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

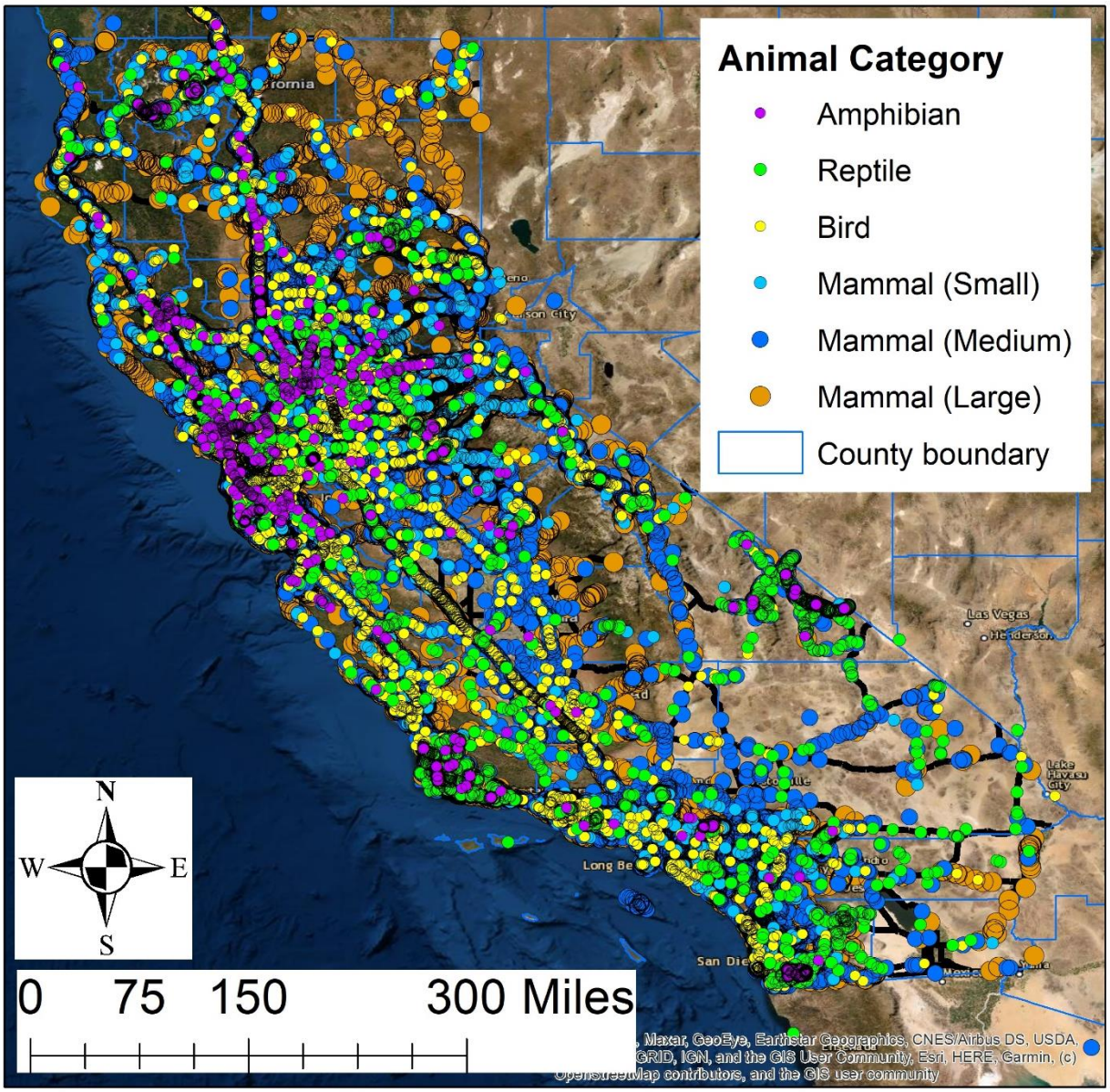

Figure 1. California wildlife-vehicle collision observations reported in the California Roadkill Observation System (https://wildlifecrossing.net/california) and California Highway Incident Processing System. Observations are primarily on state highways, but also on major and minor county and city roads.

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.

