Where to Build a Wildlife Corridor in California to Reduce Mammalian Roadkill

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Abstract

Roads generate habitat fragmentation, which put wildlife populations at risk of genetic bottlenecks or possibly extinction. Roadkill is another consequence of roads. Traffic collisions with wildlife threatens human safety and creates a financial burden to the people involved in the accident and taxpayers. The goal of this GIS project is to mitigate roadkill incidences by finding the most suitable location in California to build a wildlife crossing for mammals. We considered where was the largest hotspot for mammalian roadkill, where is habitat connectivity needed, and where will be the most cost-effective location for the site. Our analyses revealed that a crossing on Route 70 in Plumas County would best mitigate the occurrence of roadkill. Retrofitting our roads with wildlife corridors would minimize roadkill; and in turn, genetic diversity, human welfare, and economic savings would ensue.

Introduction

Human encroachment on wildlife habitat has reduced shelter for animals as well as increased habitat fragmentation. Lack of gene flow results, which creates a risk of population bottlenecks and ultimately extinction of wildlife species affected by the fragmentation (Richter, 2009). As we continue to build roads, habitat fragmentation intensifies due to the creation of physical barriers that partition one natural environment into several degraded environments. Road ecology examines the impacts of roads on abiotic and biotic components (Coffin, 2007) and the implications of their prevalence across landscapes.

A species that once occupied wide geographic ranges is now forced to cross roads in order to utilize its entire habitat range. Vehicle collisions with wildlife have increased by 50% since 1996, but have shown to decrease by 85% with the implementation of wildlife corridors (Gale). Building wildlife crossings is a promising solution to address the pervasive issue of

anthropogenically induced habitat fragmentation. Additionally, the financial costs associated with vehicle repairs and removal of carcasses produces an economic burden. Wildlife-vehicle collisions cost California around $276 million in 2016 (May, 2017).

At Humboldt State University, a group of GIS students developed a set of criteria to determine an ideal site in California to build a wildlife corridor to address the problems associated with mammalian roadkill. Figure 1 reveals the general area of the suggested crossing.

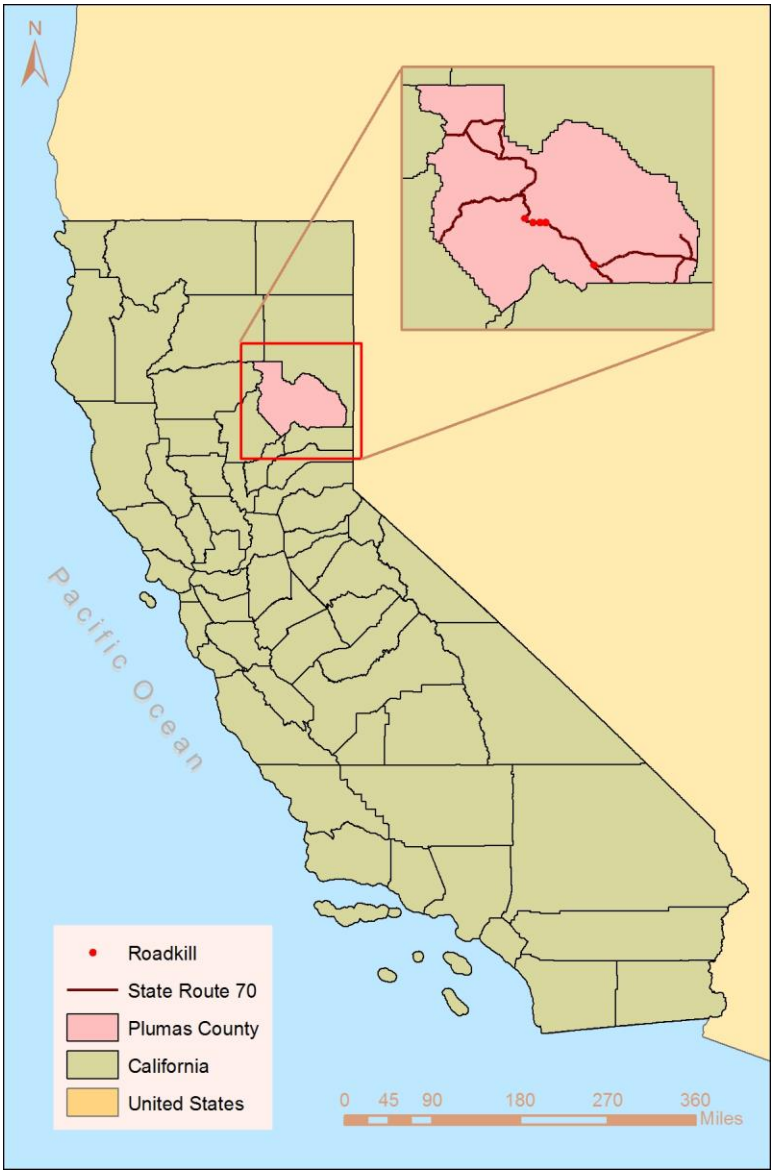

Figure 1: The following map depicts the general location where the wildlife corridor should be constructed.

