

# The Role of State-Level Rabies Control Policy and Terrestrial Mammal Reservoir Variant on Canine and Feline Rabies in the United States

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# Rabies Disease Background

- Fatal encephalitic disease
- Caused by viruses in the *lyssa* family
- 55,000-75,000 human rabies death per year

# Rabies Elimination Successes and Setbacks

- 1961—Taiwan eliminates dog-to-dog transmission of rabies
- 2013—Taiwan's first positive rabies test results in 52 years
- 2007—Bohol Rabies Prevention and Elimination Program (BRPEP)
- 2008—Bali Indonesia suffers introduction of canine rabies and over 100 human deaths
- 2007—United States declared canine rabies free

# Study Objective

- To analyze state level domestic animal rabies prevention and control strategies
- To evaluate the relationship between positive rabies cases in canines and felines and state level rabies policy
- To determine if terrestrial mammal reservoir variant had an effect on the number of canines and felines that tested positive for rabies

# Data Accumulation

- The National Association of State Public Health Veterinarian's *Compendium of Animal Rabies Prevention and Control, 2011*
- The Journal of the American Veterinary Medical Association's annual publication: *Rabies Surveillance in the United States*
- Public Health representatives from individual states were contacted
- Additional information obtained from state websites

# Data Analysis

- 48 states evaluated for 2009 through 2012
- States grouped based on state level regulation
- States grouped based on rabies variant regions
- Data organized using Microsoft Excel 2013
- Chi-Square test for independence

# Definitions

- *State Statute—regulations enacted by the governing body of the state that apply to entities residing in or traveling through the state; the highest level of regulation in a state, superseded only when federal statute contradicts the state*
- *Administrative Code—regulations that are created and enforced by an administrative body (i.e. a state department of public health, ag, etc.)*

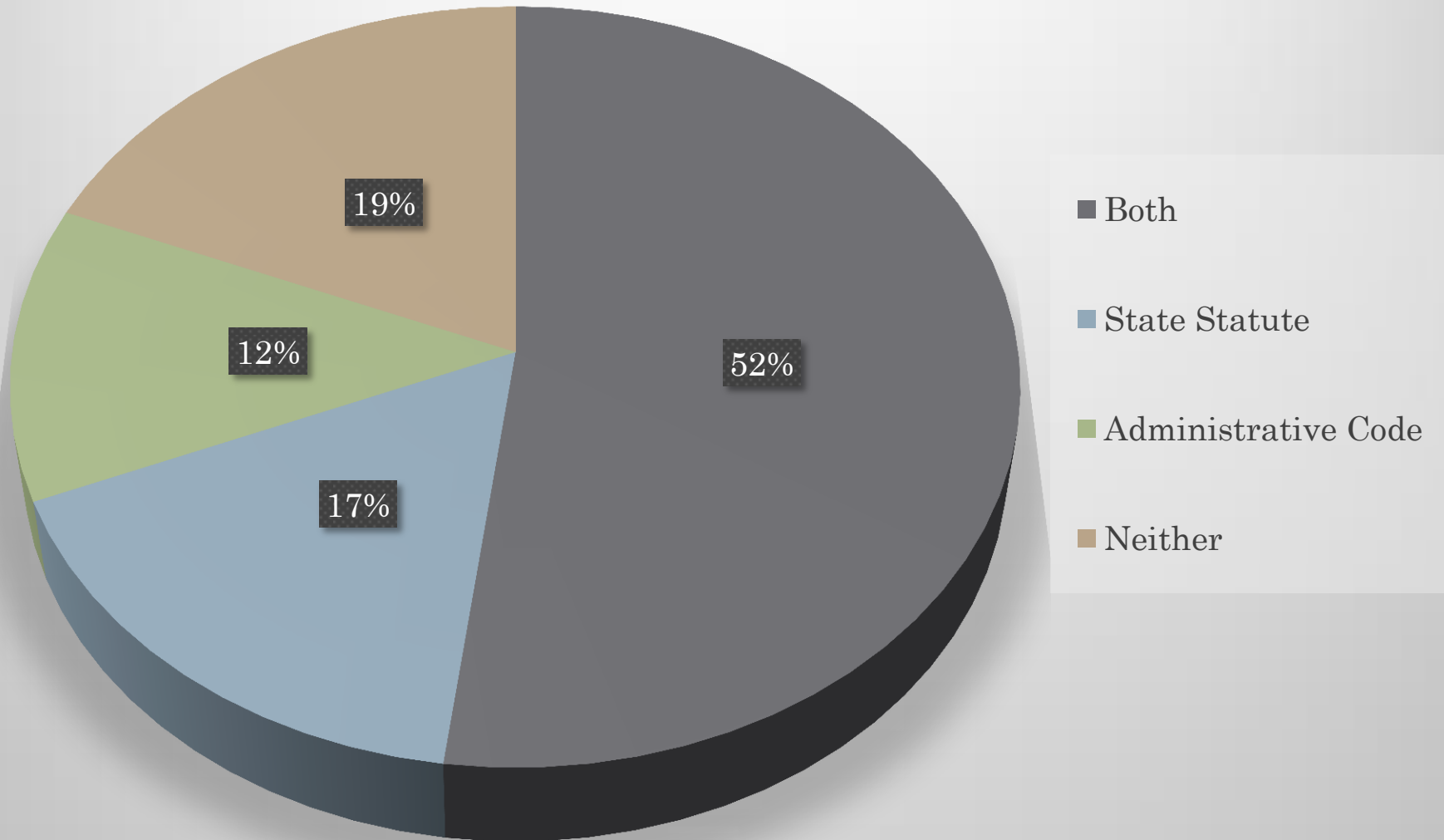
# Domestic Animal Rabies Prevention and Control