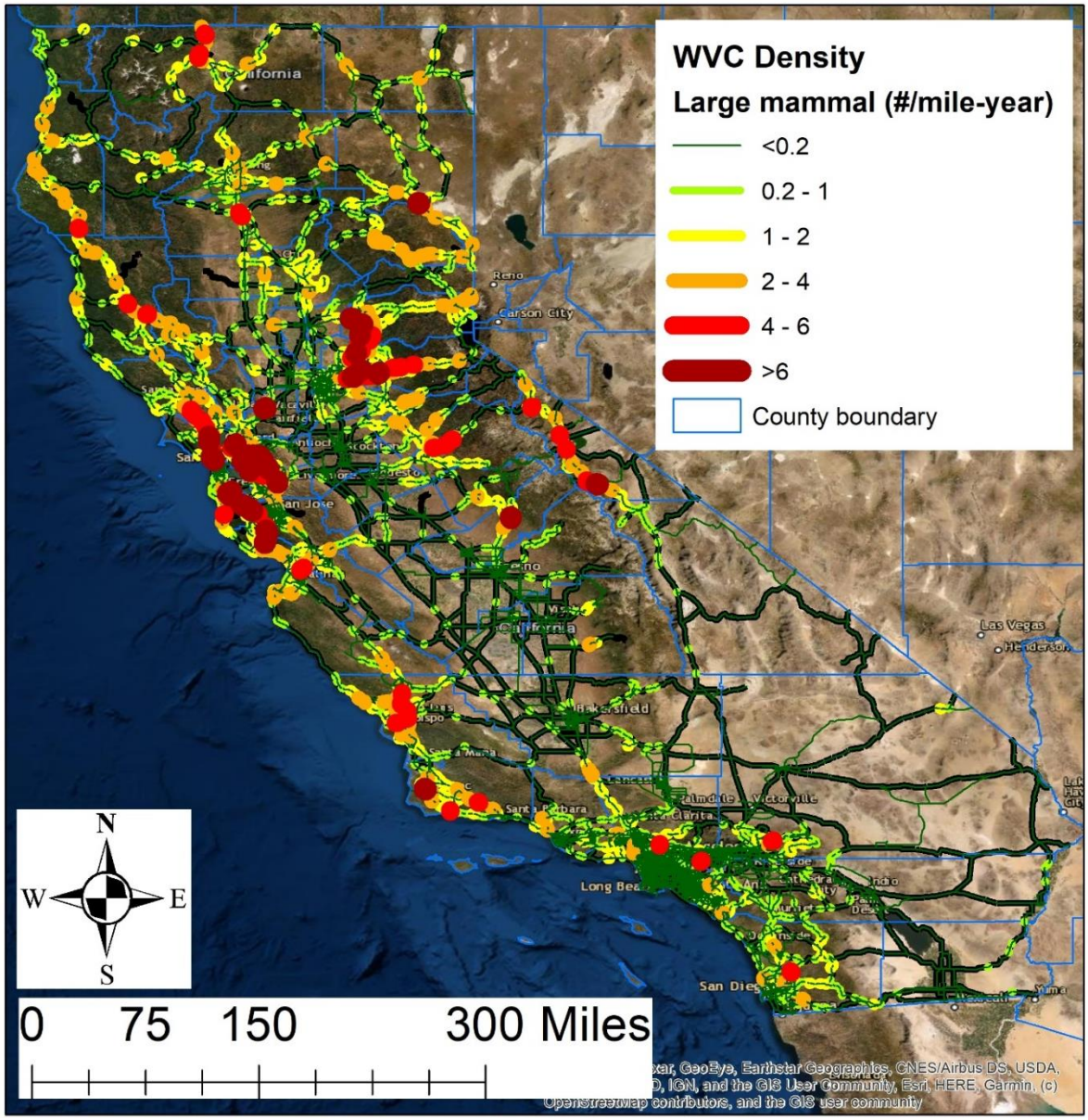

Figure 2. Annual density of large-mammal WVC per mile of state highway.

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 1).

Table 1. 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. **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			$1,083,002,241 /$2,153,834,122[3]

1 -- Wildlife values are from AZ

2 -- On average, there are 5 fatal crashes with wildlife per year in CA (Insurance Institute for Highway Safety). 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).

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).

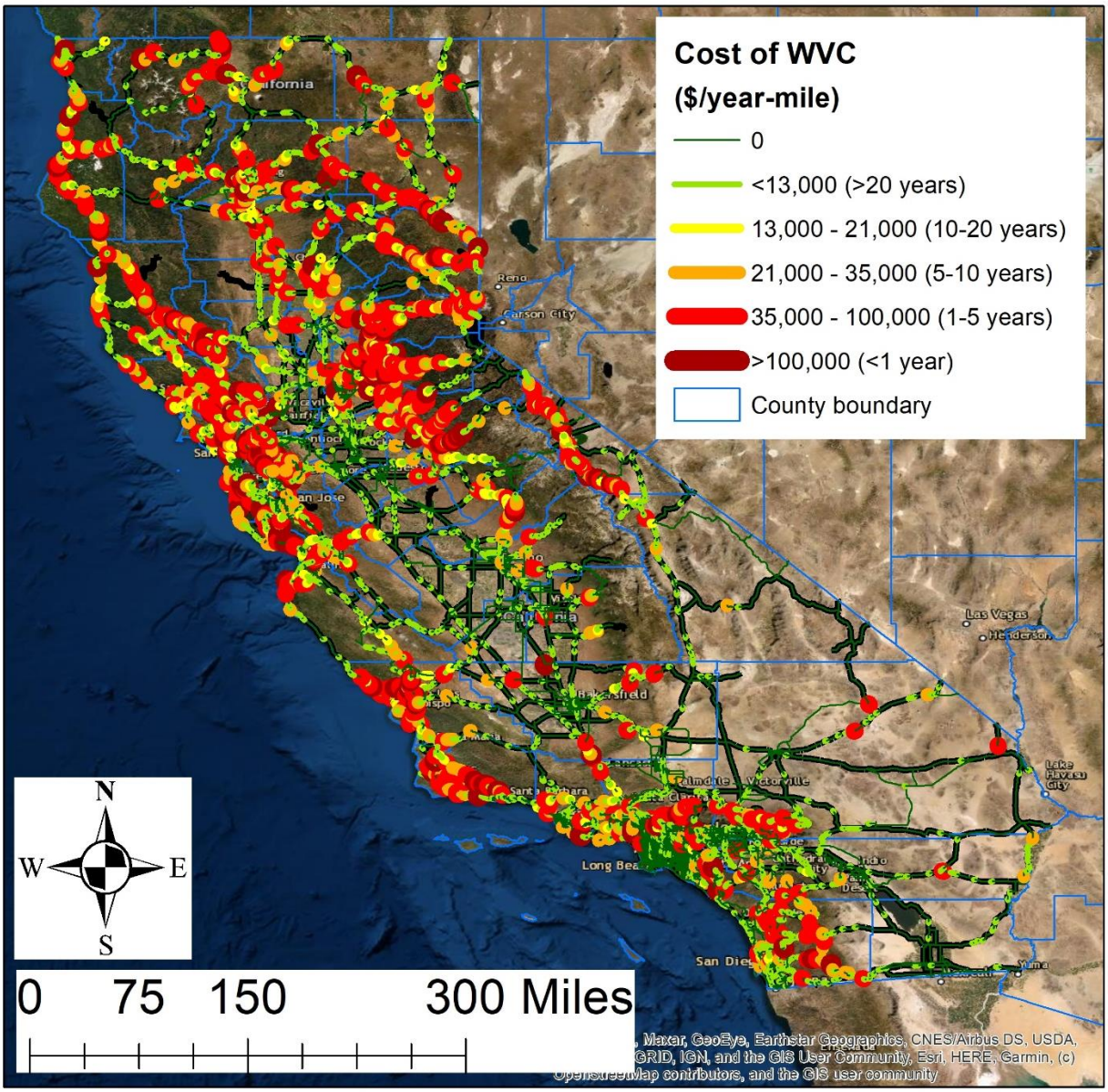

Figure 3. Annual cost of WVC per mile. The length of time in parentheses in the legend indicate how many years of reduced WVC on a highway segment would be needed to have the equivalent cost of fencing along that segment. For example, "1-2 years" indicates that the cost of fencing that segment is the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

Table 2. 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, 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.

