Roadkill, a Preventable Natural Disaster

Photo credit: Sally Gale

2024

"…the evidence for [wildlife] population-level effects of roads and traffic is already strong enough to merit routine consideration of mitigation of these effects in all road construction and maintenance projects….." – **Rytwinski and Fahrig, 2009**

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Executive Summary: Roadkill, a Preventable Natural Disaster

This report marks the 11th year we have been providing a statewide overview of wildlife-vehicle conflict (WVC) in California, including collisions with small and large animals. As usual, in this report we highlight WVC hotspots on California highways based on a combination of >52,660 traffic incidents involving wildlife that were recorded by the CHP (primarily mule deer) and >162,000 carcass observations reported to the California Roadkill Observation System (CROS, https://wildlifecrossing.net/california) and other roadkill reporting systems, between 2009 and 2023, inclusive. **The primary message of this report is that WVC is a damaging and preventable natural disaster for the state's wildlife and drivers.**

In this report we highlight two specific problems occurring at the local and statewide scale. Both are indicative of larger roadkill impacts that are likely to affect California's wildlife. The first is a rapid decline in the rate of newt roadkill on Alma Bridge Rd in Santa Clara County, a road adjacent to Lexington Reservoir. Every year thousands of Pacific newts die while trying to cross the road and reproduce in the reservoir. The rate of roadkill has declined by almost half in the last 6 years, suggesting that the population may also be declining at that rate. The other problem is the total number of mule deer killed every year by WVC in California. We calculated that 48,442 deer are killed every year, representing over 10% of an estimated 475,000 deer in the state (WAFWA, 2023). **This excess deer mortality on roads may explain the continuing decline of deer in California.**

Using observations of reported traffic incidents and carcasses we estimate the total economic cost of reported (large) wildlife-vehicle collisions in California for 2016 to 2023, inclusive to be > $1.64 billion. which could have been reduced by >$200,000/mile over the last eight years by installing fencing on 669 1-mile highway segments. There were also 627 statistically-significant hotspots, appropriate for constructing wildlife crossings and fencing combinations. We highlight and give kudos for the dramatic increase in wildlife fencing and crossing planning that the state has engaged in the last 2 years. **Fencing remains the only way to reduce WVC at the state scale.**

Data Sharing/Collaboration: We frequently receive data requests from transportation and environmental planners, fish and wildlife scientists, academic faculty, students, and non-governmental organizations. With funding from the Wildlife Conservation Network, we will be releasing a web-system that allows users to define project areas and collect our data (and other data) for project planning purposes. Our crowd-sourcing approach depends on constant data contributions and our California Roadkill Observation System app supports "one-click" reporting (https://wildlifecrossing.net/california) with a smartphone. **We will continue to share data freely with organizations and agencies that also share data freely.**

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Other Contributors:

Winston Vickers (UC Davis). Hundreds of CHP officers, Caltrans Maintenance staff, and state and federal fish and wildlife agency staff.

Contents

Pacific Newt (Photo credit: Richard James)

Top 5 Talking Points

1. **Wildlife-vehicle collisions continues to be an under-recognized and under-reported threat to wildlife populations and drivers and is preventable with fencing.** Even common species like mule deer may be experiencing unsustainable levels of mortality from traffic. In addition, WVC continues to be costly to the State (>$200 million/year) and occurs in identifiable "hotspots". This type of safety issue for the driving public is preventable with adequate fencing. The recent death of a mountain lion near the Wallis-Annenberg crossing clearly points to the need for fencing along highways, not just crossings. Wildlife crossings don't prevent roadkilled mountain lions, fencing does.
2. **Wildlife populations are in local and statewide decline and traffic is (partly) to blame.** Although California does not track the size of most wildlife populations, measuring rates of roadkill provides insight into the impact of WVC on population trends of easy-to-monitor species (e.g., mule deer). The rate at which mule deer are dying from traffic (48,442 in 2023) represents >10% of the population per year, at the same time the population is declining, possibly because of vehicle-strikes. In what may be the largest population in the state, Pacific newts are dying from roadkill at a rapidly declining rate, suggesting that the population is also declining quickly.
3. **Roadkill is a preventable natural disaster.** One comment we often get in regards to suggesting that public agencies act more quickly and thoroughly on wildlife fencing and crossings is that transportation projects take time. That may be true for non-emergency situations, but when a road is flooded, fails in a landslide, or is otherwise damaged by a natural disaster, state and local agencies act immediately. To avert growing catastrophes, such as for the Pacific newts on Alma Bridge Road in Santa Clara County, we should require the same rapid response when the natural disaster is happening to wildlife on the road due to traffic.
4. **The increase in state and federal legislative, public, and agency support for wildlife crossing and fencing projects may help to reduce WVC.** In the past seven reports we highlighted the massive ecological debt that is accumulating because of un-mitigated traffic impacts on wildlife. In the 2022-23 session, California legislators approved close to $1 billion in new funding to help us catch up to other states and build wildlife fencing and over and under-passes (hopefully its not taken back because of the budget deficit). Ecological champions in Caltrans and the Wildlife Conservation Board are already taking advantage of this opportunity. In the last 4 years, the WCB has allocated almost $100 million for wildlife crossing planning projects.
5. **We can all help the State systematically collect and share data.** California agencies should be encouraged to collect and share data about WVC and wildlife connectivity to help inform decision-making about this important conservation and safety problem. Recently, we at the Road Ecology Center, with partner organizations, have tried to access CDFW wildlife data for the purposes of planning wildlife crossings in CDFW Priority Barrier areas, with state (WCB) funds. It took 6 months to receive one small dataset and we are still waiting for others. New statutory requirements are needed to push state agencies to share data for conservation and other scientific purposes. Recent legislation (AB2344) requires greater attention to safe passage for wildlife across highways in California, but so far that statute has not been supported by requirements for data collection and use. To overcome data gaps in wildlife-vehicle collisions, we urge all Californians to collect roadkill data using this web-app: https://wildlifecrossing.net/california, which not only support research efforts but are also used to support building wildlife crossings.