- 25 of 48 states have both state statute and administrative code
- 7 have only state statute
- 7 have only administrative code
- 9 have neither state statute nor administrative code

Control Policy	% of States
Both	52.08
State Statute	16.67
Administrative Code	12.50
Neither	18.75



# Percent of Examined States Utilizing the Described Rabies Control Policies





Statute and Administrative Code		2009		2010		2011		2012	
Postal Code	State	Canine	Feline	Canine	Feline	Canine	Feline	Canine	Feline
KY	Kentucky	5	1	0	0	3	0	2	0
MA	Massachusetts	0	9	0	9	0	2	0	2
MD	Maryland	0	19	0	17	3	17	0	13
ME	Maine	0	1	0	1	0	2	1	4
MS	Mississippi	0	0	0	0	0	0	0	0
NC	North Carolina	7	19	2	17	4	26	9	25
NE	Nebraska	1	9	1	6	0	2	1	5
NJ	New Jersey	0	20	0	12	0	22	0	20

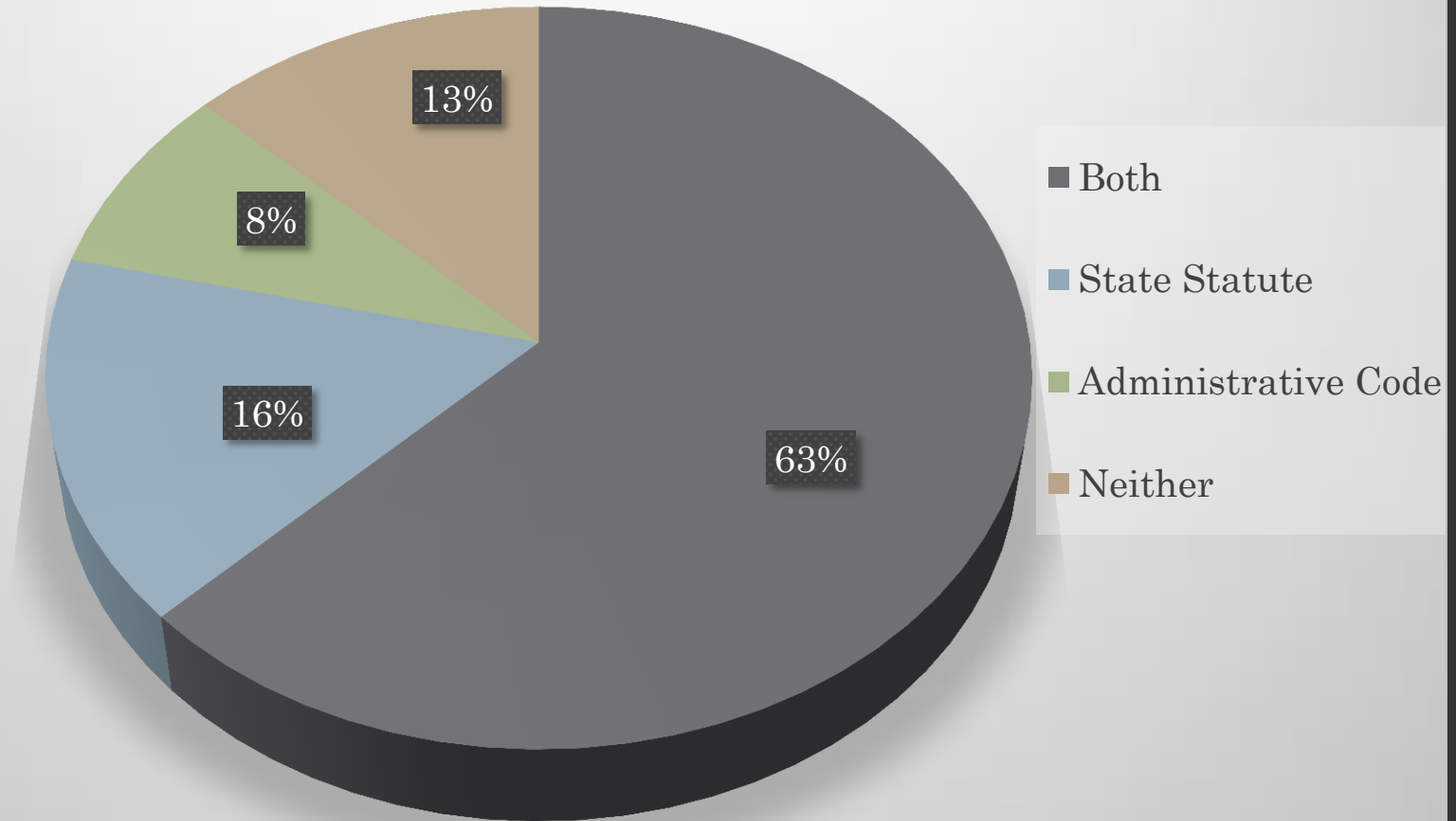


STATUTE ONLY		2009		2010		2011		2012	
Postal Code	State	Canine	Feline	Canine	Feline	Canine	Feline	Canine	Feline
DE	Deleware	0	4	0	5	0	3	0	3
GA	Georgia	3	16	4	21	12	22	7	24
MI	Michigan	0	1	1	1	1	0	0	0
NH	New Hampshire	0	2	0	2	0	1	0	1
OR	Oregon	0	0	0	0	0	0	0	0
SC	South Carolina	5	8	4	3	1	5	0	4
WI	Wisconsin	1	0	0	0	0	0	0	0
WV	West Virginia	0	4	1	7	0	8	2	2