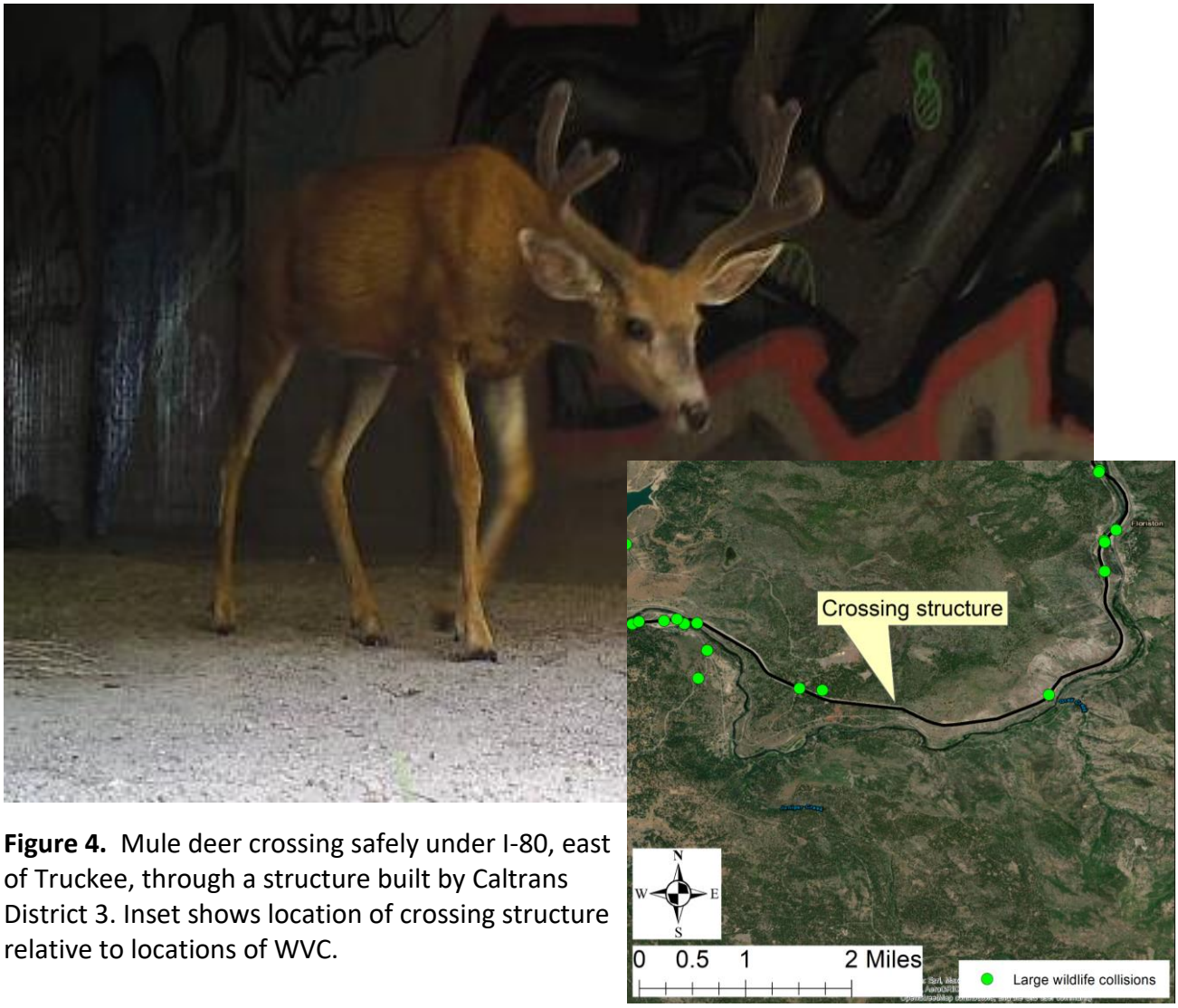

Figure 4. Mule deer crossing safely under I-80, east of Truckee, through a structure built by Caltrans District 3. Inset shows location of crossing structure relative to locations of WVC.

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.

