2021

From Wildlife-Vehicle Conflict to Solutions for California Wildlife & Drivers

ROAD ECOLOGY CENTER

Roadecology.ucdavis.edu

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From Wildlife-Vehicle Conflict to Solutions for California Drivers & Animals

Using observations of reported traffic incidents and carcasses the Road Ecology Center has estimated the **total cost** of reported (large) wildlife-vehicle collisions in California for 2016 to 2020, inclusive to be **at least $1 billion**. The cost is calculated using California Highway Patrol (CHP) reports of crashes with wildlife, volunteer reports of roadkilled large animals and US Department of Transportation equivalent values for different types of crashes (e.g., property damage vs. major injury). When including crashes with mule deer that are claimed to insurance companies but un-reported to police, the estimated cost could be **as high as $2 billion** for 2016-2020. This report provides an overview of wildlife-vehicle conflict (WVC) in general, including collisions with small and large animals. We highlight WVC hotspots on California highways between 2016 and 2020, inclusive, based on a combination of >44,000 traffic incidents involving wildlife that were recorded by the CHP (primarily mule deer) and >65,000 carcass observations reported to the California Roadkill Observation System (CROS, https://wildlifecrossing.net/california) between 2009 and 2020, inclusive. This report includes **maps of WVC hotspots**, discusses impacts to wildlife and people from WVC, and presents new tools to help organizations, state agencies and individuals collect and use this information. Projects to **reduce WVC** can be the most effective of any safety project, with effectiveness often >80%.

Data Sharing/Collaboration: We frequently receive requests from highway planners, fish and wildlife scientists, academic faculty, students, and non-governmental organizations. We can typically meet data requests within CA for specific highways, counties, etc., but please keep in mind that this is an unfunded effort of the Road Ecology Center, so give us a few days.

Our re-vamped California Roadkill Observation System app supports "one-click" reporting (https://wildlifecrossing.net/california) –take a picture of a roadkilled animal with your smartphone and upload with one click (which automatically creates a database record).

Contributors:

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Other Contributors:

Winston Vickers (UC Davis), Kathryn Harrold (Independent Consultant), Hundreds of CHP officers, Caltrans Maintenance staff, and state and federal Fish and Wildlife agency staff.

Cover photo credit. Bighorn sheep killed by a vehicle on a desert highway, source = Bighorn Sheep Institute.

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Mountain lion near I-15 in Riverside County (Photo credit: Winston Vickers, UC Davis)

UC Davis Road Ecology Center: Seventh Annual Special Report on the Impact of Wildlife-Vehicle Conflict (WVC) on California Drivers and Animals

Top 5 Talking Points

1. Wildlife-vehicle collisions continues to be an under-recognized and under-reported threat to wildlife populations and to drivers in certain areas. Even common species like mule deer may be experiencing unsustainable levels of mortality. The state should spend its ample transportation funds to solve this traffic safety and sustainability issue.

2. We can all help the state systematically collect and share data. The data assembled here from the CHP were not collected with the purpose of studying WVC, the volunteer data were. California agencies should be encouraged to collect and share data about WVC to help inform decision-making about this important conservation and safety problem. Although there are "ecological champions" in certain Caltrans districts who encourage WVC data collection, it is not a publicly-supported activity by the agency in general. Recent legislation (SB 395) requires creation of a roadkill reporting and salvage system for California, but so far that statute has not been implemented. All Californians can collect roadkill data using this web-app: https://wildlifecrossing.net/california, and we have found that these data are used to support building wildlife crossings.

3. Legislative support is needed for highway/road projects that have net WVC benefit. In the past, WVC-reduction projects (like wildlife crossings) were only occasionally considered and as part of partial mitigation for transportation impacts. Transportation agency planners and biologists are increasingly discussing wildlife-crossing structures and other projects as stand-alone safety and sustainability projects, providing a net benefit to drivers and wildlife, without the need for the projects to mitigate for further harm later. Legislative support is needed for WVC-reduction projects to be considered transportation projects and paid for from transportation funds, not special and occasional funds. Despite praise from environmental groups, bills like SB-790 (10/11/2021) send us in the wrong direction.

4. Building WVC-reduction projects pays for itself. WVC harms drivers & passengers, costs our economy, and cause extensive harm to local wildlife populations (e.g., newts) as well as the state's mule deer population, the prey anchor of most California ecosystems. An important question is how much would it cost to start fixing some of the un-safe highway segments with high rates of WVC? It would cost about $175,000,000 for California to treat just the 1,275 miles of highway segments where the $ value of reduced WVC would exceed the cost of building fencing. In other words, this cost-effective method to reduce WVC impacts to wildlife and the driving public statewide would cost about the same as adding one mile of new lane to the I-405 in Los Angeles (https://www.kkcsworld.com/metro-i-405), which has had mixed and possibly no net benefits.

5. Allocate sufficient funds to build needed WVC-reduction projects. With the passage of SB1, state legislators provided transportation agencies with an increase in funding (>$5 billion/year!) to protect driver safety and the environment. We know that doing nothing, or very little to reduce WVC is costly – to drivers and to the environment (~$200 - 400 million per year). There are myriad excuses for why "nothing can be done", lack of funding is not one of them.

Introduction to Study

Using California state data on traffic incidents and roadkill observations, the Road Ecology Center has mapped stretches of ~15,000 miles of California state highways that are likely to be continuing hotspots for wildlife-vehicle conflicts (WVC). Animals entering roadways are often killed and pose a hazard to drivers, who may collide with the animal, or try to avoid the animal suffering vehicle damage, injury, and even death. Wildlife populations may suffer significant losses from highways with high rates of WVC, which may cause ripple effects into surrounding ecosystems up and down the food chain. In addition, animals are injured during collisions, which is damaging to the animal and traumatic and deadly to drivers.

By identifying stretches of highway where WVC are more likely to occur, the Road Ecology Center is assisting Caltrans and other responsible entities in developing mitigation to protect drivers and wildlife populations. Measures with proven effectiveness include 1) building fencing and over/under-passes along priority highways to allow the safe passage of wildlife across highways and 2) reducing speed limits in protected wildlife habitat. Caltrans staff and Districts are ramping up their construction of mitigation solutions to WVC. To provide state and local agencies information to aid their decisions, we collate CHP and volunteer-collected data, including ~8,000 reported crashes per year on California highways involving deer and other large wildlife. Data from CROS allow state and local agencies to prioritize stretches of highway for mitigation of conflicts with particular species or groups (e.g., Ha and Shilling, 2017; Shilling and Waetjen, 2015).

Statewide Carcass Observations

Members of the public, agencies, and others have made >80,000 observations of animal carcasses on local roads and state highways to the California Roadkill Observation System (Figure 1, Table 1). These are not the total roadkill that occurred, just the ones that expert observers saw and reported to CROS.

Table 1. Summaries of wildlife categories reported as roadkill in CA to the California Roadkill Observation System between 2009 and 2020. NB: These are counts of reports, not counts of all wildlife killed on roads. These counts also do not include reports from prior to 2009.

Animal Type	Number of Species	Number of Observations
Amphibian	19	1,005
Bird	234	7,845
Mammal (Large)	9	10,689
Mammal (Medium)	30	22,538
Mammal (Small)	65	20,540
Reptile	59	2,762

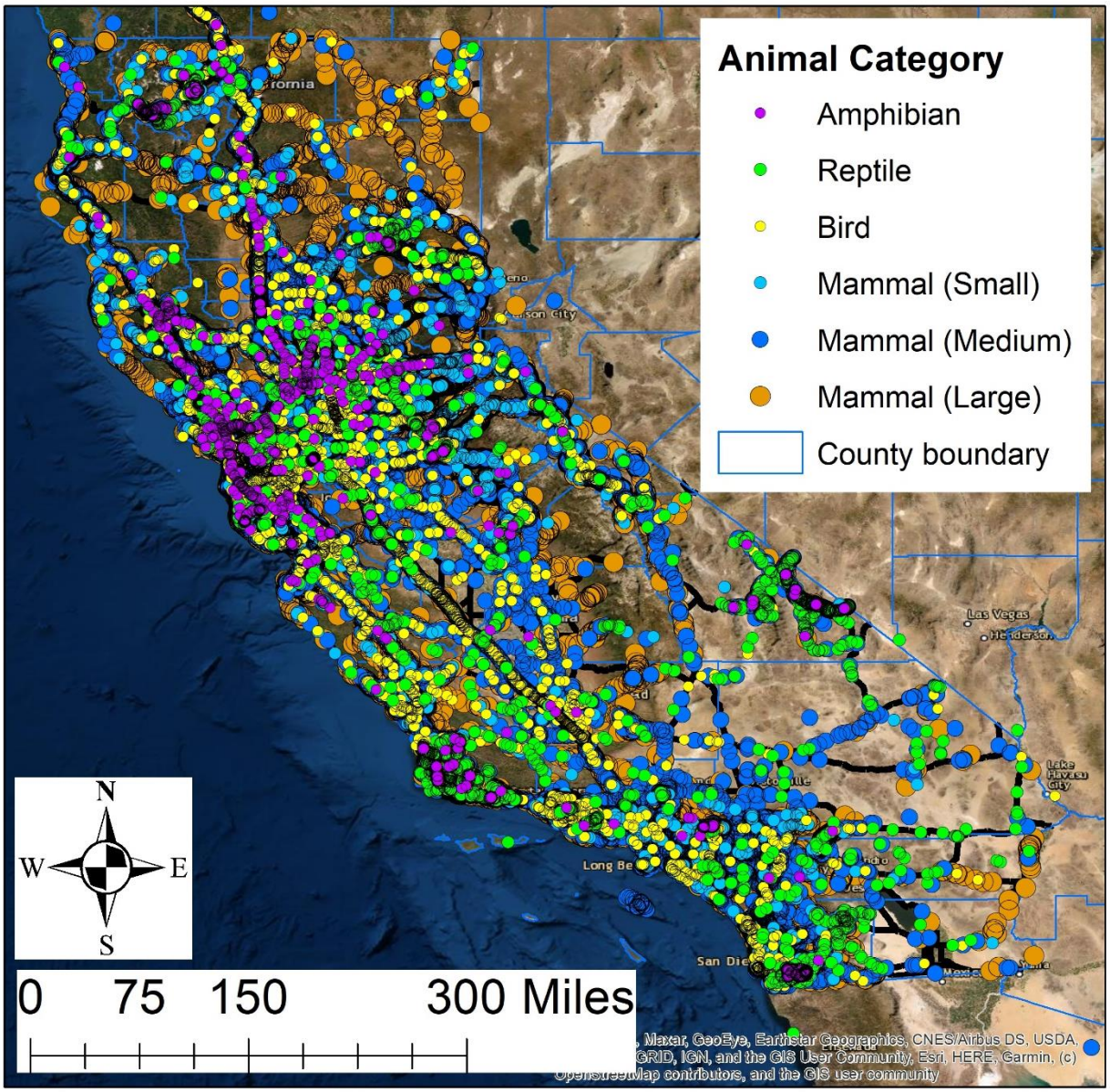

Figure 1. California wildlife-vehicle collision observations reported in the California Roadkill Observation System (https://wildlifecrossing.net/california) and California Highway Incident Processing System. Observations are primarily on state highways, but also on major and minor county and city roads.

There were >44,000 WVC (involving large mammals) across California reported to the CHP or through CROS during 2016-2020, inclusive. (Figure 2). These are not all large mammal WVC that occurred during this time. State Farm Insurance Inc. estimates that there are ~22,000 claims/year for collisions with deer in California. In other states, under-reporting of collisions can be 4 to 10-fold, meaning that 88,000 to 220,000 deer/annually could be hit by vehicles in California on all roadways.

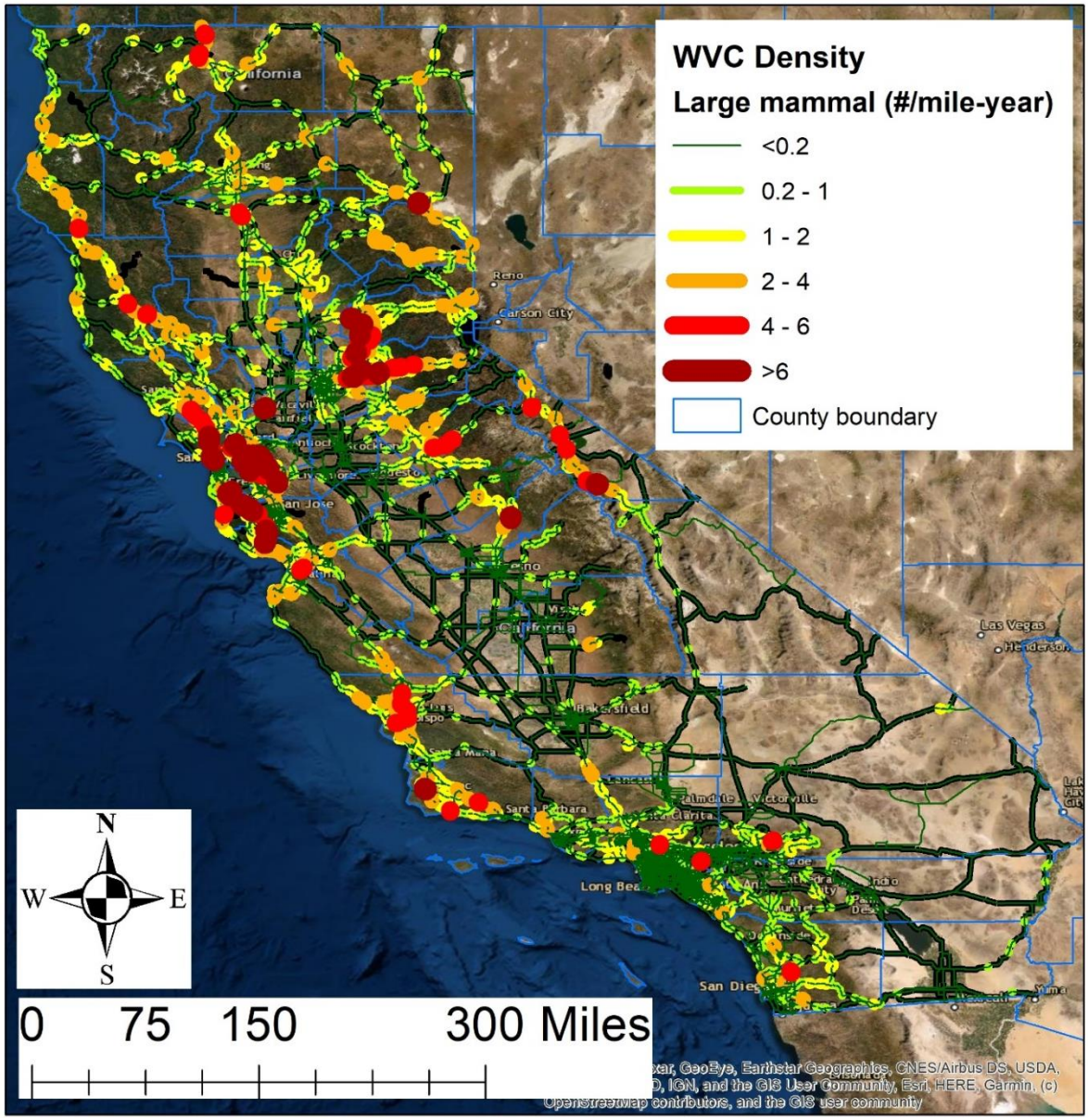

Figure 2. Annual density of large-mammal WVC per mile of state highway.

WVC can occur in clusters, which may indicate areas of particularly high rates of collision as well as being places where WVC can be prevented more efficiently. These clusters are partially indicated by higher densities (Figure 2), but are more accurately highlighted using statistical tests. We used the statistical test Getis-Ord and the index value Gi* to identify one-mile segments where WVC clusters were significantly higher than adjacent segments. We found 351 statistically-significant clusters throughout California, where clusters were usually in the same places as high densities of WVC. This suggests that mitigation action here (fencing plus crossing structure) could cost-effectively reduce WVC.

