Who Let the Dogs Out?
Canine Distemper in California

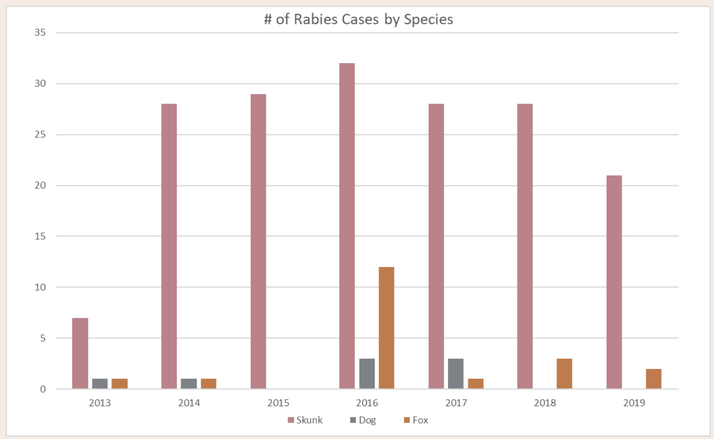
CDV Gone Wild

Canine distemper virus (CDV) is a *Morbillivirus* in the family Paramyxoviridae that causes extreme sickness and can have lasting damage to infected individuals. This virus exists in many terrestrial canids and can also infect domestic dogs. Typical of morbilliviruses, it is highly virulent and can mutate quickly as demonstrated by new strains that have been identified in the northeastern United States.

While other important viruses such as rabies, have been heavily monitored, CDV has little surveillance at state and federal levels. Since new distemper viruses are increasingly being identified, this project aims to determine areas of high risk for spillover of the virus into humans. Use of spatial analysis will allow us to look at multiple risk factors, identify recommended areas for surveillance and determine vulnerable spaces for a potentially dangers new outbreak.

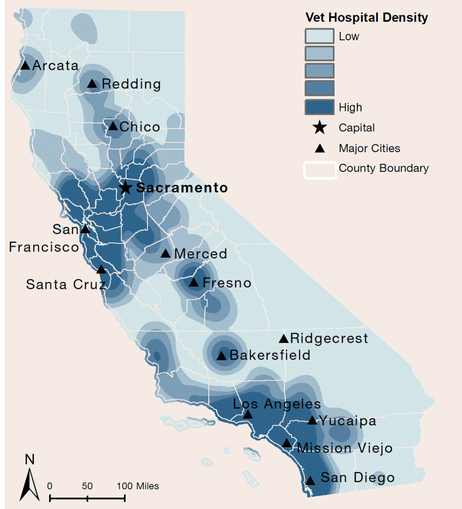
Area of High Risk

Rabies on the Rise



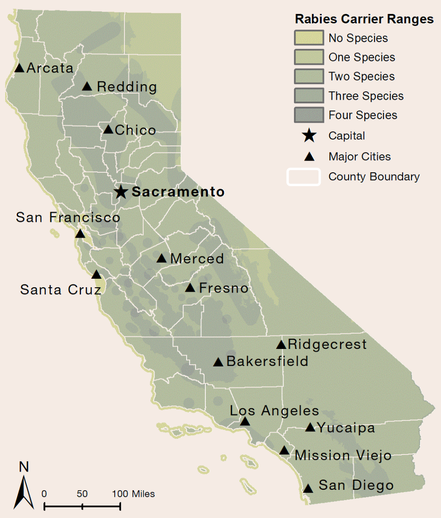
Rabies cases across California have increased over the past five years. The number of cases for 2019 has only been documented until October 11th of this year, making the counts not reflective of a full year total. With an increase in rabies cases across the state and notably in animals that are also able to carry CDV it is important to determine what is causing the rise in cases and if there are environmental or anthropogenic factors that may be making animals more susceptible. Since both rabies and CDV can present similar clinical symptoms, taking care to confirm accuracy in diagnostic testing is important.

Methodology



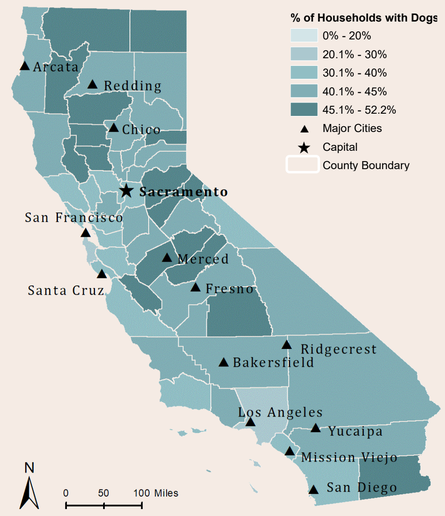
Vet Hospital Density

Vet hospitals served as a proxy for vaccinated domestic dogs, since vet hospitals are able to offer a canine distemper vaccine that has been shown to be highly effective. **Kernel density** was performed to determine areas of higher risk. Areas were reclassified, with higher density of vet hospitals being at lower risk for contracting CDV since the surrounding area is likely to have individuals who are vaccinated.