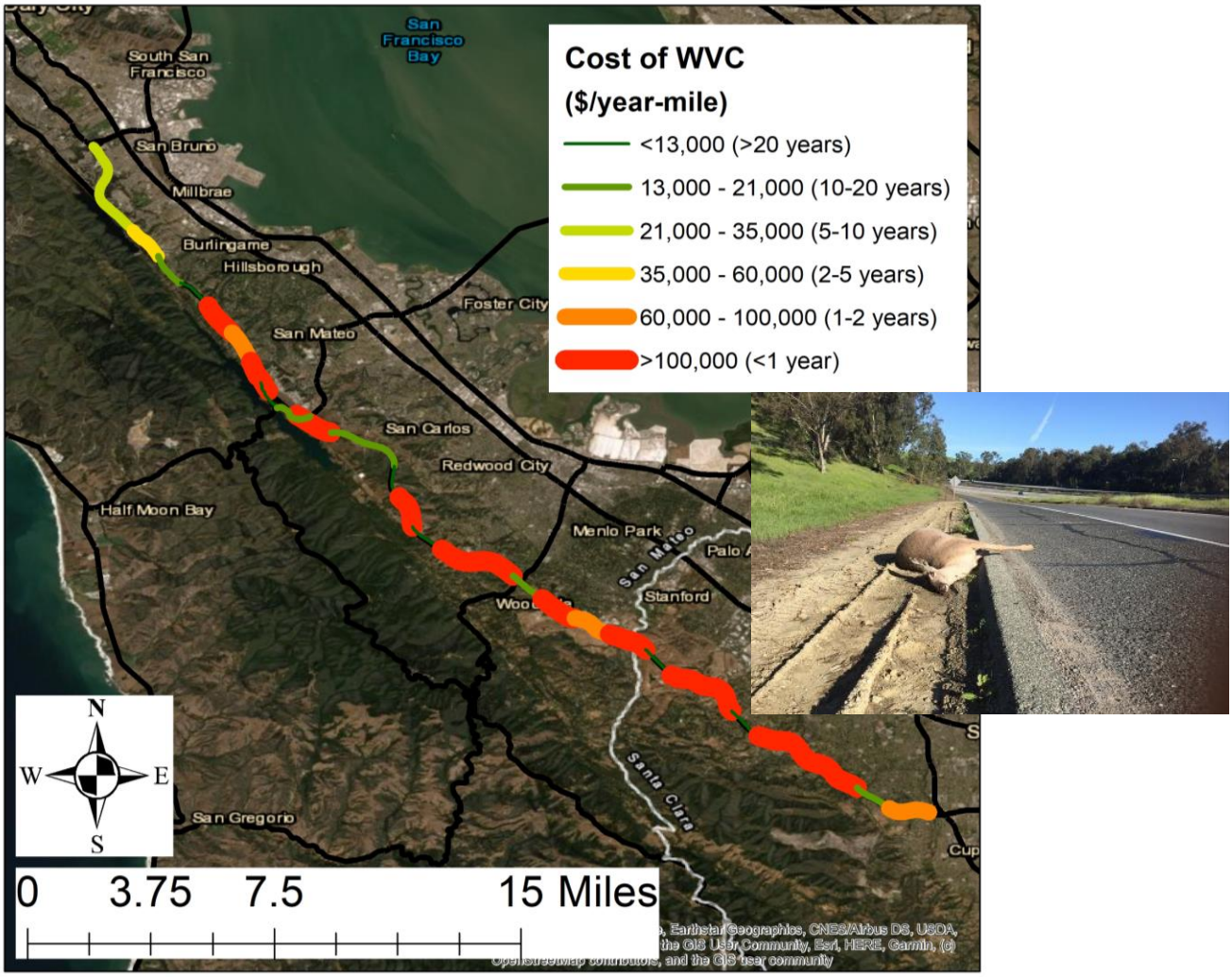

Figure 5. Annual cost of WVC ($/mile) on one mile segments of I-280 between San Bruno and Cupertino. The number in parentheses indicates the number of years of WVC reduction would be required to equal the cost of fencing the segment. The inset shows a mule deer killed on I-280 (Photo credit, Kathryn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