Cost of Statewide Highway WVC Incidents

As is the case for all states in the US, CA drivers experience costs associated with crashes, including those involving wildlife. WVC are often framed (and discounted) as “environmental

issues" by some, but there are real consequences for the drivers, passengers and wildlife involved in WVC. One way to measure these impacts is from a human economic point of view, though we acknowledge that this approach should not be seen as more important than the ecological impacts caused by WVC. Figure 3 shows these costs per mile per year for CA highways. The total value of WVC for the 5-year period 2016-2020, which can be thought of as a cost to the state, is between $1.1 billion and $2.2 billion, depending on whether or not we include the crashes that State Farm Ins. Co. estimates occur in CA (Table 2).

Table 2. Types of crashes and wild animals involved, number of each type, costs of crashes and values of wildlife for WVC in California, 2016-2020. Where an adjusted value is provided, the explanation is provided in the table footnotes. The **numbers in bold** were used in the calculation of the minimum total cost of crashes. These are reported crashes, not all crashes.

Type	Number/Adjusted Number	Cost/incident, Value[1] ($)	Total/Adjusted Total
K (Fatal crash)	9/25[2]	12,180,371	($109,623,339) /**$304,509,275**[2]
A (Debilitating injury)	46	706,282	**$32,488,972**
B (Non-debilitating injury)	555	214,043	**$118,793,865**
C (Possible injury)	1050	135,400	**$142,170,000**
O (Property damage)	27,371/110,000[3]	12,839	**$351,416,269** /$1,390,977,260[3]
Mule Deer	27,134/110,000[3]	1,500	($40,701,000) /**$162,154,500**[3]
Coyote	1,911	250	**$477,750**
Black Bear	557	1,500	**$835,500**
Wild Pig	502	500	**$251,000**
Mountain Lion	302	1,500	**$453,000**
Elk	144	2,500	**$360,000**
Bighorn Sheep	42	8,000	**$336,000**
Pronghorn	18	1,500	**$27,000**
Total			**$1,114,273,131** /$2,153,834,122[3]

1 -- Wildlife values are from AZ

2 -- According to our reporting directly from CHP officers in the field, there were 9 human fatalities due to WVC between 2016 and 2020. However, according to the Insurance Institute for Highway Safety, there are about 5 fatal crashes with wildlife per year in CA (https://www.iihs.org/topics/fatality-statistics/detail/collisions-with-fixed-objects-and-animals#collisions-with-animals). This value was used in the estimated total.

3 -- Adjusted number of incidents and deer involved based upon estimates by State Farm Insurance Co. for claims in CA for deer-vehicle collisions (https://presspage-production-content.s3.amazonaws.com/uploads/1441/deercollisionshareablepdf-490280.pdf?10000).

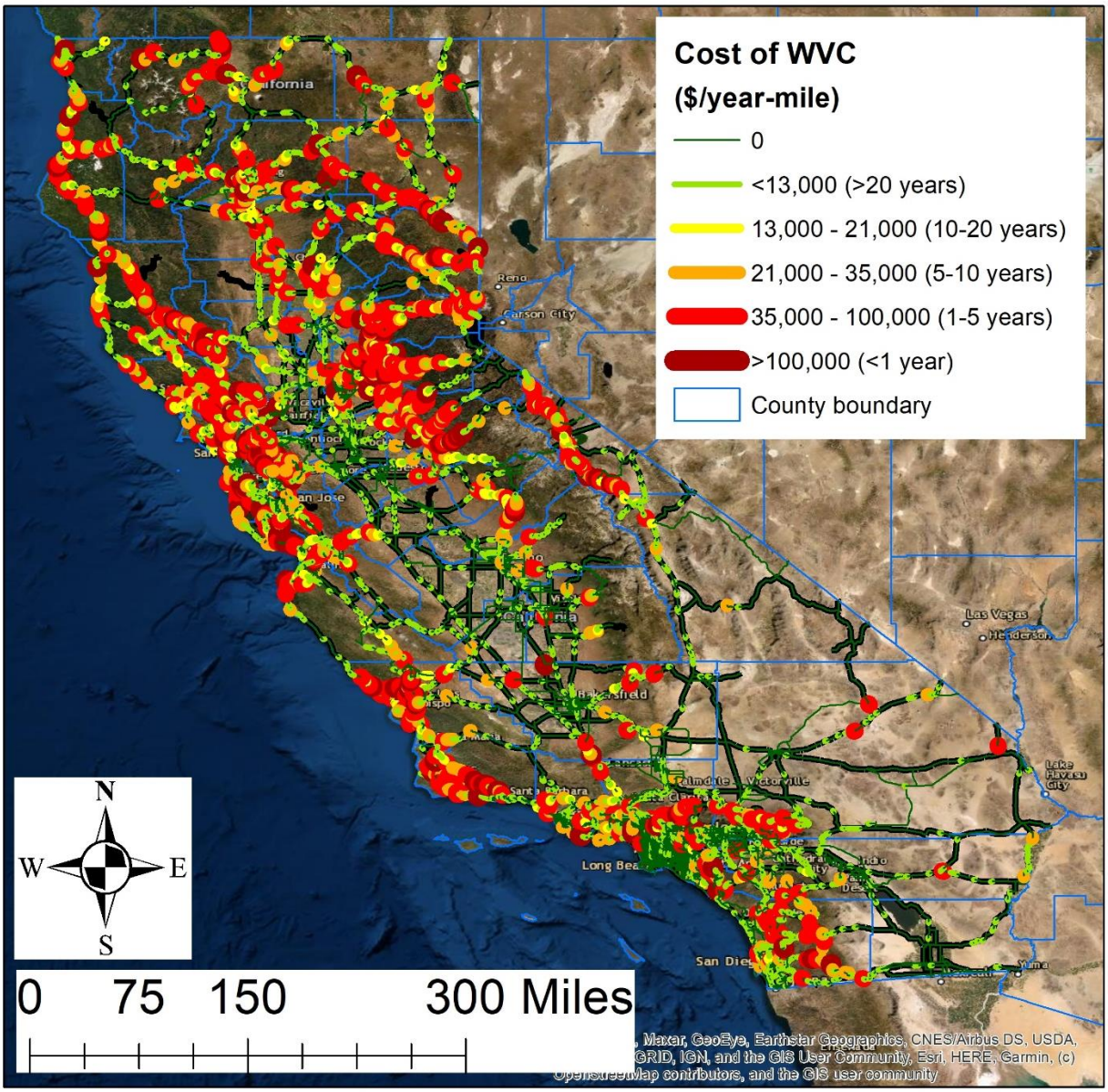

Figure 3. Annual cost of WVC per mile. The length of time in parentheses in the legend indicate how many years of reduced WVC on a highway segment would be needed to have the equivalent cost of fencing along that segment. For example, "1-2 years" indicates that the cost of fencing that segment is the same or less than the fiscal benefit of reduced WVC for <2 years.

Table 3. Number of years and one-mile segments of highway for benefit of reduced WVC to be equivalent to the cost of reducing WVC.

Annual WVC Cost	Years for Equivalent Cost Fencing	Number of one-mile segments in CA
$13,000	<20	1,717
$21,000	<10	1,275
$35,000	<5	844
$60,000	<2	379
$100,000	<1	154

So, how much would it cost to start fixing some of these broken highway segments with high rates of WVC? If California was to treat just the 1,275 miles of highway segments where it would take 10 years for the value of reduced WVC to exceed the cost of building fencing (Table 3), it would cost $175,032,000 (1,275 miles times $137,280/mile). In other words, this cost-effective method to reduce WVC impacts to wildlife and the driving public statewide would cost about the same as adding one mile of new lane to the I-405 in Los Angeles.

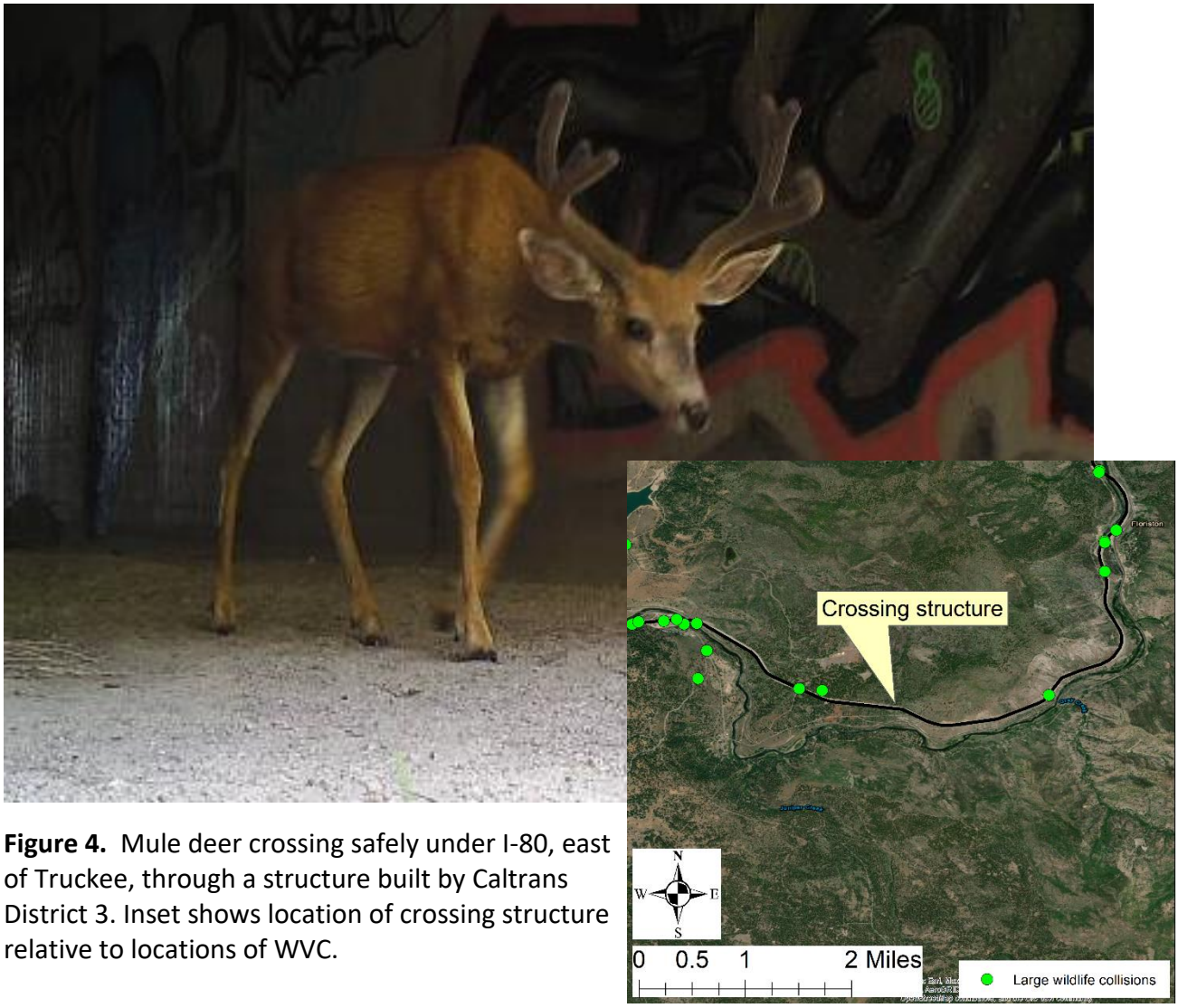

Figure 4. Mule deer crossing safely under I-80, east of Truckee, through a structure built by Caltrans District 3. Inset shows location of crossing structure relative to locations of WVC.

Special Case: Deadliest Highway in California

One of the more common questions for studies like this is "where is the worst place in California for WVC." One way to answer that is using the cost of WVC to society. The highway with the consistently highest rate and cost of WVC in any given year in the last 5 has been I-280 on the San Francisco Peninsula, between San Bruno and Cupertino (Figure 5). Five of the top-20 highest cost, 1-mile segments of highway in CA are on I-280. The total annual cost from WVC on 31 miles of I-280 is $5.8 million, or $187,897/mile-year.

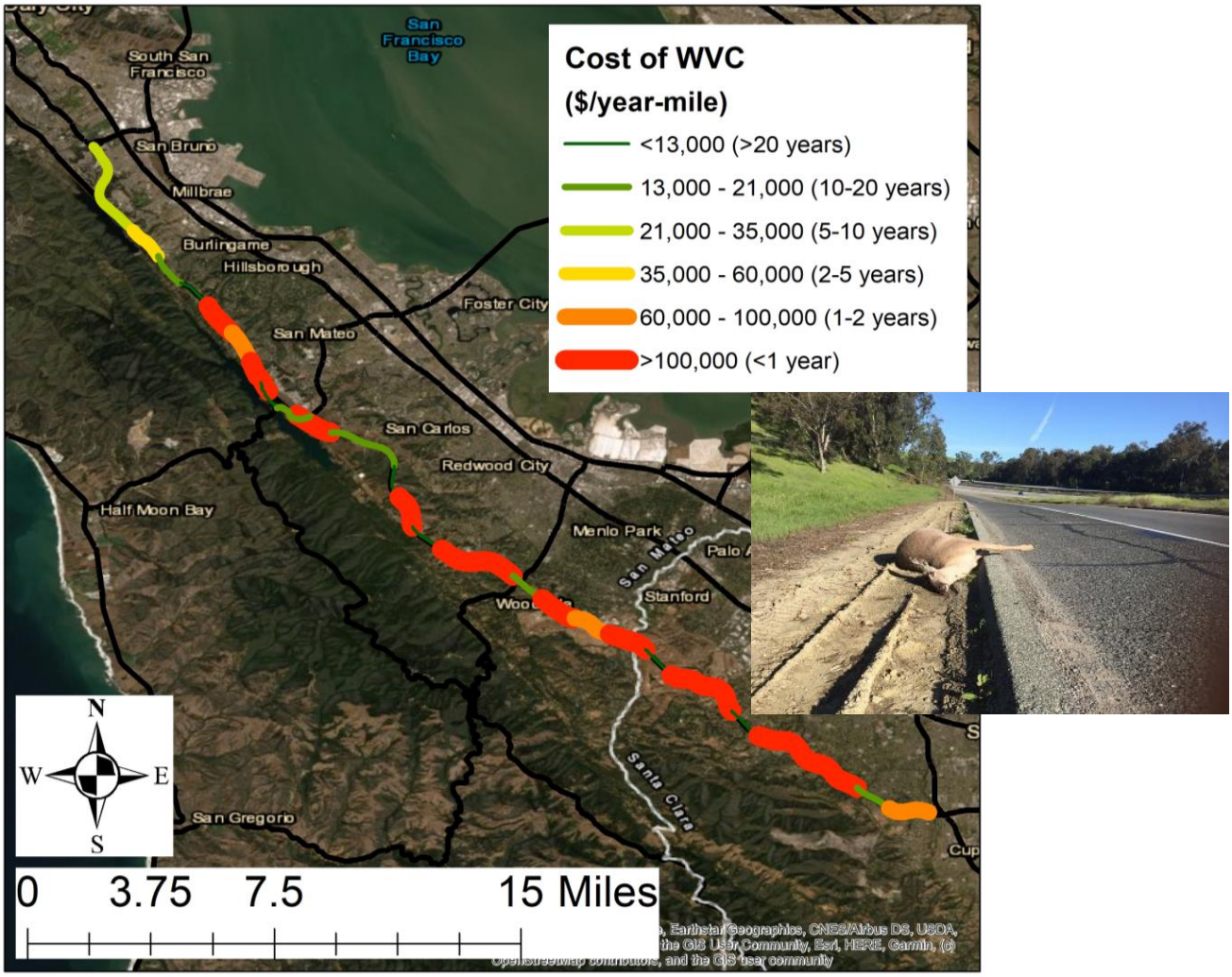

Figure 5. Annual cost of WVC ($/mile) on one mile segments of I-280 between San Bruno and Cupertino. The number in parentheses indicates the number of years of WVC reduction would be required to equal the cost of fencing the segment. The inset shows a mule deer killed on I-280 (Photo credit, Kathryn Harrold).

In 2013, the Road Ecology Center reported to Caltrans, under contract, that fencing most of I-280 to prevent wildlife access and reduce WVC would be very cost-effective (https://wildlifeobserver.net/files/projects/732/resources/FINAL_I-280_Report_122013.pdf). This is still true almost ten years later.