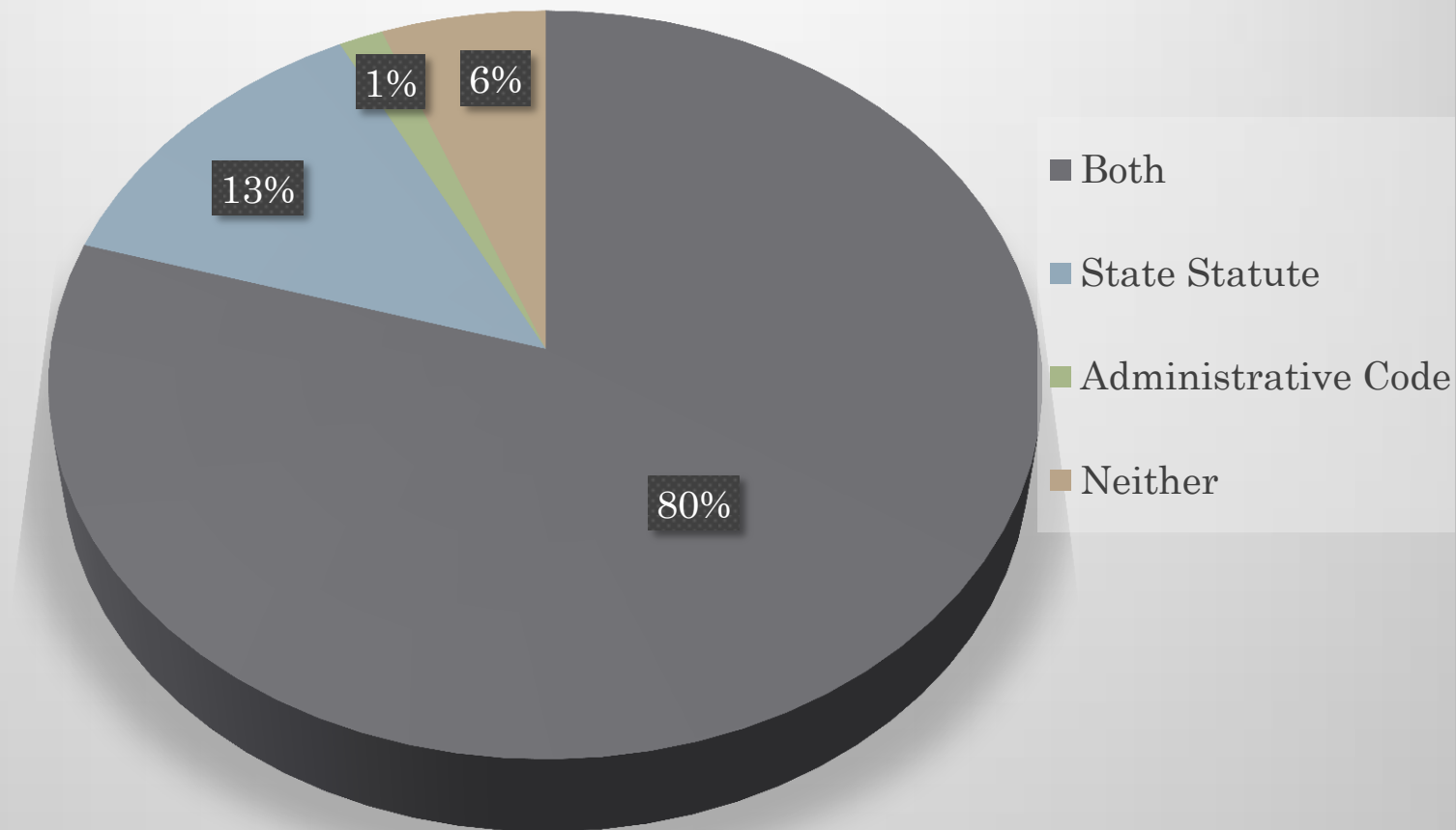
NEITHER		2009		2010		2011		2012	
Postal Code	State	Canine	Feline	Canine	Feline	Canine	Feline	Canine	Feline
CO	Colorado	0	0	0	1	0	0	0	1
ID	Idaho	0	0	0	0	0	0	0	0
KS	Kansas	4	3	3	5	0	4	0	4
MN	Minnesota	4	5	3	8	1	4	1	4
MT	Montana	0	1	0	0	0	0	1	0
ND	North Dakota	1	1	2	4	2	1	0	6
OH	Ohio	0	0	0	0	1	0	0	0
SD	South Dakota	7	4	1	3	3	4	0	2
WY	Wyoming	0	0	0	0	0	1	0	1

# Percent of Total Canines Tested Positive for Rabies 2009-2012 by State Level Policy





# Percent of Total Felines Tested Positive for Rabies 2009-2012 by State Level Policy



# Chi-Square Test for Independence

Total Positive		2009-2012		
	Policy	Canine	Feline	Row Total
Both	25 (18.918)	165 (201.140)	908 (871.860)	1098
Statute	8 (3.177)	42 (35.429)	147 (153.571)	197
Admin	6 (0.487)	22 (7.498)	18 (32.502)	46
Neither	9 (0.701)	34 (18.933)	67 (82.067)	110
Column Total	48	263	1140	1451