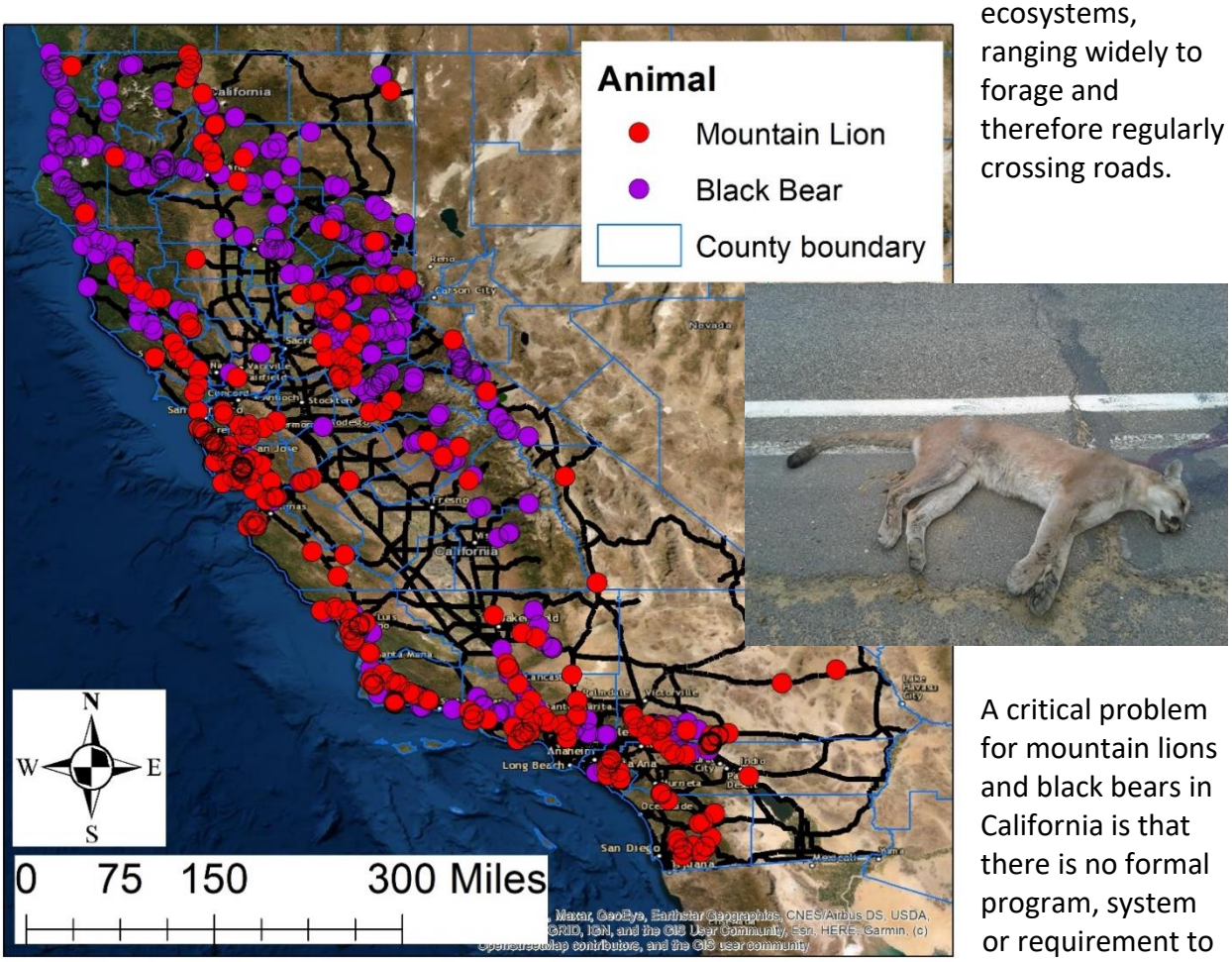

Figure 6. Mountain lions and black bears reported killed on roads, or involved in traffic incidents by the California Roadkill Observation System, CDFW, CHP, or Winston Vickers and other biologists in Southern California (Vickers et al. 2015, and Vickers unpublished data). Photo source: California Roadkill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

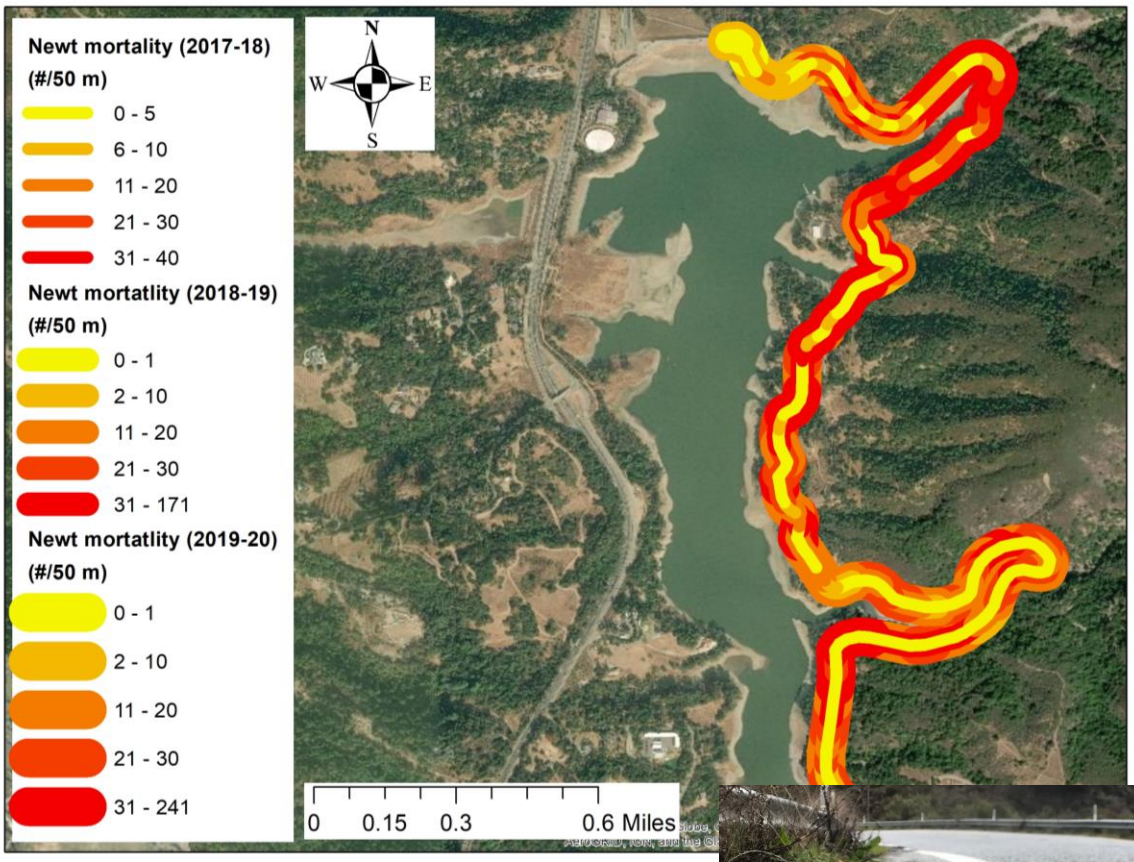

Figure 7. Pacific newt mortality rate (#/50 meters road) along Alma Bridge Rd. Photo inset shows newt beginning to cross Alma Bridge Rd (Photo credit, Merav Vonshak).