Introduction to Study

Wildlife need to move, but transportation and other linear infrastructure are barriers to this movement. Vehicular traffic often deters wildlife from crossing roads, impeding their ability to find food, water, mates and respond to extreme weather events, exacerbated by climate change. But vehicle traffic can completely arrest wildlife movement when wildlife are struck by vehicles in their attempt to cross roads, contributing to reduced genetic diversity because dead wildlife don't move into new populations and reproduce, improving gene pools. Mortality can be reduced with wildlife fencing; wildlife crossings (culverts and bridges) improve connectivity, but by themselves don't reduce mortality. In other words, reducing wildlife mortality by traffic is only accomplished with fencing, with or without associated crossings. Rates of mortality can be high enough for many species to affect population size (Fahrig and Rytwinski, 2009), especially larger, more mobile species (Rytwinski and Fahrig, 2011), and for certain species make them regionally threatened or extirpated (for example, for mountain lions in Southern California). Measuring rates of wildlife-vehicle conflict (WVC) is important for identifying locations and consequences of the conflict for wildlife populations and the driving public. With climate change and destructive land-use patterns, California's wildlife are under increasing pressure. WVC adds to this pressure, contributing to the decline of many wildlife species.

Using data on traffic incidents and roadkill observations in California, we have mapped stretches of ~15,000 miles of California state highways that are likely to be continuing hotspots for WVC. Animals entering roadways are often killed and pose a hazard to drivers, who may collide with the animal, or swerve 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 throughout the food web. In addition, animals are injured during collisions, which is damaging to the animal and 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 measures to protect drivers and wildlife populations. Measures with proven effectiveness include 1) building fencing and over/under-passes along priority (i.e., high WVC) 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 solutions to WVC, beyond that required for mitigation of transportation projects. To provide agencies information to aid their decisions, we collate CHP and volunteer-collected data, including >5,000 reported crashes per year on California highways involving deer and other large wildlife. Our data 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

In the fifteen years of the California Roadkill Observation System (CROS, https://wildlifecrossing.net/california), members of the public, agencies, and others have contributed ~200,000 observations of wild animal carcasses on local roads and state highways to various roadkill reporting systems, primarily through CROS (Figure 1). These are not the total roadkill that occurred, just the ones that expert observers saw and reported. The amphibian

reports include a large dataset of observations collected by volunteers, of thousands of Pacific newts killed every year while migrating across Alma Bridge Road in Santa Clara Co. each winter. For certain species (e.g., mountain lions), reported observations may constitute a healthy percentage of the total mortality on roads. For other species, the observations may be far less than 1% of the total killed by traffic.