# Chi-Square Test for Independence

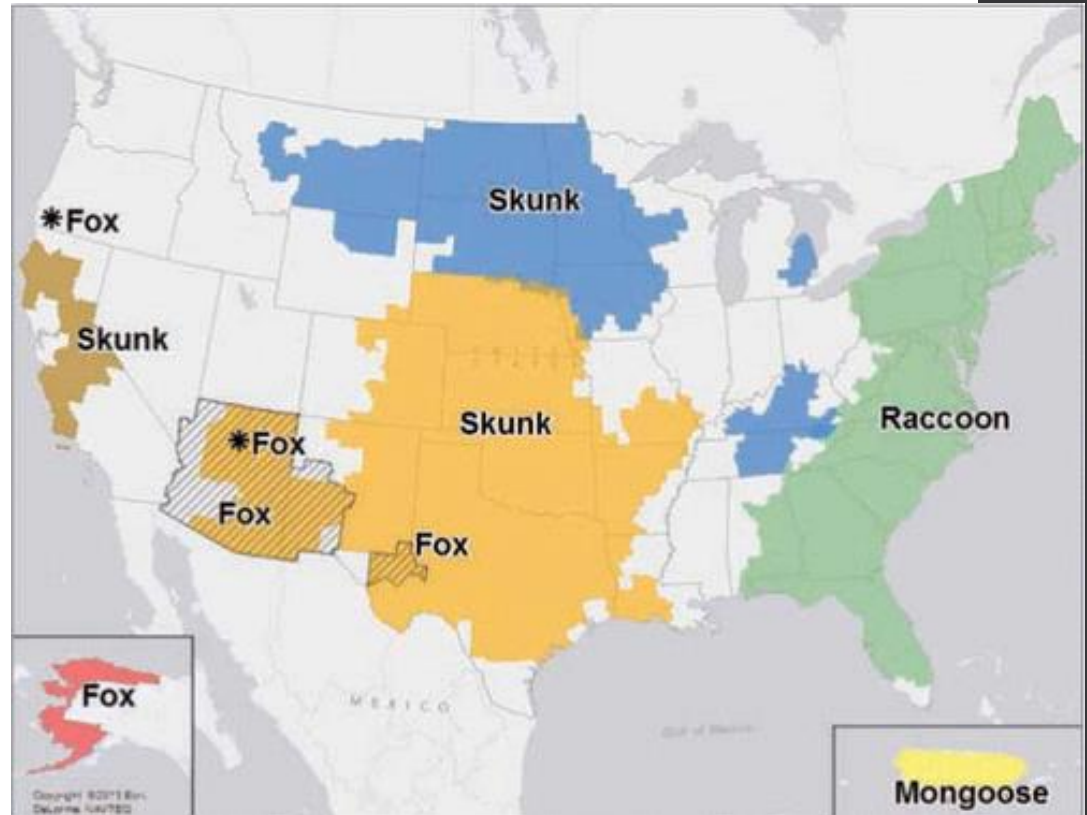
Total Positive		2009-2012		
	Policy	Canine	Feline	
Both	1.955	6.493	1.498	
Statute	7.322	1.219	0.281	
Admin	62.409	28.049	6.471	
Neither	98.250	11.990	2.766	
				Calculated Chi-Squared value= 228.704

# Conclusions

- The number of canines that tested positive is not independent of state level regulation
- The number of felines that tested positive is not independent of state level regulation