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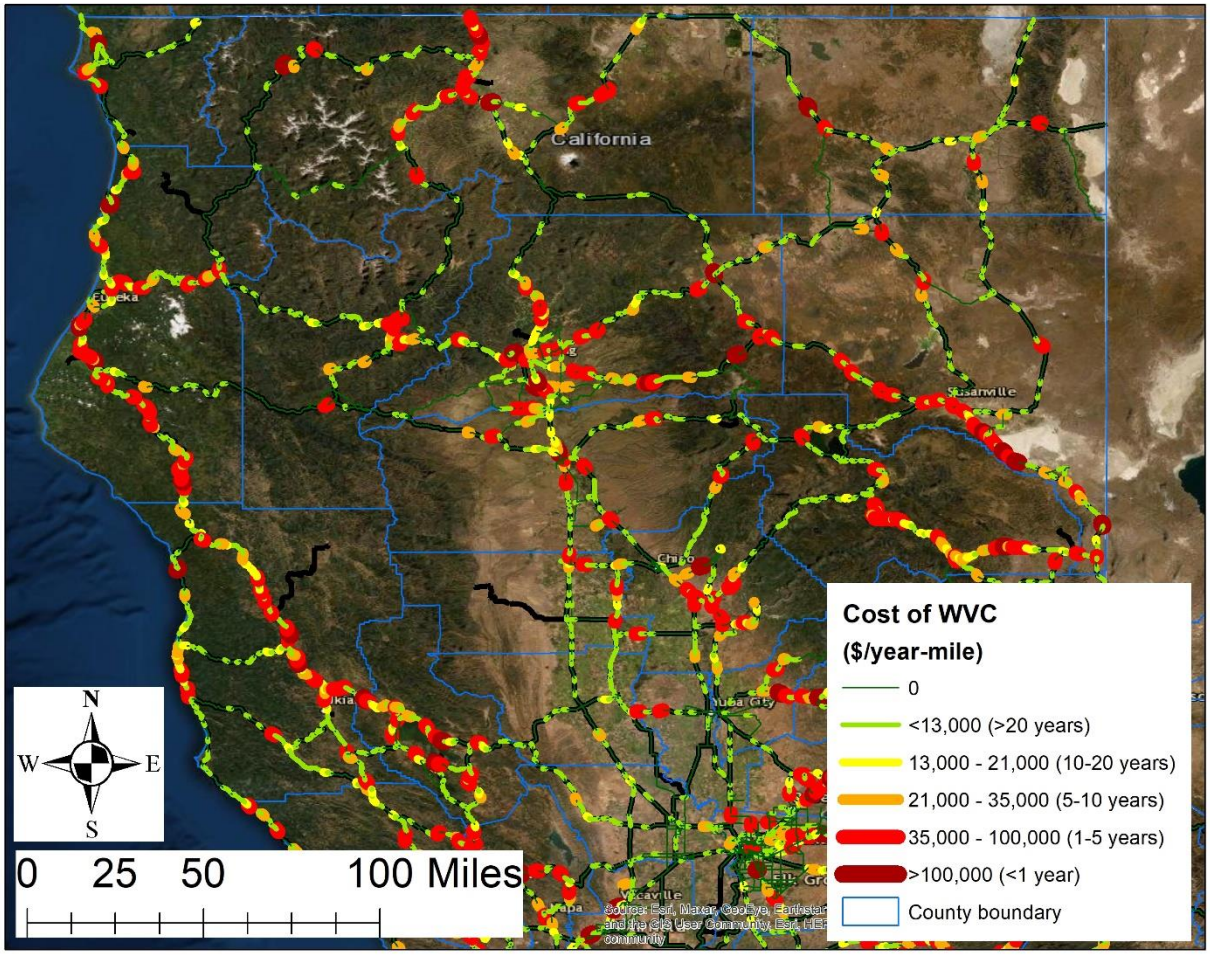
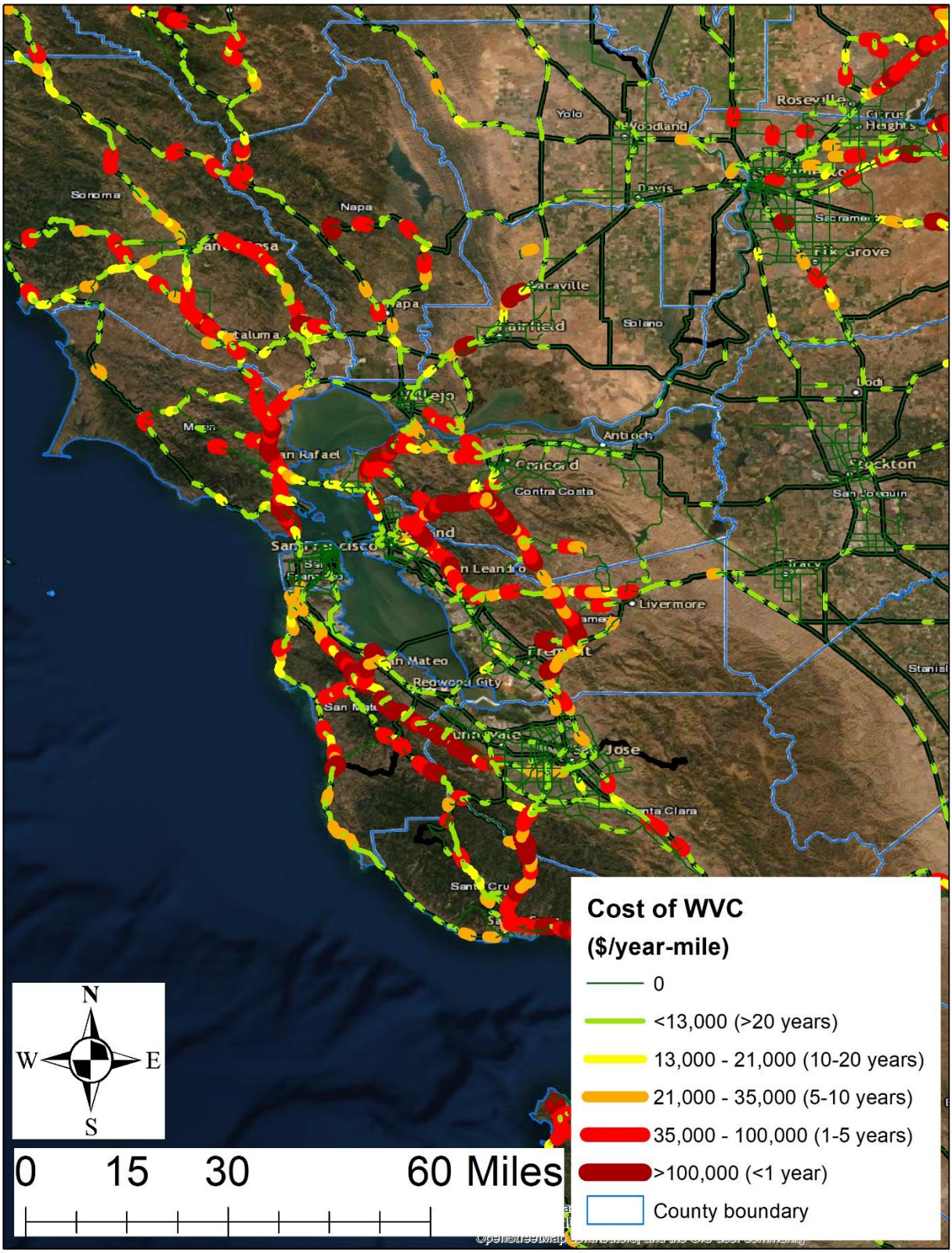
Appendix 1. Detailed maps of WVC cost per mile per year.