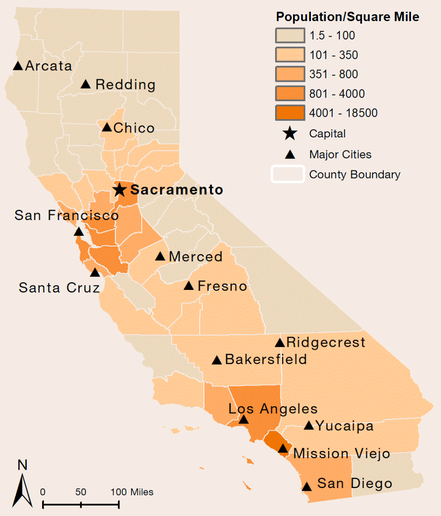
Carrier Habitat Ranges

Animals that can transmit CDV are known as carriers. Four species were included in this study: Kit Fox, Red Fox, Gray Fox and Northern Raccoon. Their habitat ranges as determined by the IUCN were added together using a **raster calculator** and reclassified to create a risk scale with. The more ranges that were overlapping suggest a higher risk of transmission.



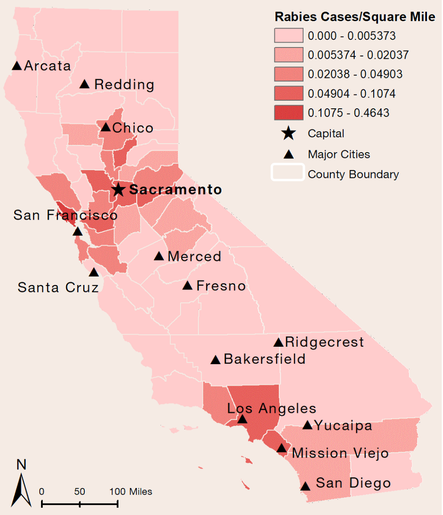
Dog Ownership

Dogs can be a means of spillover of CDV in humans since they come in such close contact with them. Number of dogs per household was averaged over the number of households with dogs by county and **reclassified** to show areas with higher dog ownership. Areas with higher dog ownership are at greater risk for canine distemper since there are more individuals to potentially transmit disease.



Population Density

Population density per square mile was symbologized by county and **reclassified** to show areas of high to low population density. Areas with high population density are at higher risk for CDV spillover by having more individuals where the virus could potentially mutate and become pathogenic to humans.



Total Rabies Cases

The number of rabies cases for each county from 2013—2019 were summed since most canids that carry the rabies virus can also transmit canine distemper virus. This was used as a proxy to predict possible areas of high CDV in wildlife. Data were **reclassified** and areas at high risk for CDV were where there were more incidences of rabies cases.

The Next Big Thing...

A raster calculator was run to determine areas that had the highest risk for CDV spillover. All factors were weighted evenly and combined. Each factor was ranked 1-5 and the total risk score was calculated to have a range of 8 to 21. The max possible score is 25. The counties with the highest score were those of Sacramento, Solano, Orange, Marin and Alameda. With new strains of canine distemper making its way across the country, these counties should take extra precaution to encourage routine vaccination in domestic dogs and increased surveillance for carrier populations. Notably, the black footed-ferret who can also succumb to canine distemper, is listed as a federally endangered species. A large outbreak in their populations may further put populations at risk.

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Analysis Factor	Risk Score 1 (Lowest Risk)	Risk Score 2	Risk Score 3	Risk Score 4	Risk Score 5 (Highest Risk)
Vet Hospital Density	0.1486-0.1857	0.1115-0.1485	0.0743-0.1114	0.0372-0.0743	0-0.0371
Overlap of Carrier Species Habitat Ranges	No species	One Species	Two Species	Three Species	Four Species
Dog Ownership (% of houses with dogs)	0-20%	20.1-30%	30.1-40%	40.1-45%	45.1-55%
Population Density (people per square mile)	1.5-100	101-350	351-800	801-4,000	4,001-18,500
Rabies Cases by County (cases per square mile)	0-0.0053	0.0054-0.0203	0.0204-0.04	0.05-0.1075	0.1076-0.4643

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Data Sources: IUCN, CA GIS, CDC, ESRIMap2018
Projection: NAD 1983 (2011) California (Teale) Albers (Meters)