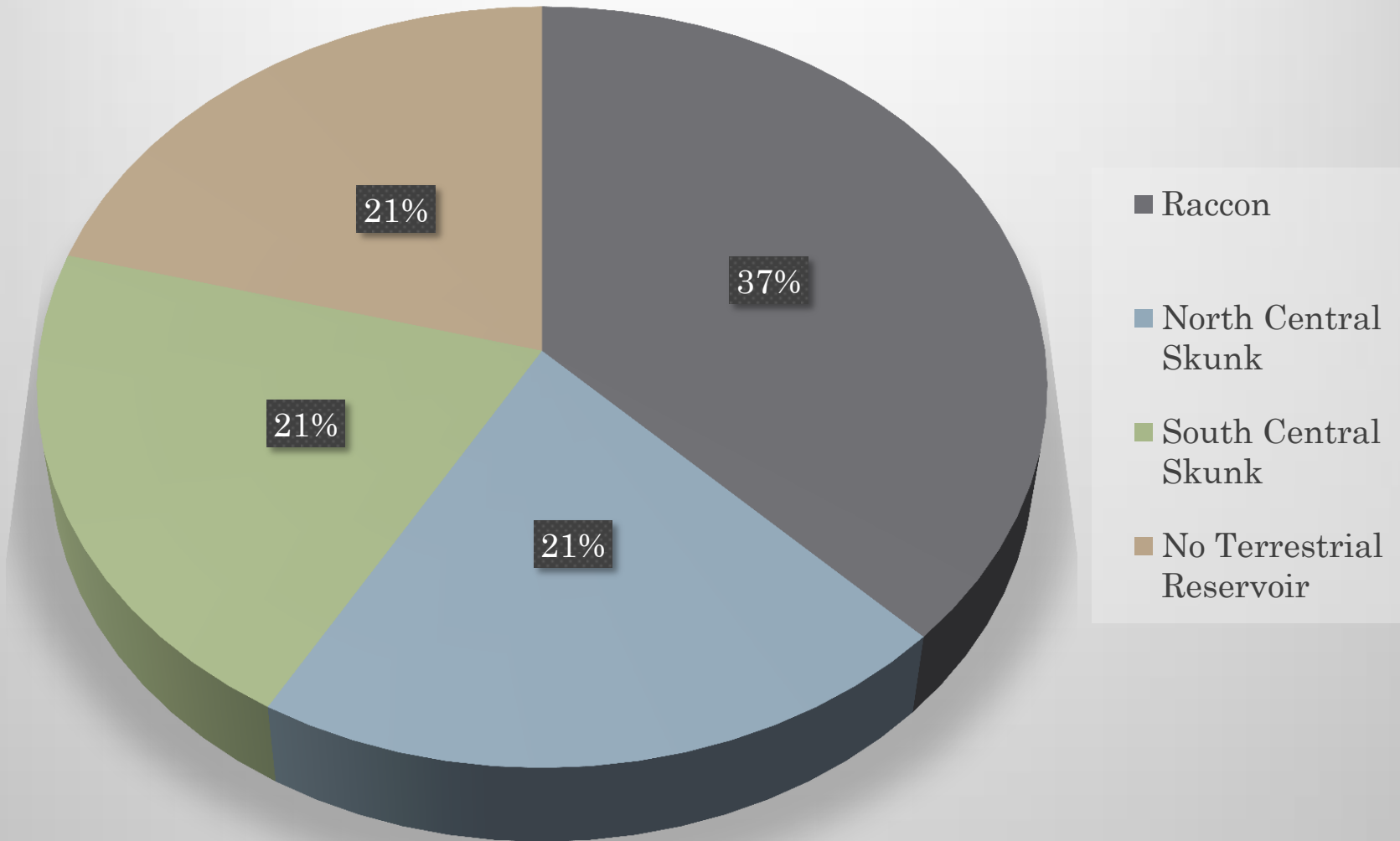
# Terrestrial Mammal Reservoir Rabies Virus Variant

- Raccoon
- North Central Skunk
- South Central Skunk
- No Terrestrial Reservoir



Graphic from The Journal of the American Veterinary Medical Association's *Rabies Surveillance in the United States During 2012*, Dyer, et al.

# Percent of States Endemic with Described Rabies Virus Variants



Raccoon Variant		2009		2010		2011		2012	
Postal Code	State	Canine	Feline	Canine	Feline	Canine	Feline	Canine	Feline
AL	Alabama	2	3	1	1	0	0	4	4
CT	Connecticut	1	2	0	1	1	7	0	3
DE	Deleware	0	4	0	5	0	3	0	3
FL	Florida	1	11	0	15	1	11	2	8
GA	Georgia	3	16	4	21	12	22	7	24
ME	Maine	0	1	0	1	0	2	1	4
MD	Maryland	0	19	0	17	3	17	0	13
MA	Massachusetts	0	9	0	9	0	2	0	2
NH	New Hampshire	0	2	0	2	0	1	0	1

RACCOON VARIANT		2009		2010		2011		2012	
Postal Code	State	Canine	Feline	Canine	Feline	Canine	Feline	Canine	Feline
NJ	New Jersey	0	20	0	12	0	22	0	20
NY	New York	0	27	1	42	1	38	0	22
NC	North Carolina	7	19	2	17	4	26	9	25
PA	Pennsylvania	6	57	4	56	3	50	0	41
RI	Rhode Island	0	0	0	2	0	3	0	2
SC	South Carolina	5	8	4	3	1	5	0	4
VT	Vermont	0	0	0	0	0	0	0	3
VA	Virginia	4	40	5	27	3	30	3	28
WV	West Virginia	0	4	1	7	0	8	2	2