Special Case: Impacts to Mountain Lions and Black Bears

Like most species at the top of the food web, mountain lions are especially vulnerable to WVC because they move around a lot and cross roads and highways. Mountain lions are important ecologically because they are the only large, widespread predator in most California ecosystems. They are also important socially, with great interest in their well-being in Southern California and Bay Area urban regions. Black bears are similarly critical species in most CA ecosystems, ranging widely to forage and therefore regularly crossing roads.

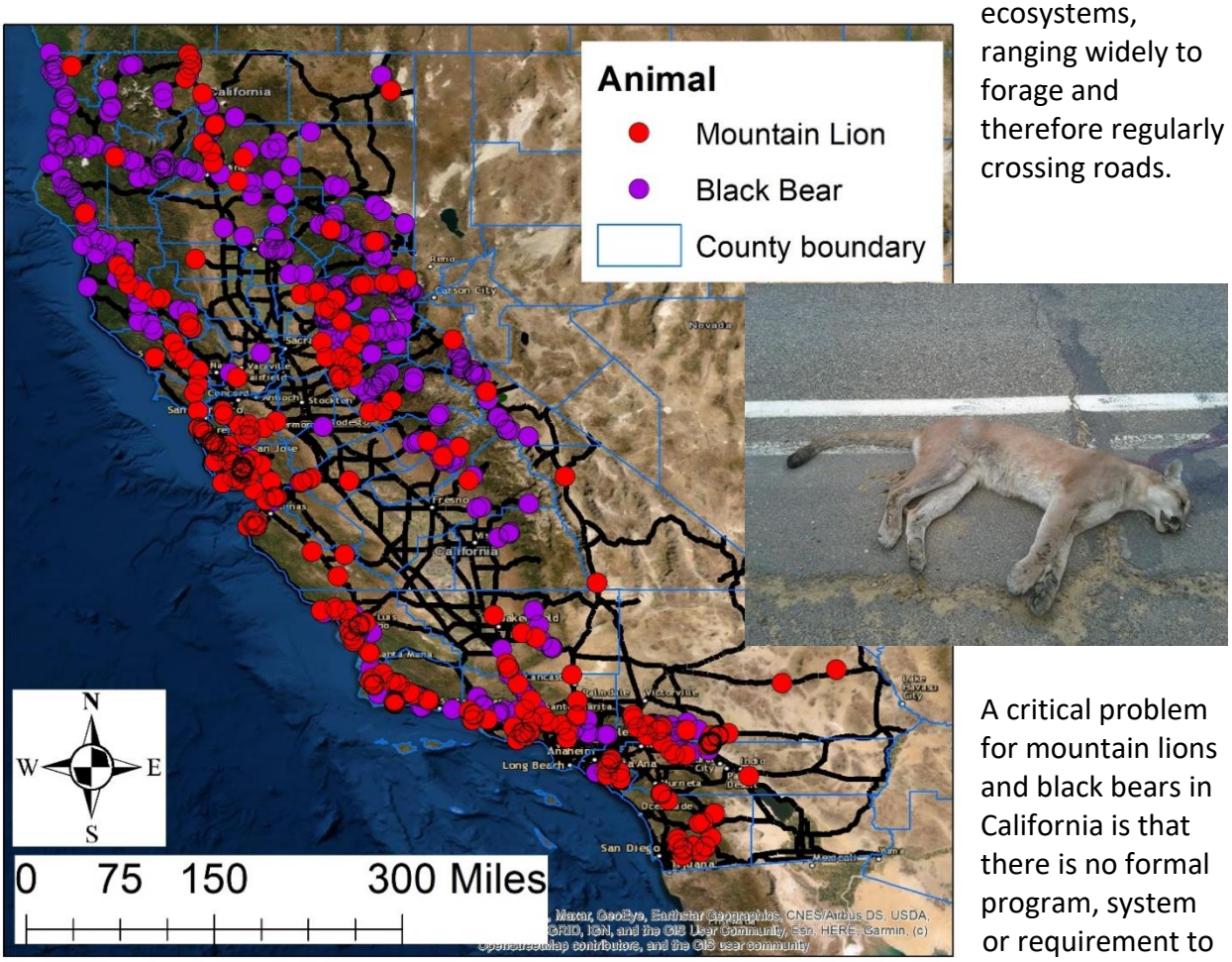

Figure 6. Mountain lions and black bears reported killed on roads, or involved in traffic incidents by the California Roadkill Observation System, CDFW, CHP, or Winston Vickers and other biologists in Southern California (Vickers et al. 2015, and Vickers unpublished data). Photo source: California Roadkill Observation System.

A critical problem for mountain lions and black bears in California is that there is no formal program, system or requirement to report when they are killed on roads, which happens frequently. As such, we only know the minimum killed each year on roads, when they are reported to CROS or by CHP, and have no way of knowing the actual WVC impact to these important and charismatic species. Between 2016 and 2020, inclusive, 302 mountain lions and 557 black bears were reported killed on roads by a combination of CROS volunteers, CHP, CDFW, and biologists in Southern California (Figure 6). These were incidental reports and **do not represent all mountain lions and black bears killed** on CA's roads and highways.

Special Case: Local Impacts to Newts

Any amphibians and reptiles may move seasonally to reproduce or to disperse. At lower temperatures, they move slowly across roads when they encounter them, putting them at risk of being killed by vehicles. There are populations of newts that move from upland forested habitat to nearby lakes and streams to reproduce, crossing roads in the process. One of the largest rates of roadkill reported for any wildlife species anywhere in the world takes place every year in California, on Alma Bridge Rd adjacent to Lexington Reservoir. Pacific newts begin migrating with the first rains from forests on the east side of the reservoir, across the road to the reservoir. After reproducing, adults and eventually juveniles make their way back to the forest. Along the way, 4,000 to 5,000 of them are killed each winter and spring by passing vehicles (Figure 7). Very few juveniles have been crossing back across the road, which along with the rate of mortality suggests that this population may be at great risk of local extinction.

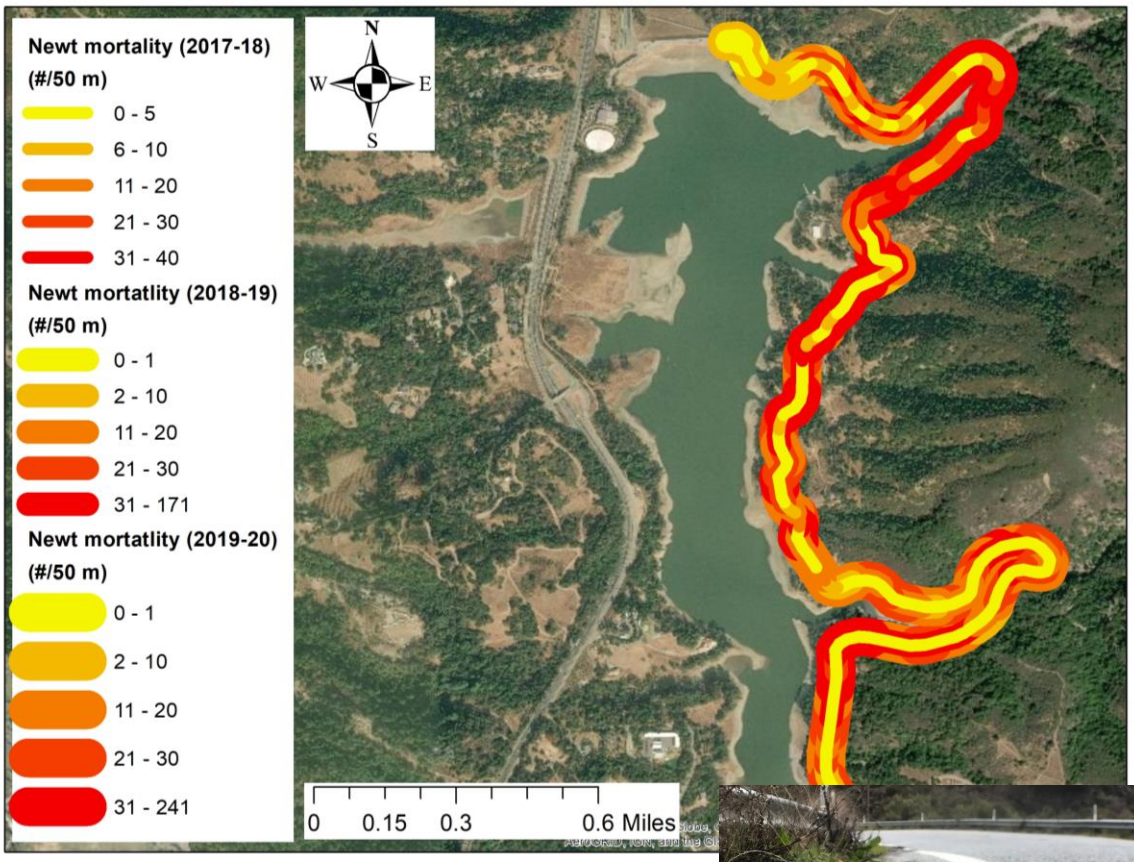

Figure 7. Pacific newt mortality rate (#/50 meters road) along Alma Bridge Rd. Photo inset shows newt beginning to cross Alma Bridge Rd (Photo credit, Merav Vonshak).

Legislative Action

Legislative direction is one of the best ways to help transportation and wildlife agency staff in their attempts to reduce wildlife-vehicle conflict. There is a strong tradition in California of thinking that the state leads the US in environmental policy and of being deferential to legislative bodies when it comes to environmental policy. However, in the case of recent state policy, we are heading in the wrong direction when it comes to wildlife-vehicle conflict. Here are two examples:

1) **SB-790** "Wildlife connectivity actions: compensatory mitigation credits" (Stern, 2021) is titled to indicate that it might protect wildlife connectivity. However, the primary action the statute takes is to "*authorize the department to approve compensatory mitigation credits for wildlife connectivity actions taken under the conservation and mitigation banking program or the regional conservation investment strategy program*." (https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB790). The outcome of the bill is that if transportation entities build wildlife crossing structures like the Liberty Canyon/Wallis-Annenberg wildlife over-crossing, they can get credit for the action and use these credits to avoid mitigating impacts to wildlife in another area. There is no reason to think this will result in more protection of wildlife than already exists. The Governor's signing of this bill into law was hailed by environmental groups, apparently without critical analysis (https://www.idausa.org/campaign/wild-animals-and-habitats/latest-news/california-sb-790/).

2) **AB-498** "Wildlife conservation: wildlife corridors" (Levine, 2015) also suggests action is being taken to protect wildlife movement. There are two problems with this bill: a) there is no scientific evidence that wildlife corridors exist or are used by the many wildlife species in California. There are a few species in N America that use "corridors" to migrate across the landscape, but in California there is no evidence that wildlife use corridors; and b) the bill does not require anything meaningful, instead stating: "*This bill would provide that the fact that a project applicant does not take voluntary steps to protect the functioning of a wildlife corridor prior to initiating the application process for the project shall not be grounds for denying a permit or requiring additional mitigation beyond what is otherwise required by law to mitigate project impacts*." This bill was similarly lauded by environmental groups as "protecting wildlife corridors", again apparently without evaluating what this would actually mean (https://ca.audubon.org/node/23171).

It is high time for the legislature to pass a bill that: 1) protects wildlife movement by requiring retrofit of existing and proposed new or expanded infrastructure to allow wildlife passage; 2) pays for improvements to transportation infrastructure using transportation funds and not the very-limited wildlife, parks, and open space bond funds; and 3) requires these actions within a timeframe that prevents local extinctions and restores wildlife populations where they have been impacted by past infrastructure. For example, if we took a 10-year view of the problem, then the state should at least restore ~200 miles of WVC hotspots per year (Figure 3, Table 2), throughout California, including wildlife crossings where needed. In Appendix 2 to this report, we provide several examples of projects that could do this for I-280, US-101, US-50, SR-108, SR-20, and SR-74.

Summary

Monitoring wildlife movement and mortality is critical for improving wildlife connectivity and survival of wildlife species in the face of the combined threats they face, such as transportation systems, climate change, rodenticides, and habitat loss. We reported here on long-term, successful methods for monitoring WVC in California, an annual analysis of locations and costs of WVC to wildlife and drivers and society. We provided key recommendations for places to reduce WVC in California through support for a several-fold increase in mitigation projects with net benefits for wildlife and driver safety. Finally, we provided examples of simple project concepts that could be used throughout California to reduce WVC.

Acknowledgements

We appreciate the support from the National Center for Sustainable Transportation (using USDOT funding) and the Institute of Transportation Studies (CA SB1 funding) for development of the automated wildlife-vehicle conflict hotspot tool and one-click reporting tool California Roadkill Observation System (CROS, https://wildlifecrossing.net/california). We also thank the Pew Charitable Trust for their support for the economic analysis component of the study. This and previous reports and the analyses contained within would not have been possible without the concerted and coordinated efforts of hundreds of volunteer roadkill observers over the last 10 years who contribute to CROS. Through their endeavors, they have so far (10/2021) collected >70,000 observations of >430 species, representing one of the largest and most comprehensive wildlife monitoring programs in California and the US. Their accuracy rate for species identification is >97% and have high locational accuracy (median <±13 meters). For the scientific article describing CROS, see citation below (you can paste the "doi" value below into a browser and access the papers). The report also benefited from the efforts of many unknown law enforcement personnel who described traffic incidents in enough detail that we could use their observations to help plan for reduced wildlife-vehicle conflict. Finally, we have partnered with other similar systems around the world in the Globalroadkill.net project (http://globalroadkill.net).

Citation for CROS: Waetjen DP and Shilling FM (2017) Large Extent Volunteer Roadkill and Wildlife Observation Systems as Sources of Reliable Data. Frontiers in Ecology & Evolution 5:89. doi:10.3389/fevo.2017.00089

Additional CROS citation: Tiedeman, K., R.J. Hijmans, A. Mandel, D.P. Waetjen, F. Shilling (In Press) The quality and contribution of volunteer collected animal vehicle collision data in ecological research. Ecological Indicators. https://doi.org/10.1016/j.ecolind.2019.05.062