The goal of this project was to determine the best location in California to construct a wildlife corridor for mammals. We intended for the proposed site to mitigate mammalian roadkill, which would enhance genetic diversity among mammalian species, decrease hazards to drivers, and minimize roadkill-related economic costs.

Methods

To determine the most effective location for a wildlife crossing we developed a set of criteria based on where was the largest hotspot for roadkill, where is habitat connectivity needed, and where will be the most cost-effective location. We acquired the necessary shapefiles to begin analysis: the downloaded data entails roads, counties, and federal lands (wildlife habitats) within California. Table 1 depicts the shapefiles used, their descriptions, and where to access them.

Table 1: Datasets Used and their Corresponding Information

Dataset	Description	Data Source	Link to Data
California Roads	Roads in California	United States Census Bureau	https://www.census.gov/cgi-bin/geo/shapefiles/index.php
California Counties	Counties in California	California Open Data Portal	https://data.ca.gov/dataset/ca-geographic-boundaries/resource/091ff50d-bb24-4537-a974-2ce89c6e8663
Plumas Roads	Roads in Plumas County	Plumas County GIS Portal	http://plumascounty.us/index.aspx?NID=2199
Federal Lands	Parcels specifying private and public land across California (Wildlife Habitats)	U.S. Department of the Interior	https://catalog.data.gov/dataset/blm-national-surface-management-agency-area-polygons
Location of Roadkill from Last 90 Days	Roadkill locations in California from Jan - March 2018	UC Davis - California Roadkill Observation System	http://www.wildlifecrossing.net/california/map/roadkill?tid_1=3

We adjusted each shapefile's coordinate system to NAD 1983 UTM Zone 10N since it best projects California's geography. Next, the mammalian roadkill shapefile had to be created. We referred to a citizen science online database designed by UC Davis, called California Roadkill Observation System (CROS), to learn where large mammals had been killed by vehicles in the past ninety days. Only large mammal roadkill sites were used because a wildlife corridor designed for large mammals could also be used by other, smaller mammals. To create this shapefile, the roadkill sites from the CROS were compared to Google Maps to ocularly estimate the location of each point. Upon gathering the longitude and latitude of each roadkill site via Google Maps, we manually entered these coordinates into ArcMap to create a roadkill shapefile. Once all the roadkill points were added to the map, the spatial join tool revealed which county had the highest number of roadkill. We then employed the kernel density tool to verify where the largest roadkill hotspots occurred across the state. The county with the highest incidences of roadkill was chosen for further analysis of where to build an overpass. We clipped the roads, roadkill, and federal lands shapefiles to the county. Using ocular estimation, we determined where would be the shortest distance to implement a corridor that would connect two fragmented parts of wildlife habitat.

Results

Upon conducting several analyses, we found Plumas County to have the largest roadkill hotspot in California for large mammals. Figure 2 illustrates the density of mammalian roadkill incidents per square mile across California. The densities range from high (red) to low (green). Thus, sites with dark red coloring have the highest density of roadkill per square mile. This map, in conjunction with the highest roadkill instances per county, was used to decide the preferred

site for the wildlife corridor. Six incidents of roadkill occurred in a concentrated area of Plumas County within the past ninety days.