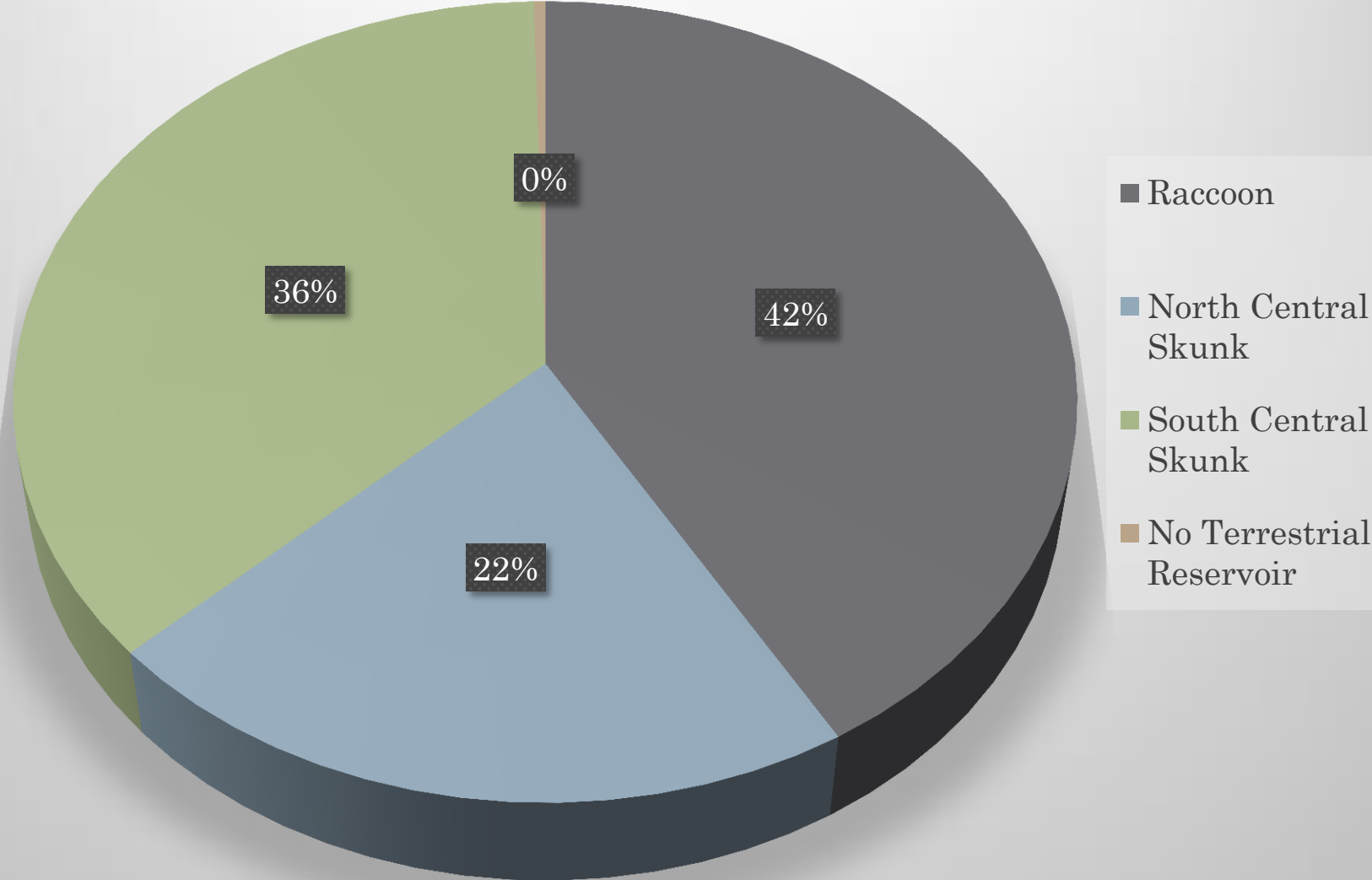


NORTH CENTRAL SKUNK		2009		2010		2011		2012	
Postal Code	State	Canine	Feline	Canine	Feline	Canine	Feline	Canine	Feline
IA	Iowa	2	3	1	1	0	3	0	1
KY	Kentucky	5	1	0	0	3	0	2	0
MI	Michigan	0	1	1	1	1	0	0	0
MN	Minnesota	4	5	3	8	1	4	1	4
MT	Montana	0	1	0	0	0	0	1	0
ND	North Dakota	1	1	2	4	2	1	0	6
SD	South Dakota	7	4	1	3	3	4	0	2
TN	Tennessee	5	0	3	1	4	0	2	1
WI	Wisconsin	1	0	0	0	0	0	0	0
WY	Wyoming	0	0	0	0	0	1	0	1