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.

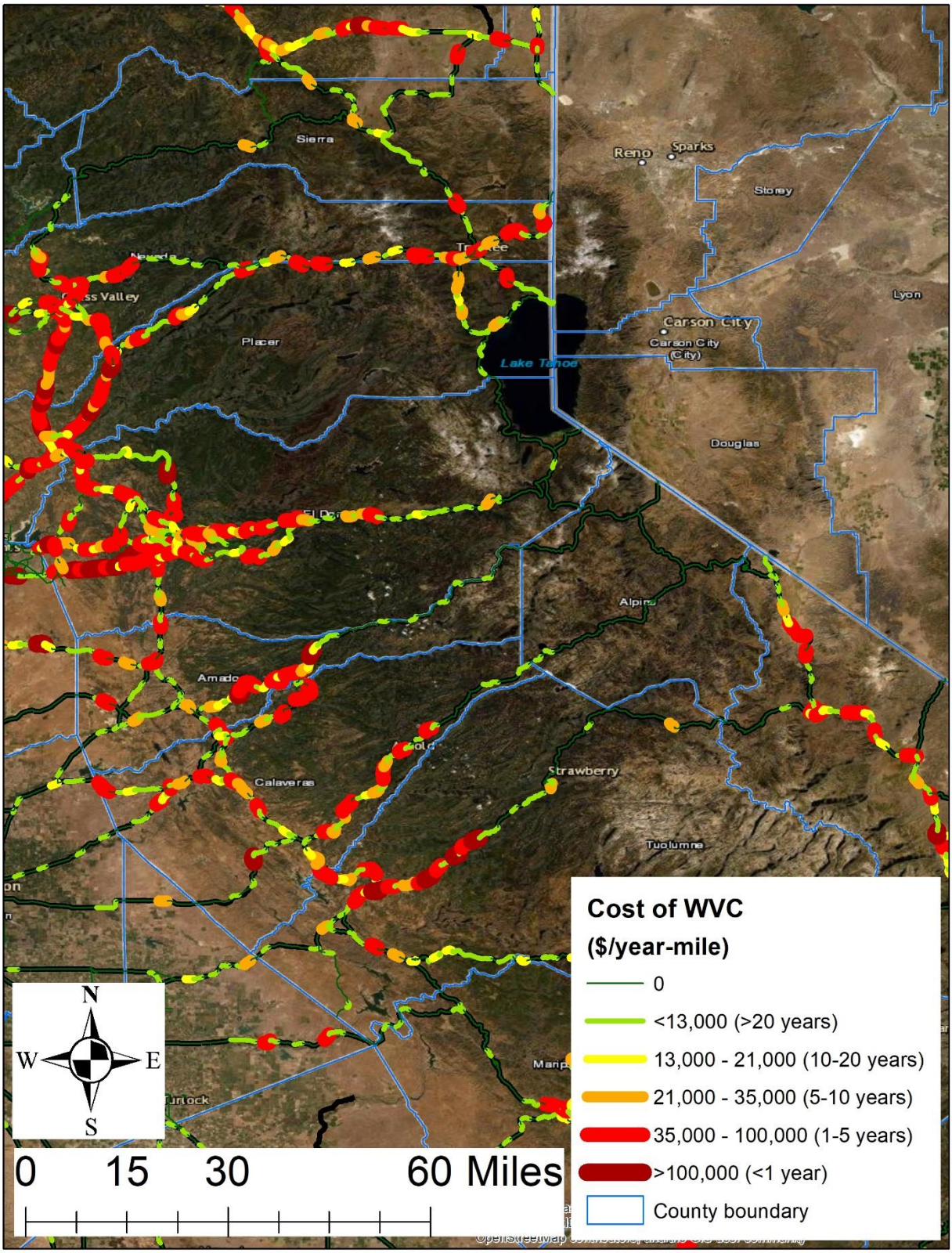
A) Northern California



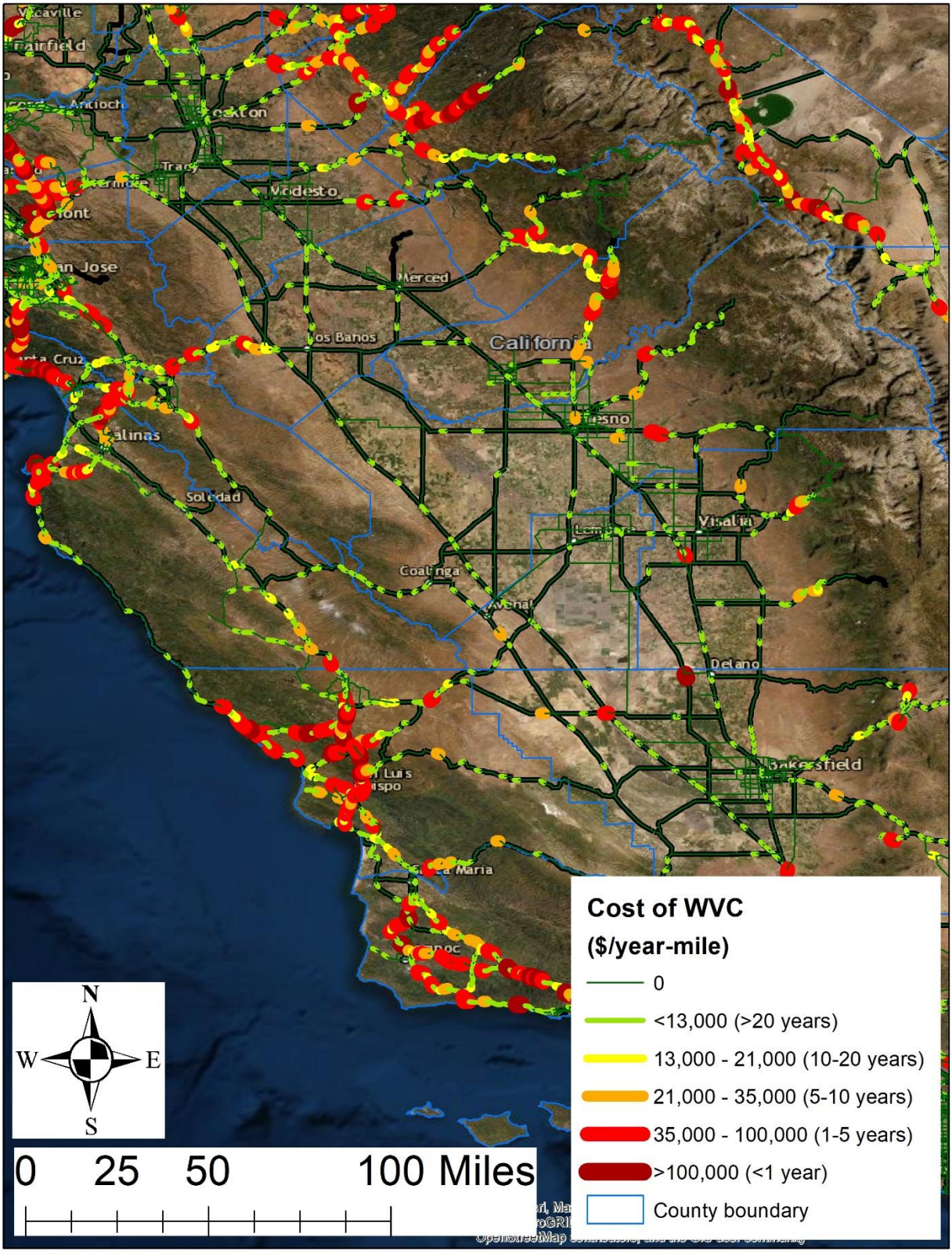
B) Bay Area