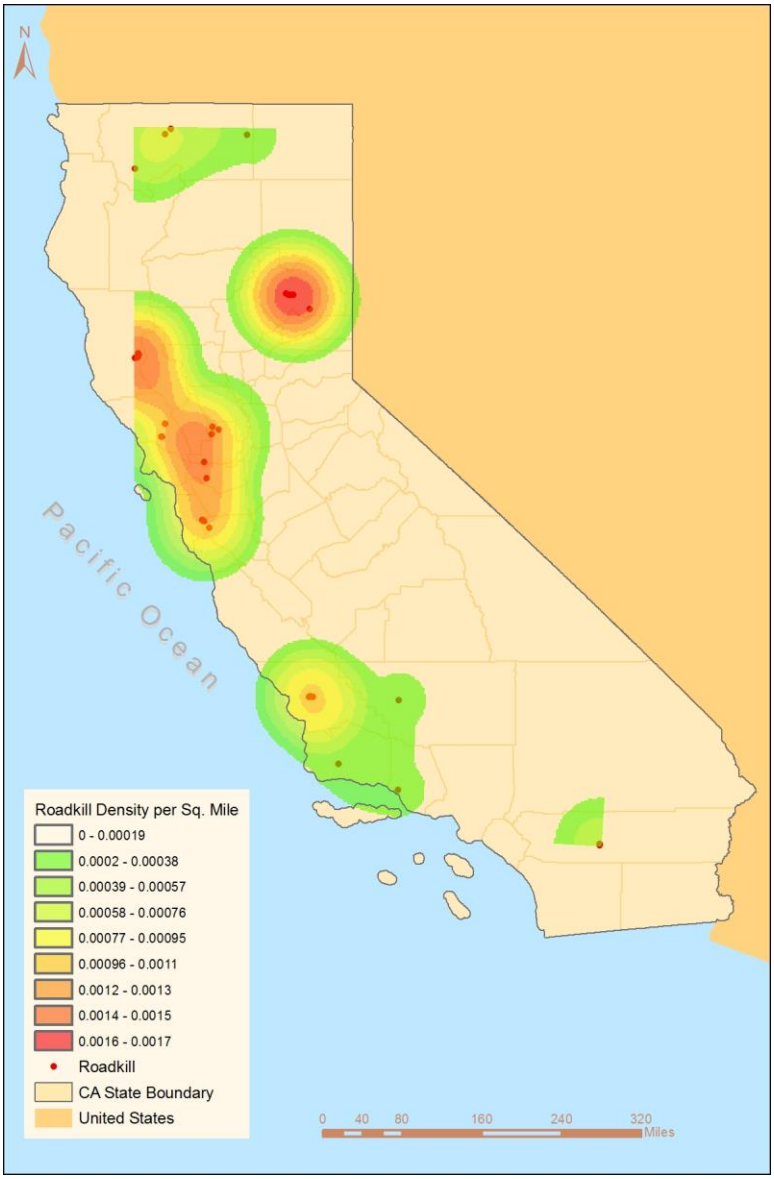

Figure 2: This map illustrates mammalian roadkill density per square mile across California, with red signifying a hotspot and green symbolizing a relatively insignificant occurrence.

Figure 3 reveals where the desired wildlife corridor should be located based on the established criteria. There exists a high density of roadkill in this county; and the residential zones fragment Plumas National Forest, which is critical habitat for wildlife, and this fragmentation increases the probability of vehicle collisions with wildlife to occur. Lastly, the

most economically feasible placement of a corridor would be over one major road, as opposed to several roads. Therefore, a wildlife crossing in Plumas County, along State Route 70, would best address the problem of mammalian roadkill in California.