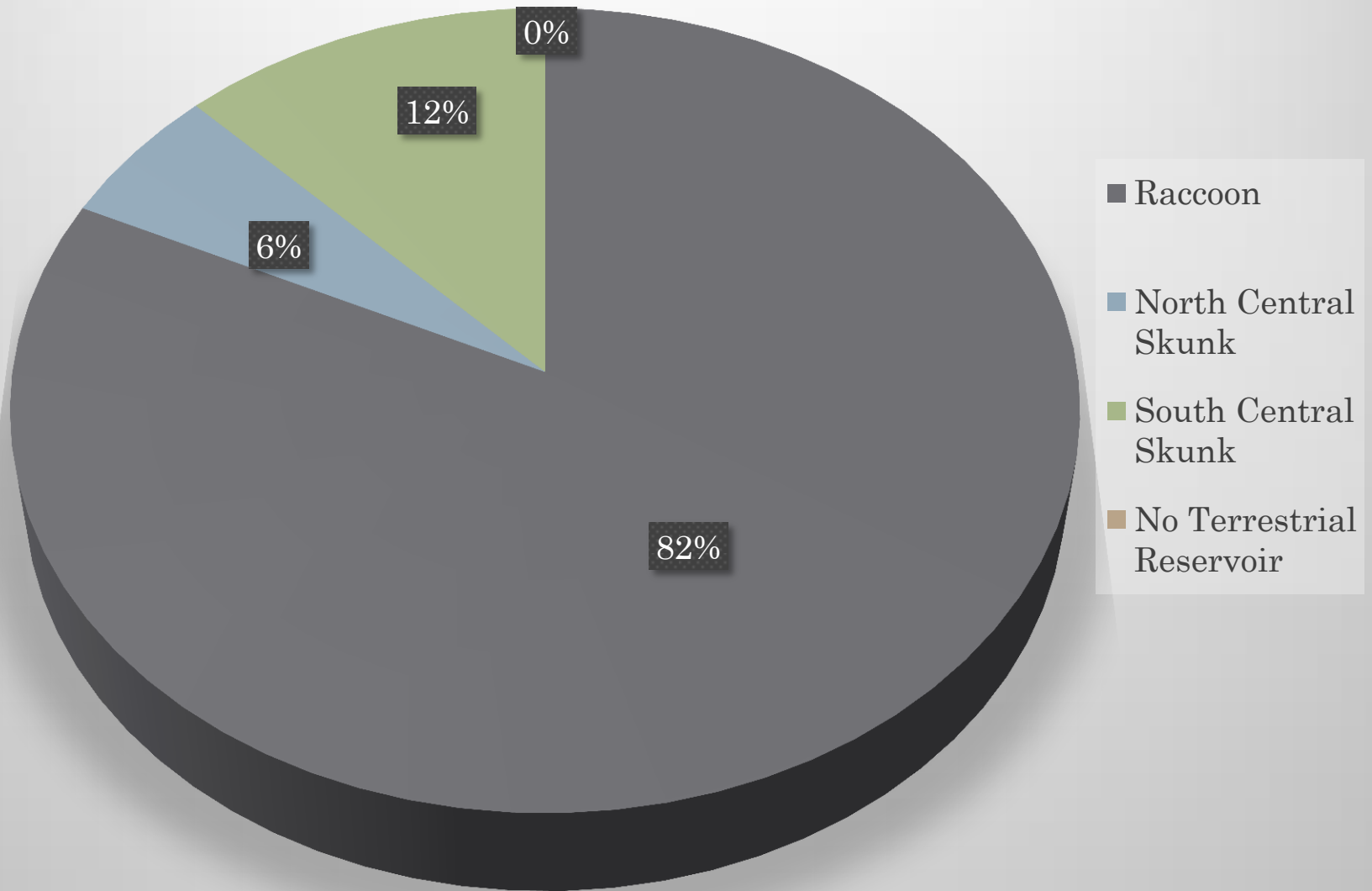
SOUTH CENTRAL SKUNK		2009		2010		2011		2012	
Postal Code	State	Canine	Feline	Canine	Feline	Canine	Feline	Canine	Feline
AZ	Arizona	0	1	0	0	0	0	0	0
AR	Arkansas	2	0	1	0	0	1	3	1
CO	Colorado	0	0	0	1	0	0	0	1
KS	Kansas	4	3	3	5	0	4	0	4
LA	Louisiana	0	1	1	0	0	0	0	0
MO	Missouri	0	1	0	1	0	0	0	0
NE	Nebraska	1	9	1	6	0	2	1	5
NM	New Mexico	0	0	0	1	1	0	2	0
OK	Oklahoma	1	7	3	4	10	3	7	1
TX	Texas	14	15	15	20	9	30	16	14

NO TERRESTRIAL RESERVOIR		2009		2010		2011		2012	
Postal Code	State	Canine	Feline	Canine	Feline	Canine	Feline	Canine	Feline
ID	Idaho	0	0	0	0	0	0	0	0
IL	Illinois	0	0	0	0	0	0	0	0
IN	Indiana	0	0	0	0	0	0	0	0
MS	Mississippi	0	0	0	0	0	0	0	0
OR	Oregon	0	0	0	0	0	0	0	0
NV	Nevada	0	0	0	0	0	0	0	0
UT	Utah	0	0	0	0	0	0	0	0
WA	Washington	0	0	0	0	0	0	0	0
OH	Ohio	0	0	0	0	1	0	0	0

# Percent of Total Canines Tested Positive in States with Described Rabies Virus Variants from 2009-2012



# Percent of Total Felines Tested Positive in States with Described Rabies Virus Variants from 2009-2012



# Chi-Square Test for Independence

Total Positive		2009-2012		
	Variant	Canine	Feline	Row Total
Raccoon	18 (35.180)	108 (190.559)	936 (836.261)	1062
North Central Skunk	10 (4.306)	56 (23.326)	64 (102.367)	130
South Central Skunk	10 (8.149)	95 (44.141)	141 (193.710)	246
No Terrestrial Reservoir	10 (0.364)	1 (1.974)	0 (8.662)	11
Column Total	48	260	1141	1449

# Chi-Square Test for Independence

Total Positive		2009-2012		
	Variant	Canine	Feline	
Raccoon	8.390	35.768	11.896	
North Central Skunk	7.529	45.768	14.380	
South Central Skunk	0.420	58.599	14.343	
No Terrestrial Reservoir	255.089	0.481	8.662	
				Calculated Chi-Square value= 461.326

# Conclusions

- The number of canines that tested positive is not independent of rabies virus variant
- The number of felines that tested positive is not independent of rabies virus variant



# Discussion

- Incidence data
- Variability of testing protocols and surveillance
- High proportion of feline vs. canine positive cases
- Population density

# Further Investigation of State Rabies Control in the United States

- Analysis of rabies incidence
- Historical comparison rabies control strategy and rabies incidence
- State to state comparison of the control strategy effectiveness
- Analysis of individual state rabies testing policy
- Analysis of population densities in relation to rabies incidence

# Further Investigation of Rabies Impact on Human Health in the United States

- Examination of human rabies treatment guidelines
- Analysis of post exposure prophylaxis administered