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

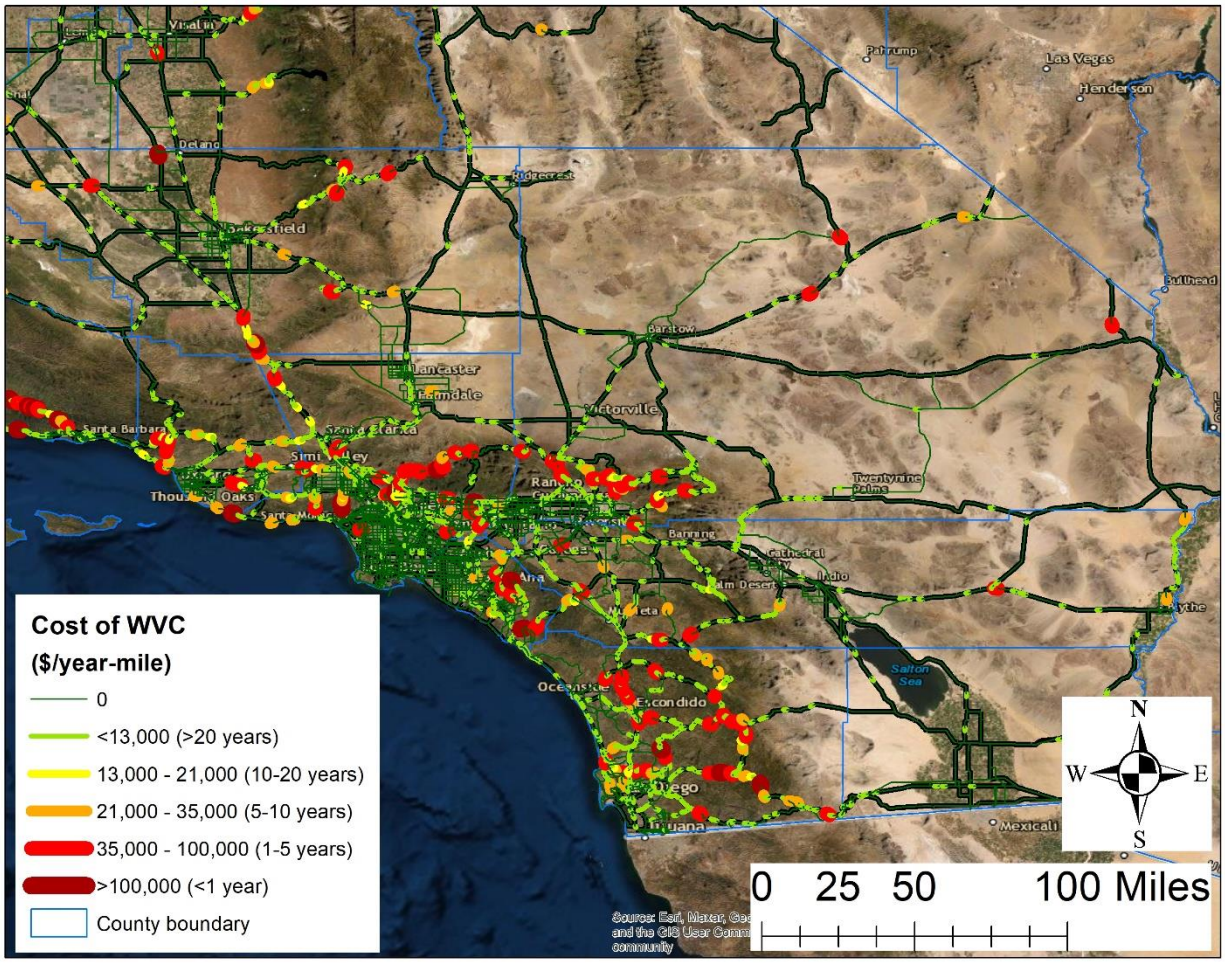
C) Sierra Nevada



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.