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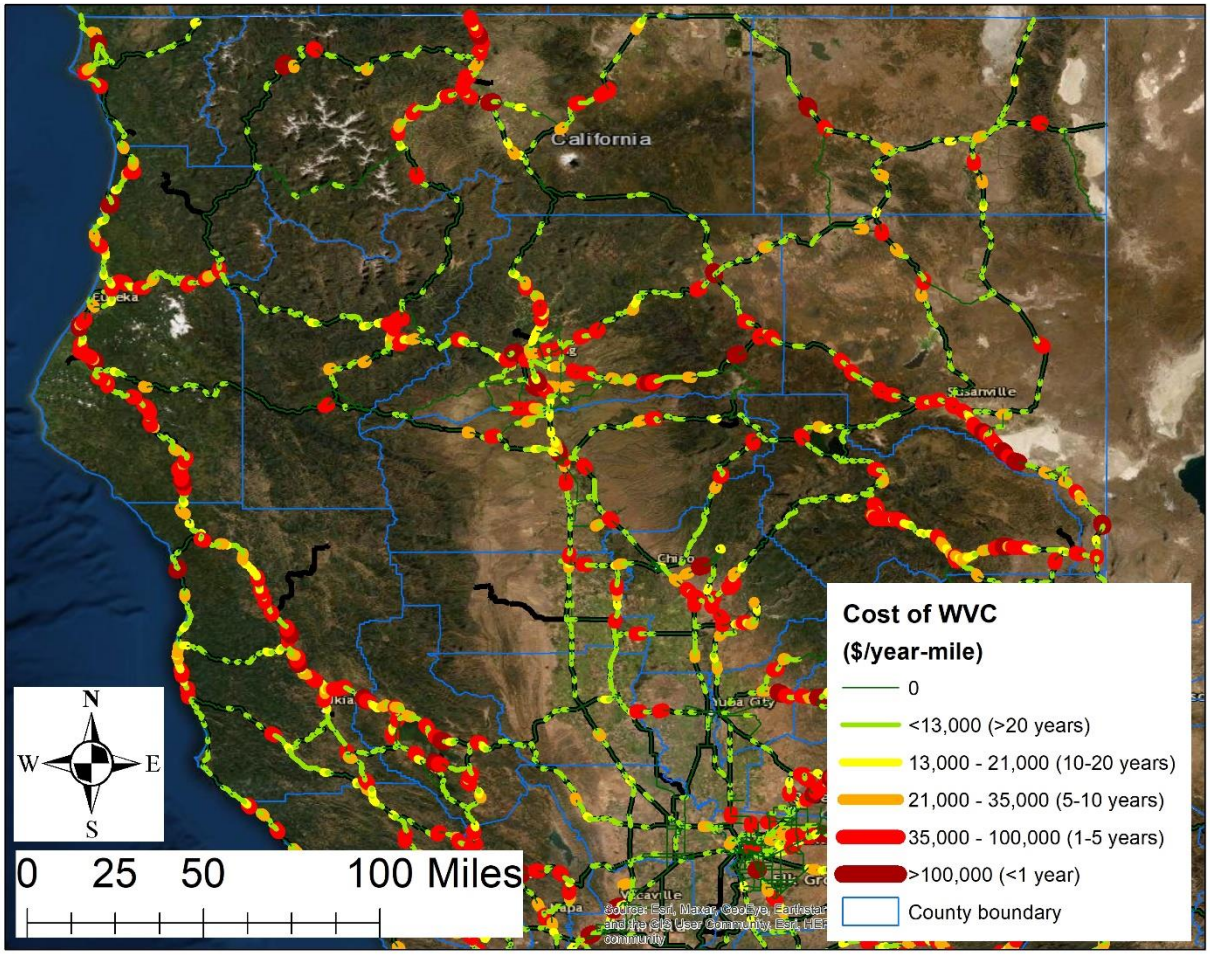
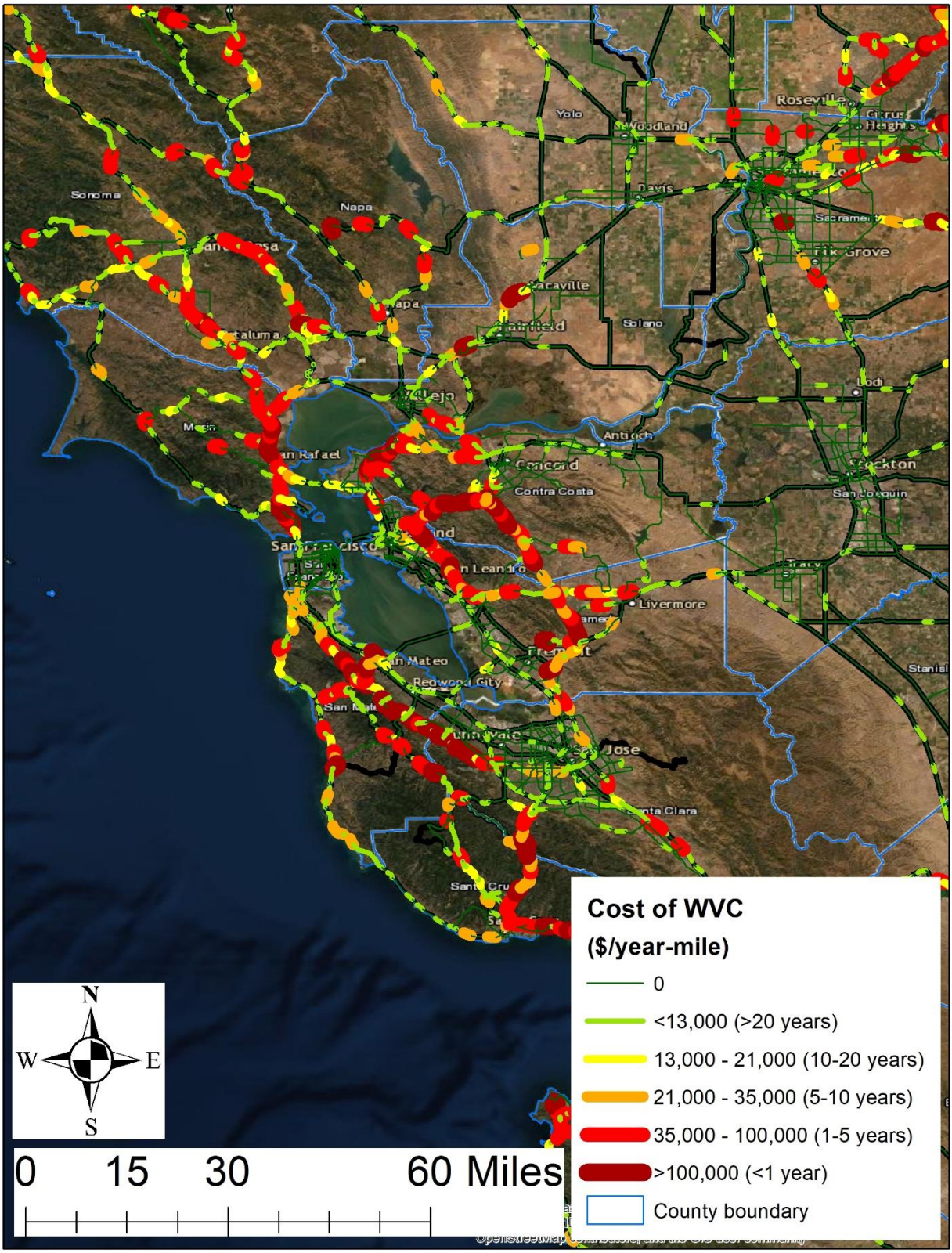
Appendix 1. Detailed maps of WVC cost per mile per year.

The maps here provide more detail of the impacts from crashes involving large wildlife (e.g., mule deer, black bear). All maps use the same legend with WVC cost per mile per year, where the darker red indicates higher cost. The number years of reduced WVC that would be needed to "pay for" the fencing is indicated in parentheses.

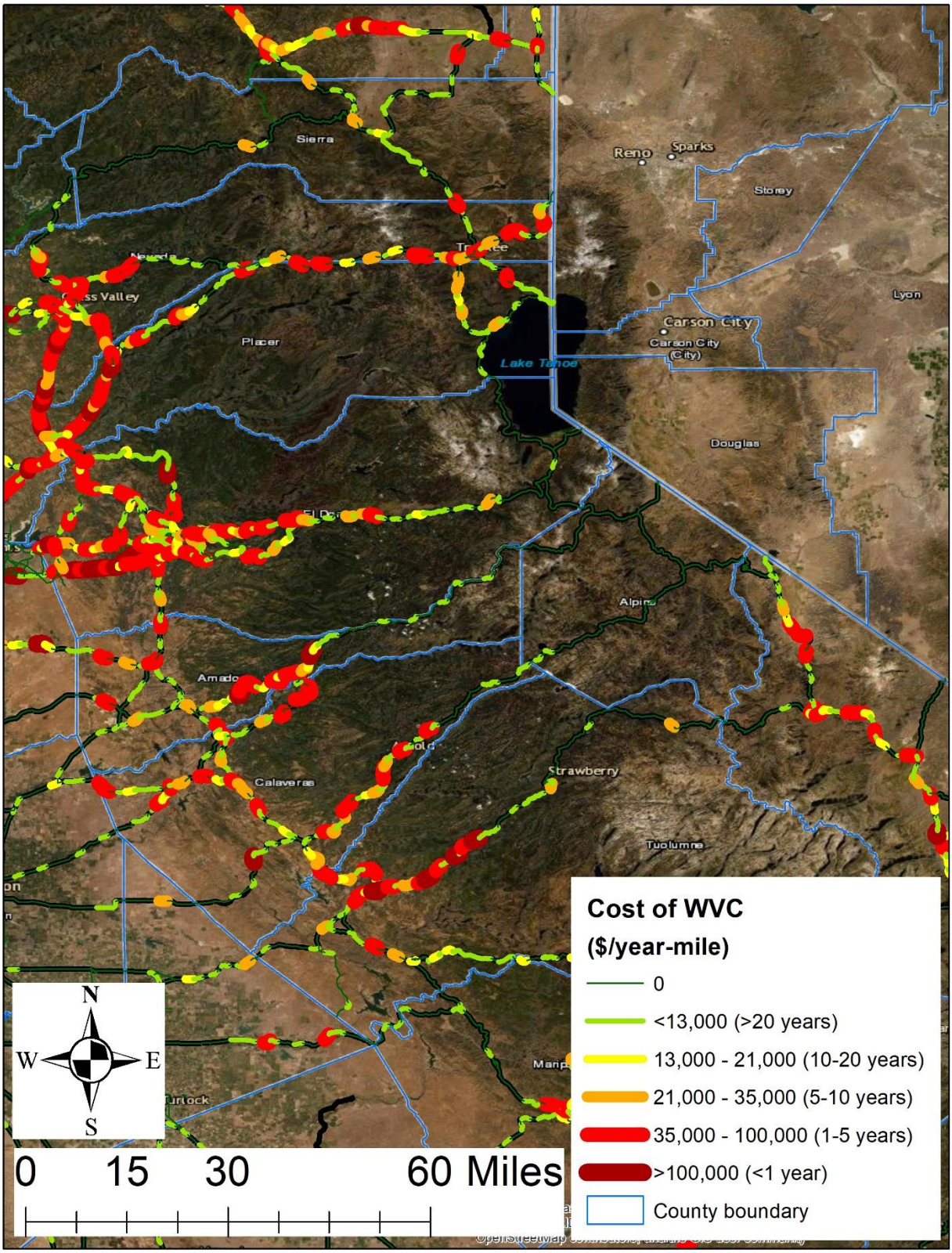
A) Northern California



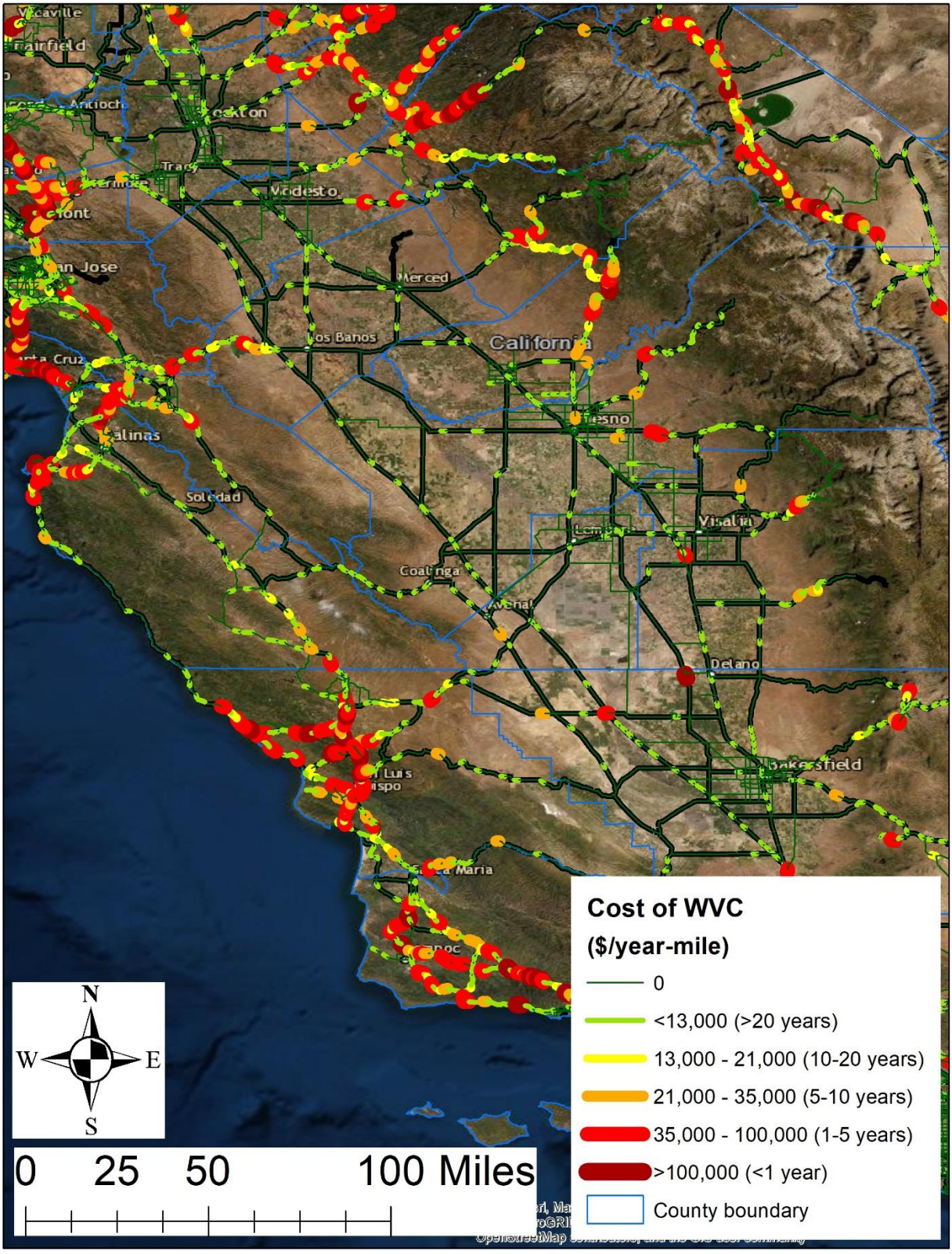
B) Bay Area


Cost of WVC
($/year-mile)
0
<13,000 (>20 years)
13,000 - 21,000 (10-20 years)
21,000 - 35,000 (5-10 years)
35,000 - 100,000 (1-5 years)
>100,000 (<1 year)
County boundary
N
W
E
S
0 15 30 60 Miles
Yolo
Napa
Sonoma
Solano
Contra Costa
Livermore
Antioch
Stockton
Lodi
Davis
Woodland
Roseville
Rancho Cordova
Elk Grove
Vacaville
Fairfield
Vallejo
Concord
Pleasanton
Tracy
San Rafael
San Mateo
Redwood City
San Jose
Santa Clara

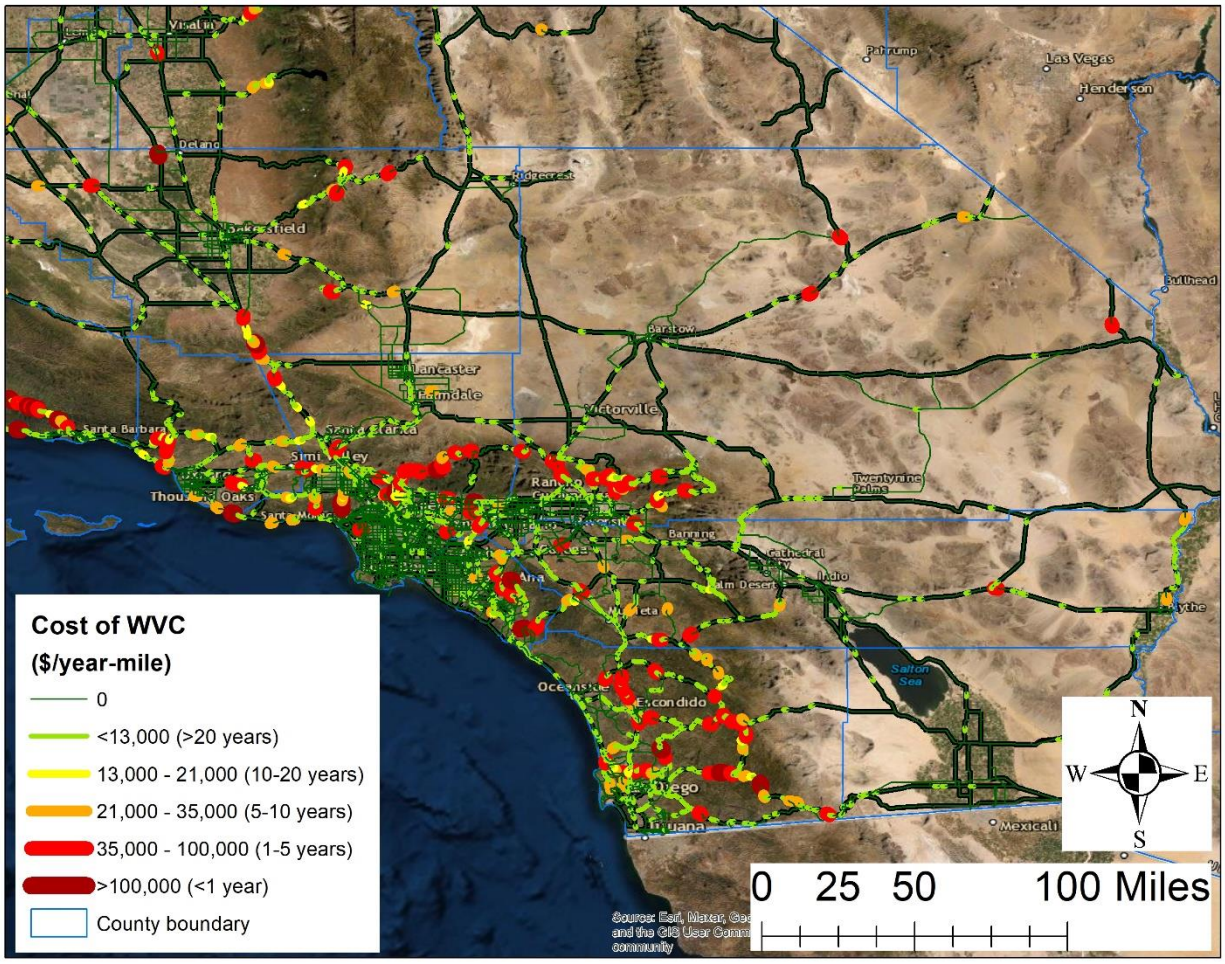
C) Sierra Nevada



D) Central Coast/Southern Sierra Nevada



E) Southern California



Appendix 2. Sample project descriptions to reduce WVC.

