```
Sample  X    N  Sample p
1       1  166  0.006024
2       4  166  0.024096


Difference = p (1) - p (2)
Estimate for difference:  -0.0180723
95% CI for difference:  (-0.0442018, 0.00805722)
Test for difference = 0 (vs ≠ 0):  Z = −1.36  P−Value = 0.175


* NOTE * The normal approximation may be inaccurate for small samples.

Fisher's exact test: P-Value = 0.371
```

Test and CI for Two Proportions

```
Sample    X      N  Sample p
1        55  38317  0.001435
2       131  38317  0.003419


Difference = p (1) - p (2)
Estimate for difference:  -0.00198345
95% CI for difference:  (-0.00268008, -0.00128683)
Test for difference = 0 (vs ≠ 0):  Z = −5.58  P−Value = 0.000

Fisher's exact test: P-Value = 0.000

===============================
```

Results for: no rio

Binary Logistic Regression: FIV versus Biome

Method

Link function	Logit
Categorical predictor coding	(1, 0)
Rows used	15

Response Information

Variable	Value	Count	Event Name
FIV	Event	1731	FIV
	Non-event	40692	
n	Total	42423	

Deviance Table

Source	DF	Seq Dev	Contribution	Adj Dev	Adj Mean	Chi-Square	P-Value
Regression	2	238.6	24.68%	238.6	119.29	238.58	0.000
Biome	2	238.6	24.68%	238.6	119.29	238.58	0.000
Error	12	728.3	75.32%	728.3	60.69		
Total	14	966.9	100.00%				

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC
24.68%	24.47%	14232.71

Coefficients

Term	Coef	SE Coef	95% CI	Z-Value	P-Value	VIF
Constant	-1.9934	0.0784	(-2.1470, -1.8398)	-25.44	0.000	
Biome Tropical vs.						
Temperate	-1.3057	0.0831	(-1.4685, -1.1428)	-15.71	0.000	1.85
Mediterranean	-0.608	0.109	(-0.822, -0.395)	-5.58	0.000	1.85

Odds Ratios for Categorical Predictors

Level A	Level B	Odds Ratio	95% CI
Biome			
Tropical	Temperate	3.6901	(3.1355, 4.3428)
Mediterranean	Temperate	2.0085	(1.7148, 2.3525)
Mediterranean	Tropical	0.5443	(0.4396, 0.6739)

Odds ratio for level A relative to level B

Regression Equation

P(FIV) = exp(Y')/(1 + exp(Y'))

Y' = -1.9934 - 1.3057 Biome_Temperate + 0.0 Biome_Tropical - 0.608 Biome_Mediterranean