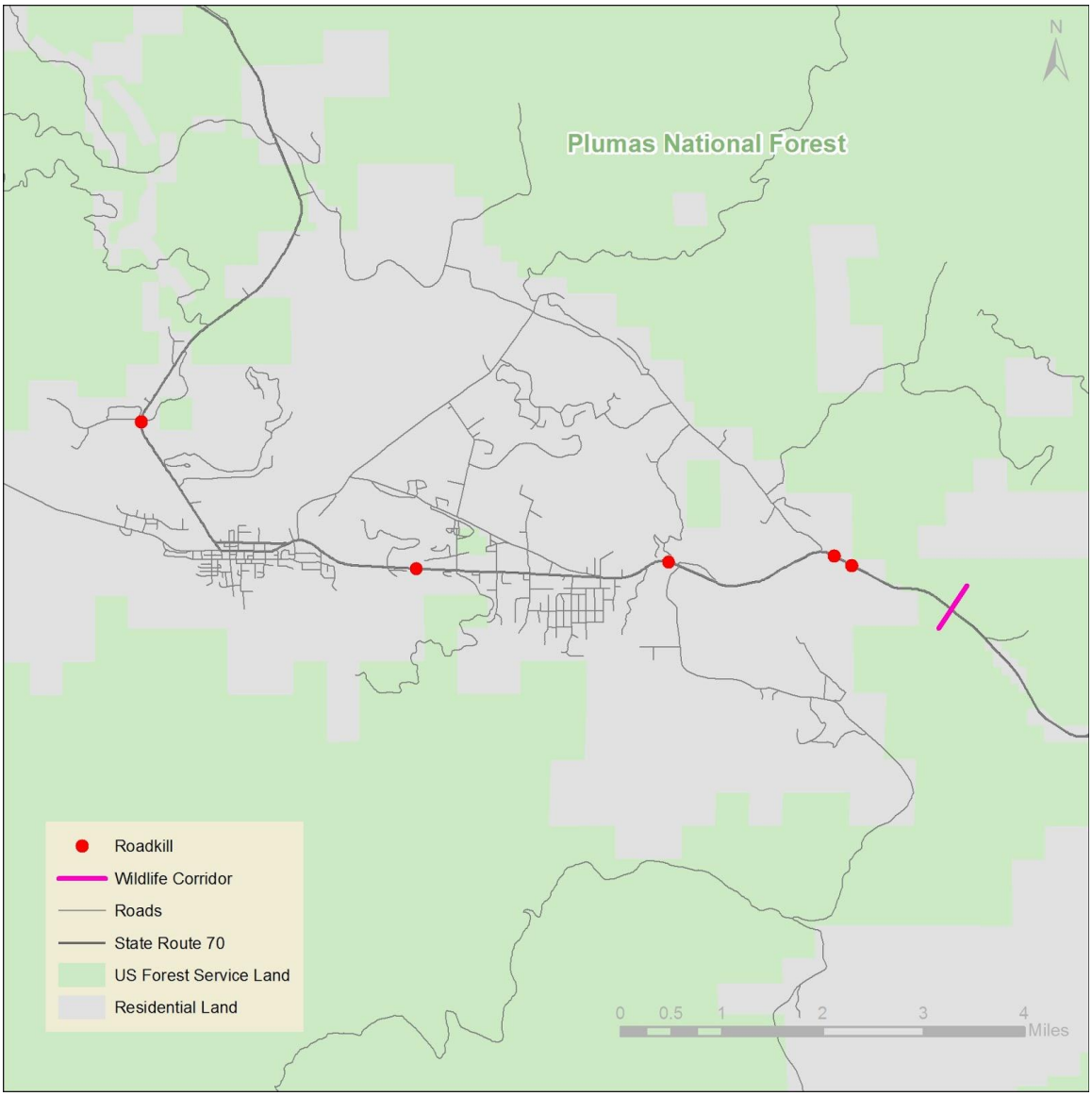

Figure 3: The following map indicates a proposed site to construct a wildlife corridor across State Route 70 in Plumas County, California. The wildlife corridor is not drawn to scale.

Conclusion

Urban sprawl necessitates the construction of roads to connect people across the landscape; however, as a consequence wildlife loses connectivity within its environment.

Population bottlenecks force inbreeding, and in turn leads to genetic erosion (Richter, 2009). Eventually, local extinction of a population may occur. As human population continues to increase, we must strategize how to reduce current defilement of nature and prevent future encroachment on wildlife habitat.

The approximate $276 million we lose annually to roadkill accidents (May, 2017) can be invested to retrofit our infrastructure as a way to ameliorate conditions for wildlife and people. California Department of Transportation (Caltrans) tends to major roads in California, so they are responsible for removing carcassases off roads. If Caltrans can begin to record occurrences of roadkill at the same level of detail as CROS (the citizen science database), then landscape planners could base their designs on information that considers the prevalence and distribution of wildlife and their habitat.

This leads to an important consideration for future wildlife corridor projects. A greater accuracy and abundance of roadkill data could have emphasized the cogency of our project's results. Many roadkill accidents are unreported; and since roadkill data is poorly recorded, we were limited with what was available to us as a means of determining the site of a wildlife corridor. Another consideration to improve the results of our project is to include a digital elevation model and soil type shapefile to consider where the actual construction of a corridor is most feasible in terms of stable infrastructure. Lastly, incorporating roadkill data of all mammals, not just large mammals, could improve the accuracy of our site choice.

Acquiring more data pertinent to roadkill can transform the way we build transportation networks. Road ecology is a blossoming field that can provide great insight to decision-makers on the effects of roads on ecosystems, and ways to design urban development more effectively to accommodate to wildlife in spite of increasing human populations.

Acknowledgements

County, roads, and federal lands shapefiles were downloaded from Plumas County, California, and United States GIS portals. Roadkill data was obtained from the UC Davis California Roadkill Observation System.

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Literature Cited

California Roadkill Observation System. (ND). *UC Davis*. http://www.wildlifecrossing.net/california/map/roadkill?tid_1=3

Coffin, A. (2006) From roadkill to road ecology: A review of the ecological effects of roads. *Journal of Transport Geography*, *15* (2007), 396-406. https://www.researchgate.net/profile/Alisa_Coffin/publication/222688089_From_roadkill_to_road_ecology_A_review_of_the_ecological_effects_of_roads/links/59dfcdfea6fdcca98420e3b4/From-roadkill-to-road-ecology-A-review-of-the-ecological-effects-of-roads.pdf

Gale, S. F. (2011, 07). Animal crossing. *PM Network, 25*, 12-13. http://ezproxy.humboldt.edu/login?url=https://search.proquest.com/docview/897930670?accountid=11532

May, P. (2017, September 08). California roadkill map: 6 of worst 10 roads are in Bay Area. *Mercury News.* https://www.mercurynews.com/2017/09/07/the-bay-area-scores-high-when-it-comes-to-roadkill/

Richter, S. Crother, B. Broughton, R. (2009). Genetic consequences of population reduction and geographic isolation in the critically endangered frog, *Rana sevosa*. *Copeia, 2009* (4), 799-806. http://www.bioone.org/doi/abs/10.1643/ch-09-070