There are close to 2,000 one mile segments of California highways where reducing WVC would result in reduced crash costs that are greater than the cost of fencing those segments. Students at the Road Ecology Center have developed example project descriptions for different types of highways in California, showing the cost and types of mitigation that could be built in high WVC areas, as well as the benefits from the projects.

Wildlife-Vehicle Collision Reduction Project: Edgewood I-280

Summary

The stretch of Interstate 280 in southeast of Crystal Springs Reservoir is a hotspot for wildlife-vehicle collisions. The San Francisco peninsula protected areas provide habitats for wildlife, and the interstate is currently unfenced. Wildlife-vehicle collisions are dangerous for drivers, result in ecological losses, and are expensive for the state of California, so we propose fencing this stretch of I-280 to reduce the number of collisions.

Project Area

The project area is ~1.25 miles of I-280 in San Mateo County, California, between Canada Rd and the Ralph D. Percival Memorial Vista Point. This section of I-280 crosses over Edgewood Rd (60 m bridge) and the Edgewood Trail (30 m bridge), with the trail under-crossing providing a substantial vegetated under-crossing, though it is frequently used by people hiking.

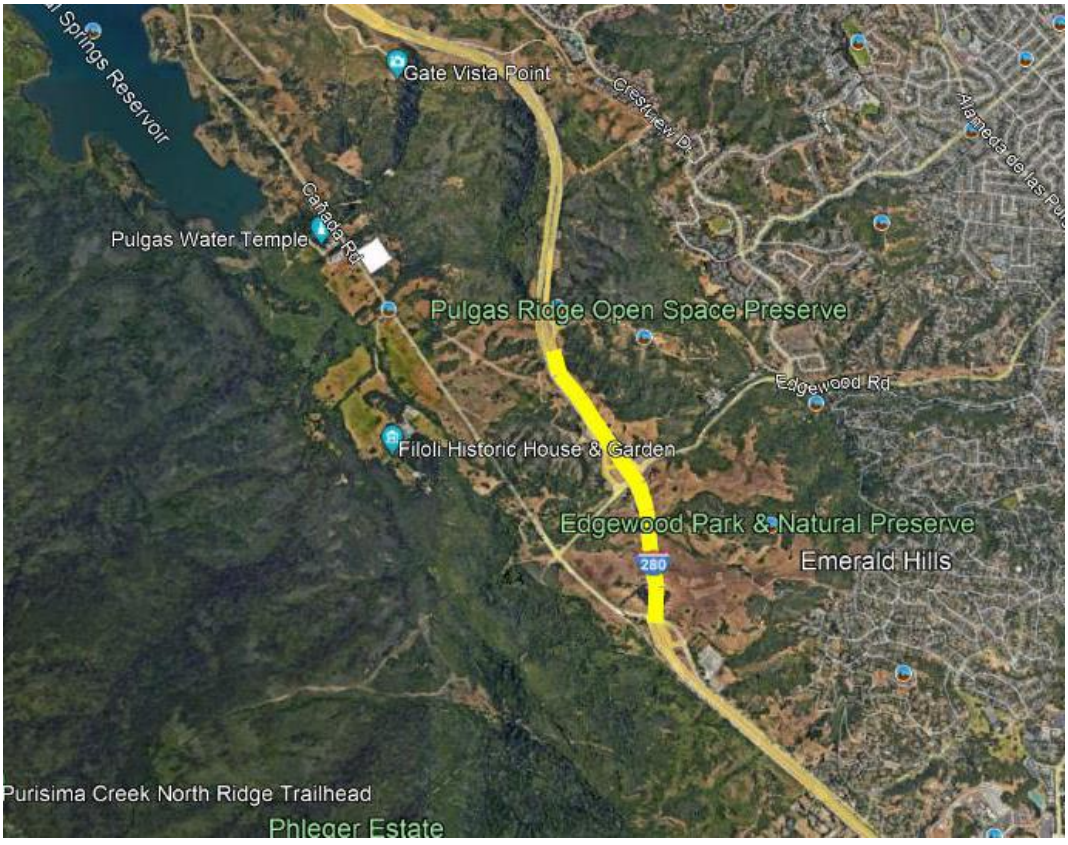


Figure 1. The project area is the highlighted section of Interstate 280. The edge of Crystal Springs Reservoir is in the top left corner.

Figure 2. Google Maps street-view image of the bridge over Edgewood Rd.

Figure 3. Mule deer crossing under I-280 using the Edgewood County Park trail.

Crash Statistics

We estimated the annual economic cost of wildlife-vehicle collisions in the project area using the Wildlife Crossing Calculator, which uses data from reports by California Highway Patrol officers from 2016-2020. The estimated annual cost is $284,284 due to property damage and hospitalizations.

In addition to economic impacts, several wildlife species have been killed by vehicles in this stretch of highway. Between 2011 and 2021, California ground squirrel, Mountain lion, Mule deer, Raccoon and Virginia opossum were found dead on the highway, or involved in crashes, including 57 mule deer.

Mitigation Package

Fencing along roads reduces wildlife vehicle collisions by about 54% and combining fencing with crossing structures reduces wildlife-vehicle collisions by about 83% (Rytwinski et al., 2016). We propose fencing the entire project area. There are 3 bridges over minor roads and a hiking trail where wildlife could safely cross if there was fencing to keep them off the highway.

We used the Wildlife Crossing Calculator to determine the most effective and affordable infrastructure for the project area. Fencing the project area requires 13,000 feet of eight-foot-high wildlife fencing, which should be mesh with wooden posts. It also requires 4 escape ramps to allow any animals that get trapped on the highway side of the fence to jump out, as well as 1 wildlife guard for a minor road exiting the highway.

The fencing costs about $13 per foot, the estimated upfront cost of fencing the project area is $169,000 and the estimated annual cost for maintaining the fencing is $3,380. The total annual cost for maintaining the fencing for 20 years, its expected lifespan, is $101,400. The escape ramps cost about $12,000 each, and the total estimated upfront cost for 4 escape ramps is $48,000. They're expected to last about 30 years, and their maintenance cost is negligible. The total upfront mitigation cost for the project area is $279,500.

Figure 4. Mesh fencing with wooden posts, similar to the fencing proposed for the project area (https://www.sfbayfences.com/deer-fences-sonoma-marin-ca.shtml).

Figure 5. Escape ramps, which allows animals trapped on the road side of the fence to jump over to the other side (Source: Colorado Department of Transportation and Eco-Resolutions).

Economic and Other Benefits of the Project

We used the Wildlife Crossing Calculator to run a benefit-cost analysis for the proposed infrastructure. We found that it would result in a net economic benefit due to reduced wildlife-vehicle collisions after less than one year (for fencing alone) and the economic benefit would continue to increase for several decades.

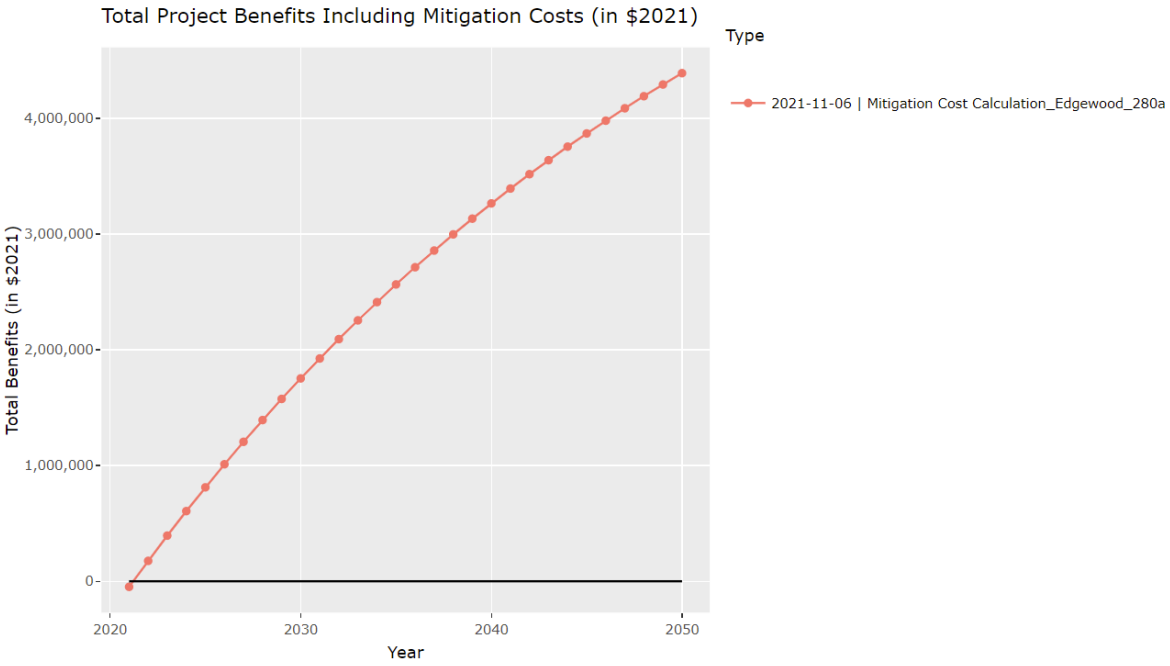


Figure 7. Benefit-cost analysis chart showing a net economic benefit from the fencing mitigation infrastructure after less than one year (where the red line crosses 0).

There would also be non-economic benefits from fencing this stretch of highway. It would reduce the number of injuries and fatalities for people driving on this stretch of road, as well as reduce the amount of property damage. In addition, fewer wildlife, including native species, would die in collisions.

Citations

Rytwinski, T, K Soanes, JAG Jaeger, L Fahrig, CS Findlay, J Houlahan, R van der Ree, EA van der Grift. 2016. How Effective Is Road Mitigation at Reducing Road-Kill? A Meta-Analysis. PLOS, https://doi.org/10.1371/journal.pone.0166941

Wildlife Crossing Calculator. UC Davis Road Ecology Center. https://wildlifecrossingcalculator.org/group/1. Accessed September 14, 2021.

Wildlife-Vehicle Collision Reduction Project: Newcastle and Auburn, I-80

Summary

The stretch of Interstate 80 from Newcastle to Auburn, California is a hotspot for wildlife-vehicle collisions. There are wild areas surrounding much of this section of I-80, and it's just a few miles from Folsom Lake and runs parallel to the North Fork American River, which provide water sources for wildlife. Wildlife-vehicle collisions are dangerous for drivers, result in ecological losses, and are expensive for the state of California, so we propose fencing this stretch of I-80 to reduce the number of collisions.

Project Area

The project area is 7 miles of Interstate 80 in Placer County, California spanning from Newcastle at the southwest end to Auburn at the northeast end. Interstate-80 crosses over Rock Springs Rd at the southwest end and over a railroad track near Mikkelsen Dr at the northeast end. The bridge over Rock Springs Rd is 81 meters long, and the bridge over the railroad track is 101 meters long. There is also an 89-meter-long bridge over Highway 49, a 9.7-meter-wide concrete box culvert over Garfield St, a 55-meter-long bridge over Ophir Rd, and a 52-meter-long bridge over Werner Rd all within the project area.

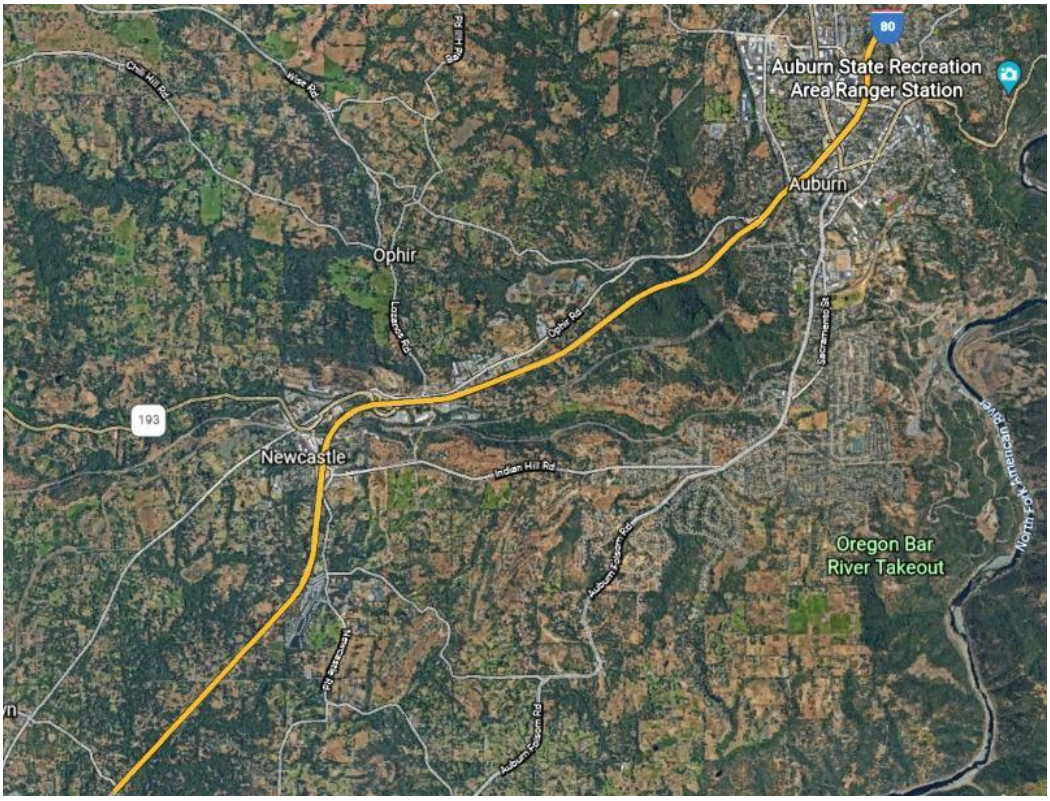


Figure 1. The project area is the highlighted section of I-80.

Figure 2. Google Maps image of the bridge over Rock Springs Rd at the southwest end of the project area.

Figure 3. Google Maps image of the bridge over the railroad tracks at the northeast end of the project area.

Figure 4. Google Maps images of four different bridges in the project area where roads cross under I-80.

Crash Statistics

We estimated the annual economic cost of wildlife-vehicle collisions in the project area using the Wildlife Crossing Calculator, which uses data from reports by California Highway Patrol officers from 2016-2020. The estimated cost is $594,541 due to property damage and hospitalizations. The project area includes two especially bad hotspots with 8.8 and 5.2 wildlife-vehicle collisions per year respectively, and the rest of the project area has between 0.4 and 4 wildlife-vehicle collisions per year.