# Thank you

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# References

- Agung Gde Putera, A., Hampson, K., Girardi, J., Hiby, E., Knobel, D., Mardiana, I., . . . Scott-Orr, H. (2013, April). Response to a Rabies Epidemic, Bali, Indonesia 2008-2011. *Emerging Infectious Diseases*, pp. 648-651.
- Anderson, E., Tremper, C., Thomas, S., & Wagenaar, A. C. (2012, February 28). Measuring Statutory Law and Regulations for Empirical Research. *PHLR Methods Monograph Series*. Philadelphia, Pennsylvania, USA: Robert Wood Johnson Foundation.
- Animal Protection of New Mexico. (n.d.). *How to Understand the Differences Between Statutes, Regulations, Ordinances and Common Law*. Retrieved March 11, 2014, from Animal Protection of New Mexico: [http://www.apnm.org/publications/animal\\_law/how\\_to/understand.php](http://www.apnm.org/publications/animal_law/how_to/understand.php)
- Briggs, D. J., & Meslin, F. X. (2013). Eliminating Canine Rabies, the Principal Source of Human Infection: What Will it Take. *Antiviral Research*, 291-296.
- Brown, C. M., Conti, L., Ettestad, P., Leslie, M. J., Sorhage, F. E., & Sun, B. (2011). *Compendium of Animal Rabies Prevention and Control, 2011*. Jamaica Plain: National Association of State Public Health Veterinarians, Inc.
- Centers for Disease Control and Prevention. (2007, September 7). *CDC In the News*. Retrieved October 3, 2013, from CDC.gov: [http://www.cdc.gov/news/2007/09/canine\\_rabies.html](http://www.cdc.gov/news/2007/09/canine_rabies.html)
- Christine, K. (2012, July). *Rabies Laws in the United States as of 7/2012*. Retrieved October 8, 2013, from Dogs4Dogs.com: [www.dogs4dogs.com/rabies-laws](http://www.dogs4dogs.com/rabies-laws)
- Coleman, P. G., Fevre, E. M., & Cleaveland, S. (2004, January). Estimating the Public Health Impact of Rabies. *Emerging Infectious Diseases*, pp. 140-142.
- Dodet, B., Korejwo, J., & Briggs, D. J. (2013, October 30). Eliminating the Scourge of Dog-Transmitted Rabies. Caluire et Cuire, France: Vaccine.
- Dye, C. (2012). National and International Policies to Mitigate Disease Threats. *Philosophical Transactions of the Royal Society*, 2893-2900.
- Dyer, J. L., Wallace, R., Orciari, L., Hightower, D., Yager, P., & Blanton, J. D. (2013, September 15). Rabies Surveillance in the United States During 2012. *Journal of the Veterinary Medical Association*, pp. 805-815.
- Food and Agriculture Organization of the United Nations. (2014, September 28). *The Battle Against Rabies - A Success Story*. Retrieved April 15, 2014, from FAO: <http://www.fao.org/news/story/en/item/158800/icode/>

# Additional References

- Hampson, K., Dushoff, J., Cleaveland, S., Haydon, D. T., Kaare, M., Craig, P., & Dobson, A. (2009, March 10). *Transmission Dynamics and Prospects for the Elimination of Canine Rabies*. Retrieved April 15, 2014, from PLOS Biology: <http://www.plosbiology.org/article/info%3Adoi%2F10.1371%2Fjournal.pbio.1000053#pbio-1000053-g004>
- Henderson, D. A. (1970). Summary Status of the Global Programme. Inter-Regional Seminar on Surveillance and Assessment in Smallpox Eradication New Delhi.
- Kansas Department of Health and Environment. (2013). *Animal and Human Health Issues*. Retrieved October 3, 2013, from Kansas Department of Health and Environment: [http://www.kdheks.gov/epi/human\\_animal\\_health.htm](http://www.kdheks.gov/epi/human_animal_health.htm)
- Lankau, E. W., Tack, D. M., & Nina, M. (2012). Preventing Rabies in an Age of Global Travel. *Crossing Borders: One World, Global Health*, 54.
- Library of Congress. (2014, February 28). *Administrative Law Guide*. Retrieved March 11, 2014, from Law Library of Congress: <http://www.loc.gov/law/help/administrative.php>
- Manning, S. E., Rupprecht, C. E., Fishbein, D., Hanlon, C. A., Lumlerdacha, B., Guerra, M., . . . Hull, H. F. (2008). *Human Rabies Prevention---United States Recommendations of the Advisory Committee on Immunization Practices*. Atlanta: National Center for Zoonotic, Vector-Borne and Enteric Diseases.
- Miller, R. S., Farnsworth, M. L., & Malmberg, J. L. (2013). Diseases at the Livestock-Wildlife Interface: Status, Challenges, and Opportunities in the United States. *Preventive Veterinary Medicine*, 119-132.
- Morters, M. K., Restif, O., Hampson, K., Cleaveland, S., Wood, J. L., & Conlan, A. J. (2013). Evidence-Based Control of Canine Rabies: A Critical Review of Population Density Reduction. *Journal of Animal Ecology*, 6-14.
- Shwiff, S., Hampson, K., & Anderson, A. (2013). Potential Economic Benefits of Eliminating Canine Rabies. *Antiviral Research*, 352-356.
- Townsend, S. E., Lembo, T., Cleaveland, S., Meslin, F. X., Miranda, M. E., Agung Gde Putra, A., . . . Hampson, K. (2012, October 8). *Surveillance Guidelines for Disease Elimination: A Case Study of Canine Rabies*. Retrieved April 24, 2014, from Science Direct: <http://www.sciencedirect.com/science/article/pii/S0147957112001221#>
- Velasco-Villa, A., Reeder, S. A., Orciari, L. A., Yager, P. A., Franka, R., Blanton, J. D., . . . Rupprecht, C. E. (2008, December). Enzootic Rabies Elimination from Dogs and Reemergence in Wild Terrestrial Carnivores, United States. *Emerging Infectious Diseases*, pp. 1849-1854.