Many different wildlife species have been killed in collisions in the project area, including coyotes, gray foxes, mule deer, raccoons, striped skunks, western gray squirrels, red-shouldered hawks, barn owls, Canada geese, rock pigeons, and wild turkeys.

Mitigation Package

Fencing along roads reduces wildlife vehicle collisions by about 54% and combining fencing with crossing structures reduces wildlife-vehicle collisions by about 83% (Rytwinski et al., 2016). We propose fencing the entire project area since wildlife could use existing bridges to cross under I-80. There is a bridge at either end of the project area as well as four other bridges in between that could be used by wildlife if there was fencing to keep them off of I-80.

We used the Wildlife Crossing Calculator to determine the most effective and affordable infrastructure for the project area. It requires 14 feet of eight-foot-high wildlife fencing, which should be mesh with

wooden posts. It also requires 13 escape ramps (about one per mile) with a 3:1 ratio to allow any animals that get trapped on the highway side of the fence to jump out.

We also used the Wildlife Crossing Calculator to estimate the mitigation cost. The fencing costs about $13 per foot, the estimated upfront cost of fencing the project area is $960,960, and the estimated annual cost for maintaining the fencing is $19,219. The total annual cost for maintaining the fencing for 20 years, its expected lifespan, is $576,576. The escape ramps cost about $12,000 each, and the total estimated upfront cost for 13 escape ramps is $156,000. They're expected to last about 30 years, and their maintenance cost is negligible. The total upfront mitigation cost for the project area is $1,116,960.

Figure 5. Mesh fencing with wooden posts, similar to the fencing proposed for the project area (https://www.sfbayfences.com/deer-fences-sonoma-marin-ca.shtml).

Figure 6. Escape ramps, which allows animals trapped on the road side of the fence to jump over to the other side (Source: Colorado Department of Transportation and Eco-Resolutions).

Economic and Other Benefits of the Project

We used the Wildlife Crossing Calculator to run a benefit-cost analysis for the proposed infrastructure. We found that it would result in a net economic benefit due to reduced wildlife-vehicle collisions after about two years, and the economic benefit would continue to increase for several decades.

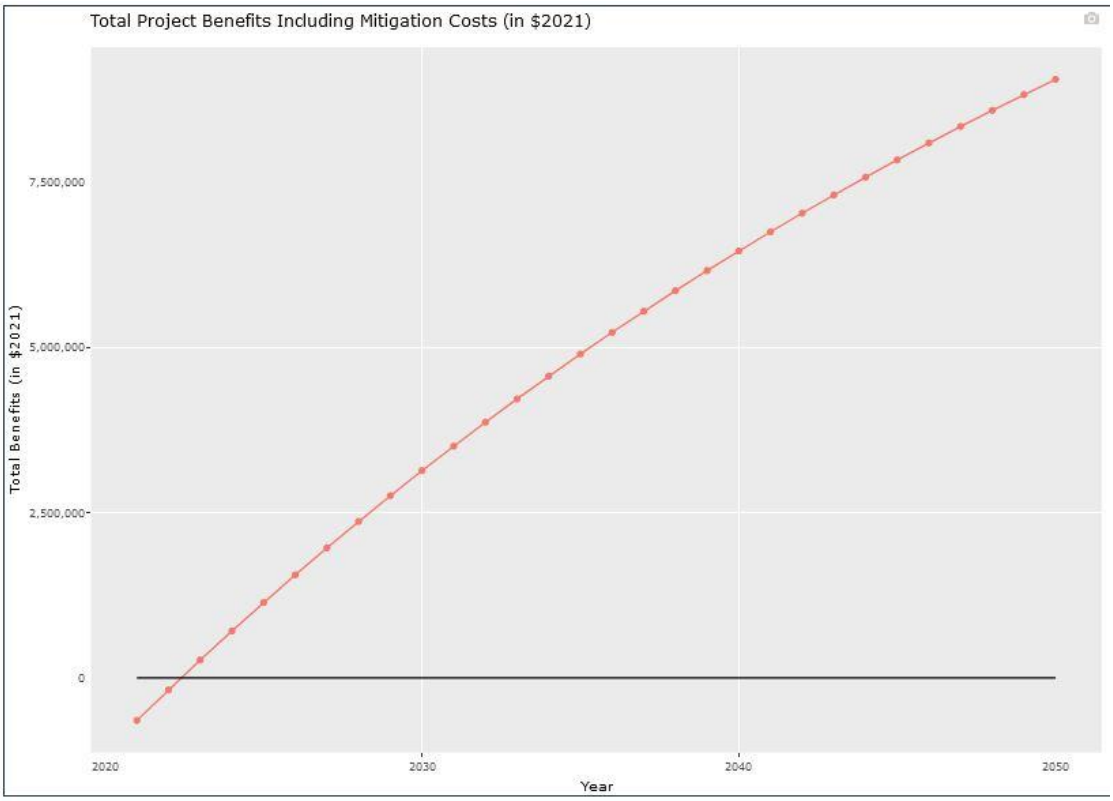


Figure 7. Benefit-cost analysis chart showing a net economic benefit from the mitigation infrastructure after about two years (where the red line crosses 0).

There would also be non-economic benefits from fencing this stretch of highway. It would reduce the number of injuries and fatalities for people driving on this stretch of road, as well as reduce the amount of property damage. In addition, fewer wildlife, including native species such as mule deer, coyotes, and gray foxes, would die in collisions.

Citations

Rytwinski, T, K Soanes, JAG Jaeger, L Fahrig, CS Findlay, J Houlahan, R van der Ree, EA van der Grift. 2016. How Effective Is Road Mitigation at Reducing Road-Kill? A Meta-Analysis. PLOS, https://doi.org/10.1371/journal.pone.0166941

Wildlife Crossing Calculator. UC Davis Road Ecology Center. https://wildlifecrossingcalculator.org/group/1. Accessed September 14, 2021.

Wildlife-Vehicle Collision Reduction Project: Folsom Lake, Highway 50

Summary

The stretch of Highway 50 in El Dorado County, California just east of Folsom Lake is a hotspot for wildlife-vehicle collisions. The lake and the American River which flows from it provide habitats for wildlife, and the highway is currently unfenced. Wildlife-vehicle collisions are dangerous for drivers, result in ecological losses, and are expensive for the state of California, so we propose fencing this stretch of Highway 50 to reduce the number of collisions.

Project Area

The project area is 10.3 miles of Highway 50 in El Dorado County, California starting in El Dorado Hills near Folsom Lake at the western end the project area. Highway 50 crosses over Clarksville Xing at the western end and over Greenstone Rd at the eastern end. The bridge over Clarksville Xing is 51 meters long, and the bridge over Greenstone Rd is 27 meters long. There is also a 37-meter-long bridge over Marble Valley Rd, a 35-meter-long bridge over Cameron Park Dr, a 40-meter-long bridge over Shingle Springs Dr, and a 52-meter-long bridge over an onramp, all within the project area.

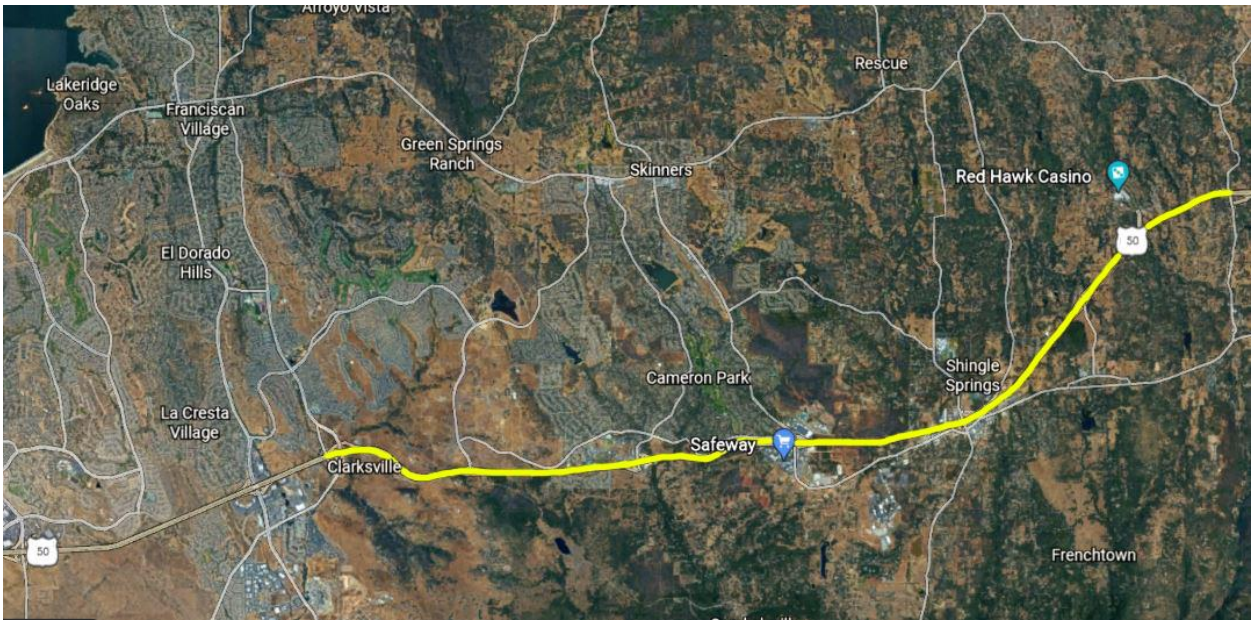


Figure 1. The project area is the highlighted section of Highway 50. The edge of Folsom Lake is in the upper left corner.

Figure 2. Google Earth image of the bridge over Clarksville Xing at the western end of the project area.

Figure 3. Google Earth image of the bridge over Greenstone Rd at the eastern end of the project area.

Figure 4. Google Earth images of four different bridges in the project area where roads cross under I-80.

Crash Statistics

We estimated the annual economic cost of wildlife-vehicle collisions in the project area using the Wildlife Crossing Calculator, which uses data from reports by California Highway Patrol officers from 2016-2020. The estimated cost is $1,523,496 due to property damage and hospitalizations. The project area includes several especially bad hotspots with 2.6, 4.4, 4.6, 5.4, 6, and 7.8 wildlife-vehicle collisions per year, respectively.

From 2011-2021, there have been 335 observations of wildlife killed in collisions in the project area, including black-tailed jackrabbits, brush rabbits, coyotes, gray foxes, mountain lions, mule deer, raccoons, red foxes, red-tailed hawks, striped skunks, turkey vultures, western gray squirrels, and wild turkeys.

Mitigation Package

Fencing along roads reduces wildlife vehicle collisions by about 54% and combining fencing with crossing structures reduces wildlife-vehicle collisions by about 83% (Rytwinski et al., 2016). We propose fencing the entire project area since wildlife could use existing bridges to cross under Highway 50. There is a bridge at either end of the project area as well as four other bridges in between. One of the bridges is over Cameron Park Dr, which is a six-lane road, and another bridge is over an onramp, neither of which would be safe places for wildlife to cross under the highway. However, the other four bridges are over small, two-lane roads where wildlife could safely cross if there was fencing to keep them off the highway.

We used the Wildlife Crossing Calculator to determine the most effective and affordable infrastructure for the project area. It requires 20.6 miles of eight-foot-high wildlife fencing, which should be mesh with wooden posts. It also requires 20 escape ramps (about one per mile) with a 3:1 slope ratio to allow any animals that get trapped on the highway side of the fence to jump out.

We also used the Wildlife Crossing Calculator to estimate the mitigation cost. The fencing costs about $13 per foot, the estimated upfront cost of fencing the project area is $1,413,984 and the estimated annual cost for maintaining the fencing is $28,279. The total annual cost for maintaining the fencing for 20 years, its expected lifespan, is $848,390. The escape ramps cost about $12,000 each, and the total estimated upfront cost for 20 escape ramps is $240,000. They're expected to last about 30 years, and their maintenance cost is negligible. The total upfront mitigation cost for the project area is $1,653,984.

Figure 5. Mesh fencing with wooden posts, similar to the fencing proposed for the project area (https://www.sfbayfences.com/deer-fences-sonoma-marin-ca.shtml).

Figure 6. Escape ramps, which allows animals trapped on the road side of the fence to jump over to the other side (Source: Colorado Department of Transportation and Eco-Resolutions).

Economic and Other Benefits of the Project

We used the Wildlife Crossing Calculator to run a benefit-cost analysis for the proposed infrastructure. We found that it would result in a net economic benefit due to reduced wildlife-vehicle collisions after less than one year, and the economic benefit would continue to increase for several decades.

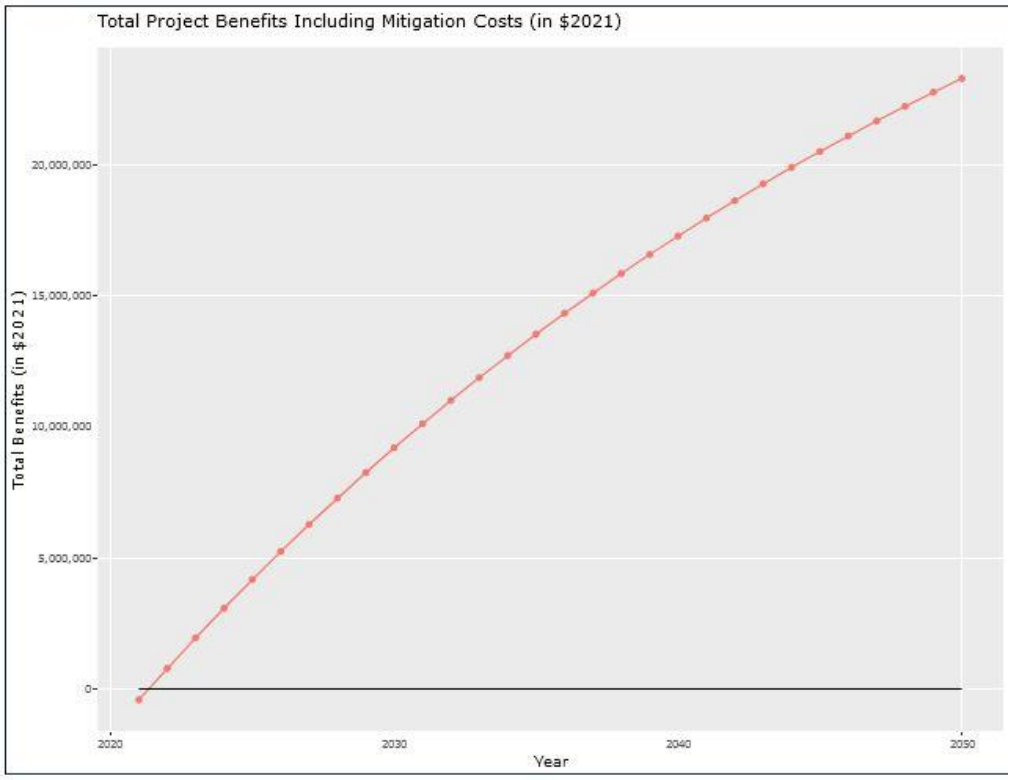


Figure 7. Benefit-cost analysis chart showing a net economic benefit from the mitigation infrastructure after less than one year (where the red line crosses 0).

There would also be non-economic benefits from fencing this stretch of highway. It would reduce the number of injuries and fatalities for people driving on this stretch of road, as well as reduce the amount of property damage. In addition, fewer wildlife, including native species such as mountain lions and gray foxes, would die in collisions.

Citations

Rytwinski, T, K Soanes, JAG Jaeger, L Fahrig, CS Findlay, J Houlahan, R van der Ree, EA van der Grift. 2016. How Effective Is Road Mitigation at Reducing Road-Kill? A Meta-Analysis. PLOS, https://doi.org/10.1371/journal.pone.0166941

Wildlife Crossing Calculator. UC Davis Road Ecology Center. https://wildlifecrossingcalculator.org/group/1. Accessed September 14, 2021.

Wildlife-Vehicle Collision Reduction Project: San Rafael North 101

Summary

The Project area of San Rafael North 101 is a particularly dangerous stretch of highway 101 concerning wildlife-vehicle collisions. This project area, which spans 4.5 miles, is a hotspot for wildlife-vehicle collisions due to the area being almost completely unfenced and surrounded by wilderness. Not only do these collisions hurt wildlife species, but also people who may suffer injuries or death from these collisions. Implementing fencing in the project area will drastically reduce the wildlife-vehicle collision rate and proves to be a cost-efficient project.

Project Area

The project area is in Marin County, California, and concerns highway 101 starting from the Civic Center in San Rafael to the Inn Marin and Suites in Novato. Project San Rafael North 101 has two existing bridges, one underpass, as well as ~.5 miles of existing wall.

Figure 1. Google Earth image of project area

Figure 2. Google Earth image of project area

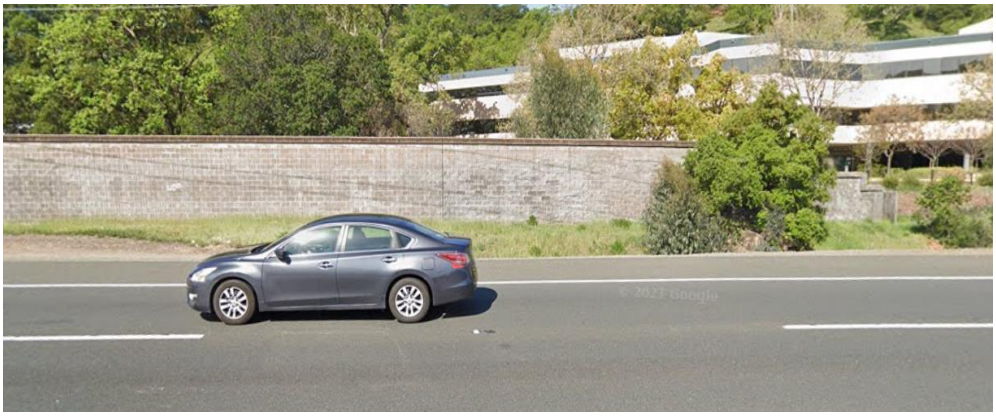


Figure 3. Google Earth image of existing wall in project area

Crash Statistics

The estimated annual economic cost for these wildlife-vehicle collisions in the project area was made using the Wildlife Crossing Calculator which uses data from reported incidents by California Highway Patrol collected from 2016-2020. The estimated cost of these wildlife-vehicle collisions in the project area totals to ~$601,456/year. This included 4 (human) injury-crashes.

In the last 10 years (2011-2020), there have been 180 observations of 9 mammal species killed on this stretch of US 101. Species include: Black-tailed rabbit, brush rabbit, coyote, desert cottontail, gray fox, mountain lion, mule deer, raccoon, and striped skunk. Over 80 of the roadkill

observations were of mule deer by the California Highway Patrol, including those involved in crashes with property damage and/or injuries to people.

Mitigation Package

Crossing structures combined with fencing have an average effectiveness of ~83% (Rytwinski et al.,2016). There are already crossing structures in the project area which allow for wildlife to cross underneath highway 101, so we propose adding fencing.

We used the Wildlife Crossing Calculator to determine the most effective infrastructure in the project area to reduce wildlife-vehicle collisions as well as the estimated cost of the proposed infrastructure. This area requires 46,675 feet of fencing as well as nine escape ramps (one per mile). The fencing should be 8 feet high, made of mesh, with wooden posts. The escape ramps should be a 3:1 ratio. Assuming that fencing costs ~$13/foot, the upfront mitigation cost for fencing would be ~$606,775. Additionally, assuming escape ramps cost ~$12/unit, the upfront cost would equal ~$108,000. This would total to ~$714,775 as the upfront cost for the described wildlife infrastructure.

The annual maintenance cost for such fencing would cost ~$12,135 and the escape ramps require no annual maintenance. With fencing having a lifespan of 20 years, the total maintenance cost would equal ~$364,065.

Figure 4. Mesh fencing with wooden posts (https://www.sfbayfences.com/deer-fences-sonoma-marin-ca.shtml).

Figure 5. An escape ramp, which allows animals trapped on the road side of the fence to jump over to the other side (Source: Colorado Department of Transportation and Eco-Resolutions).

Figure 6. Google Earth image of existing structure in San Rafael which allows for wildlife to cross underneath highway 101

Economic and Ecological Benefits

We used the Wildlife Crossing Calculator to run a benefit-cost analysis for the proposed infrastructure in the project area. The benefit-cost analysis shows that in just ~1 year (where the red line on the graph crosses 0) after implementing such infrastructure the project would result in a net economic benefit.

By implementing fencing including escape ramps in the project area, the state of California would be saving money due to the decrease in costly wildlife-vehicle collisions. Additionally, reducing these wildlife-vehicle collisions prevent human injuries, save human lives, and have ecological benefits for the wildlife with the decreased risk of death from collisions.

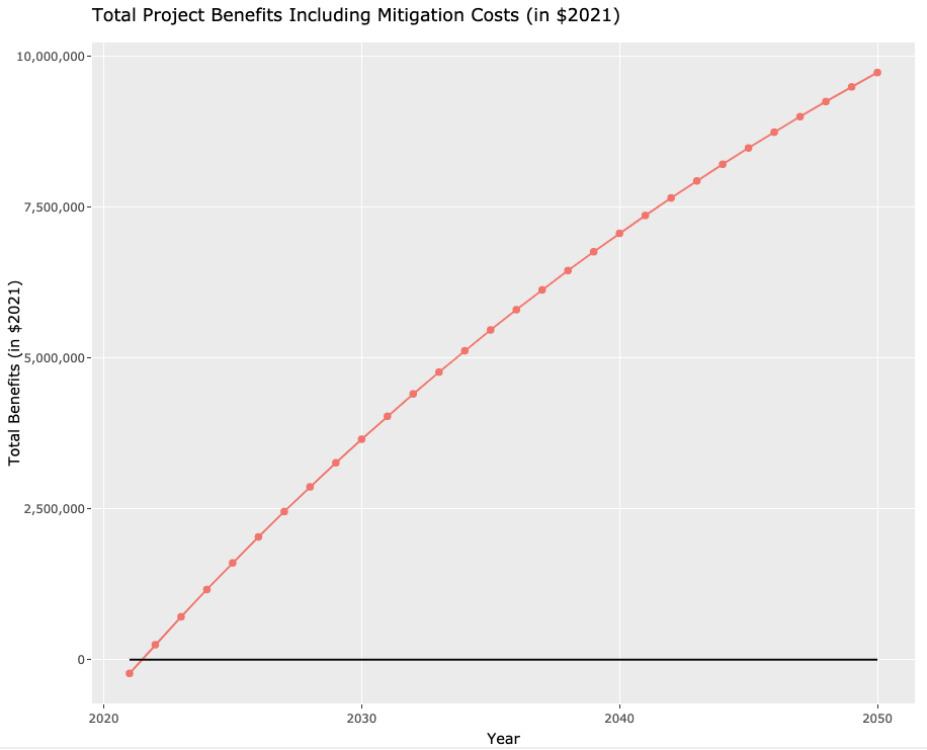


Figure 7. Graph of cost-benefit analysis for project area using Wildlife Crossing Calculator

Citations

Rytwinski, T, K Soanes, JAG Jaeger, L Fahrig, CS Findlay, J Houlahan, R van der Ree, EA van der Grift. 2016. How Effective Is Road Mitigation at Reducing Road-Kill? A Meta-Analysis. PLOS, https://doi.org/10.1371/journal.pone.0166941

Wildlife Crossing Calculator. UC Davis Road Ecology Center. https://wildlifecrossingcalculator.org/group/1. Accessed September 14, 2021.

Wildlife-Vehicle Collision Reduction Project: Blue Lakes, Highway 20

Summary

The stretch of Highway 20 near the Blue Lakes in Ukiah, California is a hotspot for wildlife-vehicle collisions. The highway is surrounded by wild areas and the lakes provide a water source for wildlife, and this section of highway is unfenced. Wildlife-vehicle collisions are dangerous for drivers, result in ecological losses, and are expensive for the state of California, so we propose fencing this stretch of Highway 20 and building a wildlife underpass to reduce the number of collisions.

Project Area

The project area is 3.8-miles of Highway 20 in Ukiah, California. The highway intersects with Old State Highway and Schuette Rd at the northwest end, and there's a 37-meter-long bridge over Cold Creek at the southeast end. This stretch of Highway 20 also intersects with Old Lake County Rd and 11 driveways.

Figure 1. The project area is the section of Highway 20 between the blue arrows.

Figure 2. Google Earth image of the bridge at the northwest end of the project area.

Crash Statistics

We estimated the annual economic cost of wildlife-vehicle collisions in the project area using the Wildlife Crossing Calculator, which uses data from reports by California Highway Patrol officers from 2016-2020. The estimated cost is $233,326 due to property damage and hospitalizations, and one wildlife-vehicle collision in the project area resulted in a major injury to a driver or passenger.

From 2011-2021, there have been 39 observations of wildlife killed in collisions in the project area, including California ground squirrels, elk, gray foxes, mule deer, raccoons, striped skunks, wildlife pigs, and wild turkeys.

Mitigation Package

Fencing along roads reduces wildlife vehicle collisions by about 54% and combining fencing with crossing structures reduces wildlife-vehicle collisions by about 83% (Rytwinski et al., 2016). We propose fencing the entire project area and building an underpass at the southeast end. The bridge at the northwest end allows wildlife to safely cross the highway, but there are no existing crossing structures at the southeast end. The ground slopes down on both sides of the highway just southeast of the intersection with Old State Highway and Schuette Rd, which makes it feasible to build an underpass.

We used the Wildlife Crossing Calculator to determine the most effective and affordable infrastructure for the project area. It requires 7.6 miles of eight-foot-high wildlife fencing, which should be mesh with wooden posts. It also requires seven escape ramps (one per mile) with a 3:1 ratio to allow any animals that get trapped on the highway side of the fence to jump out. The underpass should be a concrete box culvert 100 feet long and 12 feet wide.

We also used the Wildlife Crossing Calculator to estimate the mitigation cost. The fencing costs about $13 per foot, the estimated upfront cost of fencing the project area is $1,564,992, and the estimated annual cost for maintaining the fencing is $10,433. The total annual cost for

maintaining the fencing for 20 years, its expected lifespan, is $782,496. The escape ramps cost about $12,000 each, and the estimated upfront cost for seven escape ramps is $168,000. They're expected to last about 30 years, and their maintenance cost is negligible. The box culvert costs about $345 per square foot, and its total upfront cost is estimated to be $414,000. It's expected to last about 75 years and its maintenance cost is negligible. The total upfront cost for the proposed mitigation measures is $2,146,992.

Figure 3. Google Earth image of the southeast end of the project area where the road is raised above ground level, making it feasible to build an underpass.

Figure 4. Mesh fencing with wooden posts, similar to the fencing proposed for the project area (https://www.sfbayfences.com/deer-fences-sonoma-marin-ca.shtml).

Figure 5. Escape ramps, which allows animals trapped on the road side of the fence to jump over to the other side (Source: Colorado Department of Transportation and Eco-Resolutions).

Figure 6. A concrete box culvert similar to the type proposed for the project area (https://www.highwaywilding.org/).

Economic and Ecological Benefits of Project

We used the Wildlife Crossing Calculator to run a benefit-cost analysis for the proposed infrastructure. We found that it would result in a net economic benefit due to reduced wildlife-vehicle collisions after 13 years, and the economic benefit would continue to increase for several decades since the underpass is expected to last for 75 years.

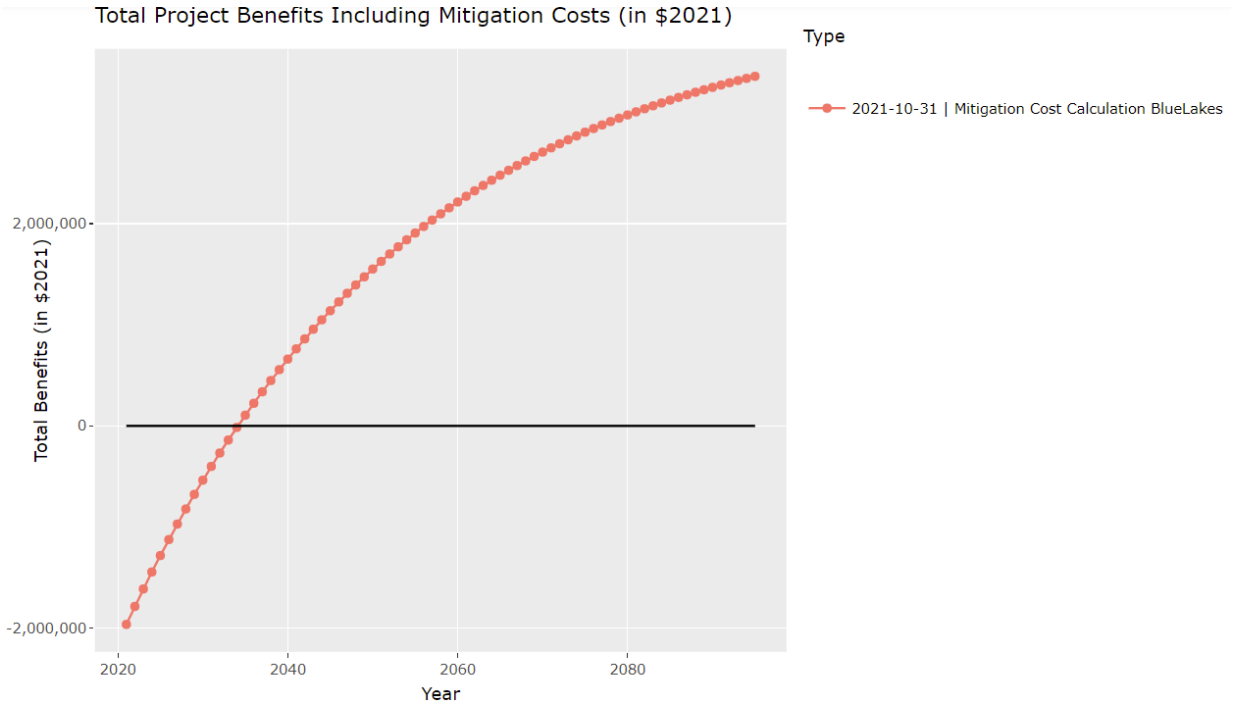


Figure 7. Cost-benefit analysis chart showing a net economic benefit from the mitigation infrastructure after 13 years (where the red line crosses 0).

Besides the economic benefits, the infrastructure would reduce the number of injuries and fatalities for people driving on this stretch of road, as well as reduce the amount of property damage.

There would also be ecological benefits. Fewer wildlife, including native species such as tule elk, gray foxes, and California ground squirrels, would die in collisions. And building an underpass would reduce habitat fragmentation, improving the habitat for species such as mountain lions that require large home ranges.

Citations

Rytwinski, T, K Soanes, JAG Jaeger, L Fahrig, CS Findlay, J Houlahan, R van der Ree, EA van der Grift. 2016. How Effective Is Road Mitigation at Reducing Road-Kill? A Meta-Analysis. PLOS, https://doi.org/10.1371/journal.pone.0166941

Wildlife Crossing Calculator. UC Davis Road Ecology Center. https://wildlifecrossingcalculator.org/group/1. Accessed September 14, 2021.

Wildlife-Vehicle Collision Reduction Project: Mi-Wuk Village, Highway 108

Summary

The stretch of Highway 108 in Tuolumne County, California just east of New Melones Reservoir is a hotspot for wildlife-vehicle collisions. The Sierra Nevada foothills provide habitats for wildlife, and the highway is currently unfenced. Wildlife-vehicle collisions are dangerous for drivers, result in ecological losses, and are expensive for the state of California, so we propose fencing this stretch of Highway 108 to reduce the number of collisions.

Project Area

The project area is 19.6 miles of Highway 108 in Tuolumne County, California starting in Jamestown near New Melones Reservoir at the western end the project area. Highway 108 crosses over Woods Creek at the western end through a culvert, across a 300 meter long bridge across Sullivan Creek. There is also a 100-meter bridge over Peaceful Oak Rd and a 215-meter-long bridge over Mono Way.

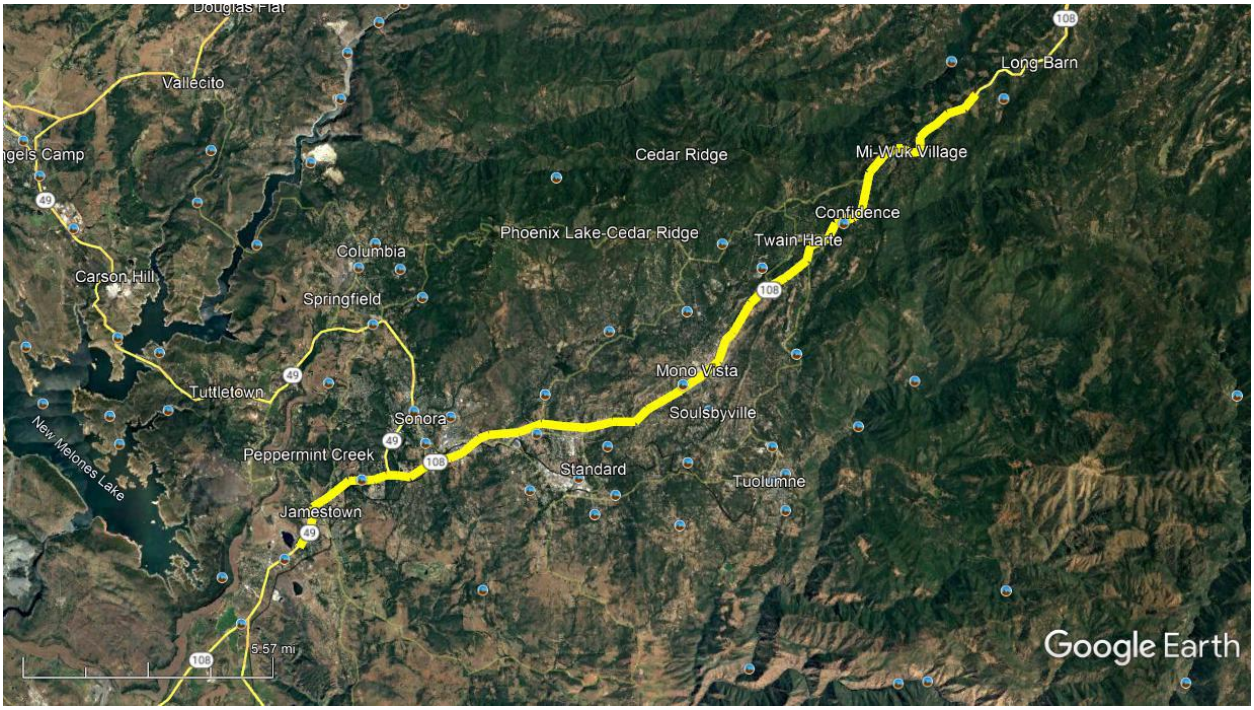


Figure 1. The project area is the highlighted section of Highway 108. The edge of New Melones Reservoir is in the bottom left corner.

Figure 2. Google Maps street-view image of the bridge over Sullivan Creek and two local roads.

Figure 3. Google Maps street-view image of the bridge over Mono Way.

Crash Statistics

We estimated the annual economic cost of wildlife-vehicle collisions in the project area using the Wildlife Crossing Calculator, which uses data from reports by California Highway Patrol officers from 2016-2020. The estimated annual cost is $962,929 due to property damage and

hospitalizations. The project area includes several especially bad hotspots with 4.2, 4.4, and 5.4 wildlife-vehicle collisions per year. There were also impacts to several wildlife species (between 2011 and 2021), including Gray fox, Mule deer, Raccoon, Striped skunk, and Virginia opossum, including 108 dead mule deer.

Mitigation Package

Fencing along roads reduces wildlife vehicle collisions by about 54% and combining fencing with crossing structures reduces wildlife-vehicle collisions by about 83% (Rytwinski et al., 2016). We propose fencing a portion of the entire project area because there are a few minor roads intersecting the highway and wildlife could use existing bridges to cross under Highway 108. There are 3 major bridges over minor roads and creeks where wildlife could safely cross if there was fencing to keep them off the highway. We also assessed an option of adding an arch underpass in an area with few under-crossing possibilities.

We used the Wildlife Crossing Calculator to determine the most effective and affordable infrastructure for the project area. Partially fencing in areas outside residential areas requires 15 miles of eight-foot-high wildlife fencing, which should be mesh with wooden posts. It also requires 15 escape ramps (about one per mile) with a 3:1 ratio to allow any animals that get trapped on the highway side of the fence to jump out, as well as approximately 4 wildlife guards for minor roads entering the highway.

The fencing costs about $13 per foot, the estimated upfront cost of fencing the project area is $884,000 and the estimated annual cost for maintaining the fencing is $17,680. The total annual cost for maintaining the fencing for 20 years, its expected lifespan, is $530,400. The escape ramps cost about $12,000 each, and the total estimated upfront cost for 15 escape ramps is $180,000. They're expected to last about 30 years, and their maintenance cost is negligible. The total upfront fencing mitigation cost for the project area is $1,074,000. The arch underpass (120' x 60') would cost $2,160,000 up front and have unknown to negligible maintenance costs. This would raise the total upfront mitigation cost to $5,192,000.

Figure 4. Mesh fencing with wooden posts, similar to the fencing proposed for the project area (https://www.sfbayfences.com/deer-fences-sonoma-marin-ca.shtml).

Figure 5. Escape ramps, which allows animals trapped on the road side of the fence to jump over to the other side (Source: Colorado Department of Transportation and Eco-Resolutions).

Economic and Other Benefits of the Project

We used the Wildlife Crossing Calculator to run a benefit-cost analysis for the proposed infrastructure. We found that it would result in a net economic benefit due to reduced wildlife-vehicle collisions after less than one year (for fencing alone), or 7 years (for fencing plus under-crossing) and the economic benefit would continue to increase for several decades.

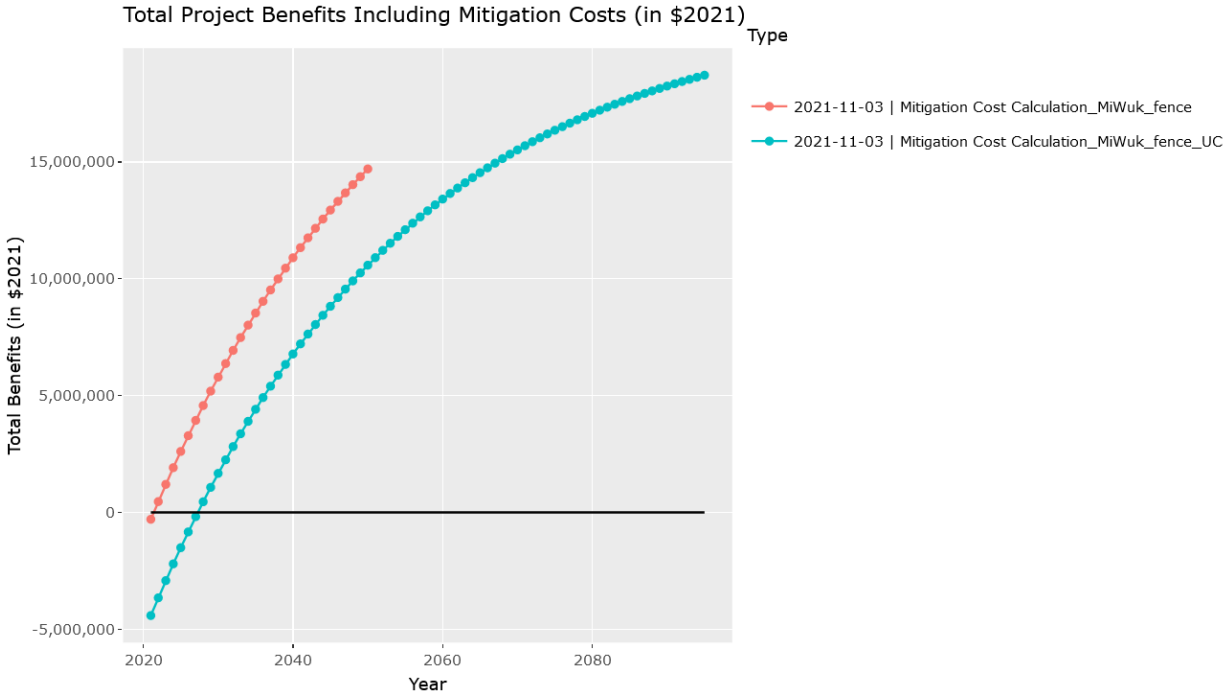


Figure 7. Benefit-cost analysis chart showing a net economic benefit from the fencing mitigation infrastructure after less than one year (where the red line crosses 0) and after 7 years for fencing + under-crossing (aqua line).

There would also be non-economic benefits from fencing this stretch of highway. It would reduce the number of injuries and fatalities for people driving on this stretch of road, as well as reduce the amount of property damage. In addition, fewer wildlife, including native species, would die in collisions.

Citations

Rytwinski, T, K Soanes, JAG Jaeger, L Fahrig, CS Findlay, J Houlahan, R van der Ree, EA van der Grift. 2016. How Effective Is Road Mitigation at Reducing Road-Kill? A Meta-Analysis. PLOS, https://doi.org/10.1371/journal.pone.0166941

Wildlife Crossing Calculator. UC Davis Road Ecology Center. https://wildlifecrossingcalculator.org/group/1. Accessed September 14, 2021.

Wildlife-Vehicle Collision Reduction Project: Caspers SR-74

Summary

The stretch of State Route 74 adjacent to San Juan Creek is a hotspot for wildlife-vehicle collisions. The Santa Ana Mountain protected and un-protected areas provide habitats for wildlife, and the highway is currently unfenced. Wildlife-vehicle collisions are dangerous for drivers, result in ecological losses, and are expensive for the state of California, so we propose fencing this stretch of SR-74 to reduce the number of collisions.

Project Area

The project area is 6 miles of SR-74 in Orange County, California, between Reeta Rd and the Ortega Flats Campground in Ronald W. Caspers Wilderness Park. This section of SR-74 crosses over San Juan Creek (85 m bridge) and several culverts ranging in size from 1-2 feet to >8 feet.

Figure 1. The project area is the highlighted section of State Route 74. San Juan Creek runs along the north side of SR-74.

Figure 2. Google Maps street-view image from the SR-74 bridge over San Juan Creek.

Figure 3. Wildlife crossing SR-74 using culverts under the highway.

Crash Statistics

We estimated the annual economic cost of wildlife-vehicle collisions in the project area using the Wildlife Crossing Calculator, which uses data from reports by California Highway Patrol officers from 2016-2020. The estimated annual cost is $205,097 due to property damage and injuries.

In addition to economic impacts, two wildlife species have been killed by vehicles in this stretch of highway. Between 2011 and 2021, carcasses and crashes involving Coyote and Mule deer were recorded, including 23 mule deer.

Mitigation Package

Fencing along roads reduces wildlife vehicle collisions by about 54% and combining fencing with crossing structures reduces wildlife-vehicle collisions by about 83% (Rytwinski et al., 2016). We propose fencing the entire project area. There is 1 bridge over San Juan Creek and culverts for drainage and hiking trails where wildlife could safely cross if there was fencing to keep them off the highway.

We used the Wildlife Crossing Calculator to determine the most effective and affordable infrastructure for the project area. Fencing the project area requires 31,680 feet of eight-foot-high wildlife fencing, which should be mesh with wooden posts. Because mountain lions have been recorded crossing through culverts in this area and have been killed while crossing the highway in other areas, 10-foot fencing may be more appropriate. It also requires 12 escape ramps to allow any animals that get trapped on the highway side of the fence to jump out, as well as up to 10 wildlife guards for minor roads exiting the highway.

The fencing costs about $13 per foot, the estimated upfront cost of fencing the project area is $411,840 and the estimated annual cost for maintaining the fencing is $8,236. The total annual cost for maintaining the fencing for 20 years, its expected lifespan, is $247,104. The escape ramps cost about $12,000 each, and the total estimated upfront cost for 12 escape ramps is $144,000. They're expected to last about 30 years, and their maintenance cost is negligible. The total upfront mitigation cost for the project area is $1,055,840.

Figure 4. Mesh fencing with wooden posts, similar to the fencing proposed for the project area (https://www.sfbayfences.com/deer-fences-sonoma-marin-ca.shtml).

Figure 5. Escape ramps, which allows animals trapped on the road side of the fence to jump over to the other side (Source: Colorado Department of Transportation and Eco-Resolutions).

Economic and Other Benefits of the Project

We used the Wildlife Crossing Calculator to run a benefit-cost analysis for the proposed infrastructure. We found that it would result in a net economic benefit due to reduced wildlife-vehicle collisions after less than one year (for fencing alone) and the economic benefit would continue to increase for several decades.

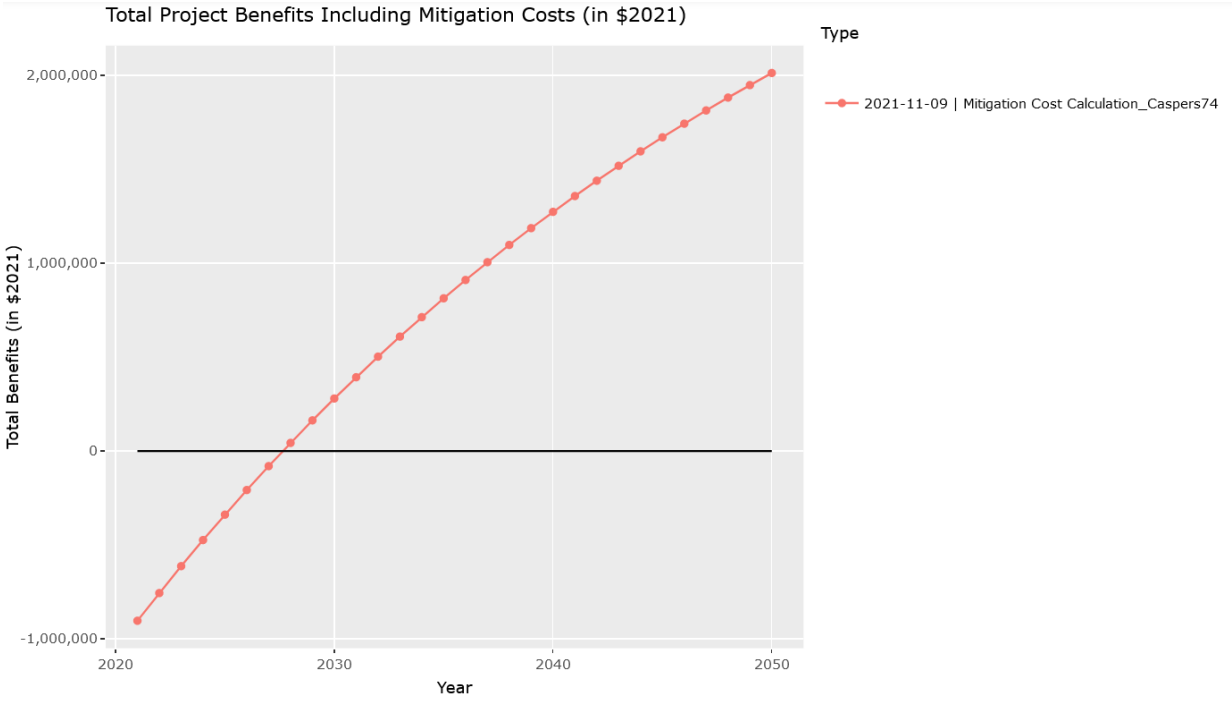


Figure 7. Benefit-cost analysis chart showing a net economic benefit from the fencing mitigation infrastructure in less than 8 years (where the red line crosses 0).

There would also be non-economic benefits from fencing this stretch of highway. It would reduce the number of injuries and fatalities for people driving on this stretch of road, as well as reduce the amount of property damage. In addition, fewer wildlife, including native species, would die in collisions.

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