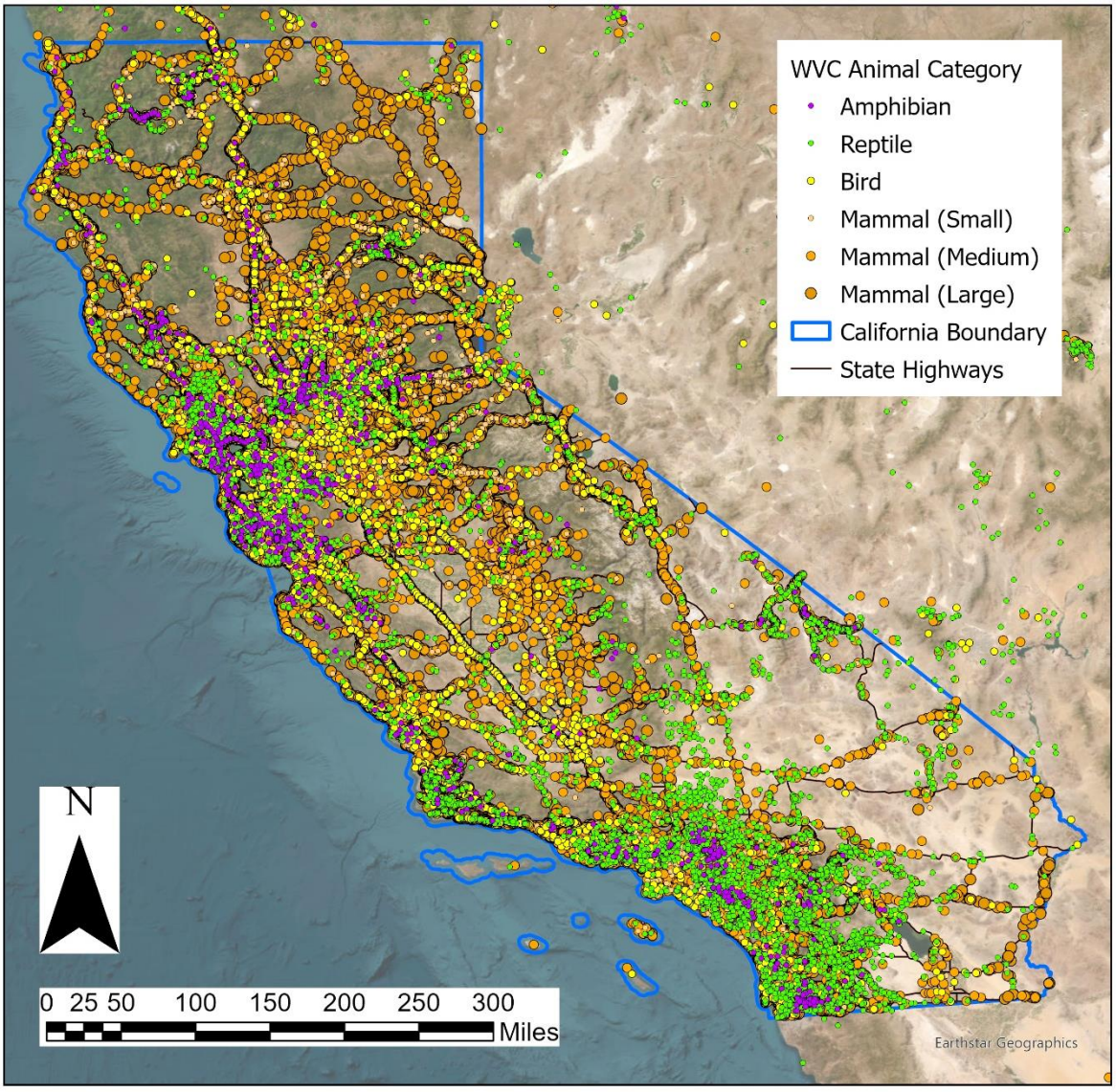

Figure 1. California wildlife-vehicle collision observations reported to various roadkill reporting systems, primarily CROS (https://wildlifecrossing.net/california).

Newt Roadkill: A Preventable Natural Disaster

[see Appendix for more information]

Since the winter of 2016-2017, volunteer scientists have been reporting roadkilled and live California newts (*Taricha torosa*) and rough-skinned newts (*Taricha granulosa*) on Alma Bridge Road. The newts are killed while attempting to go between their home on the upland forest floor and Lexington Reservoir where they can reproduce. Dozens of volunteers go out every winter and count all live and dead newts they encounter. They photo-record each one.

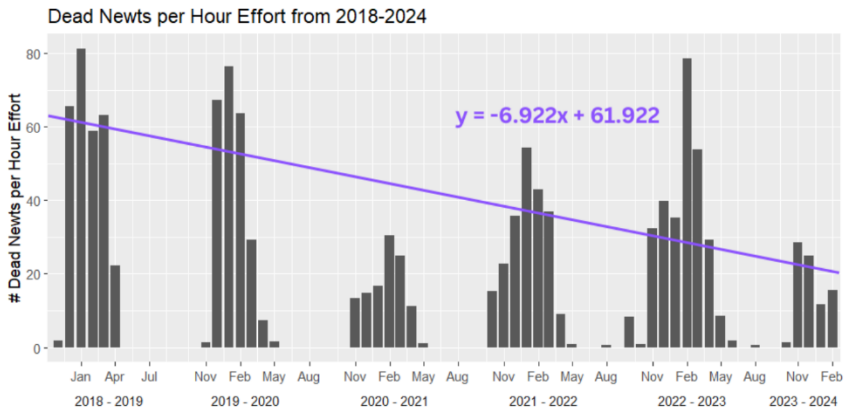

Figure 2. Trend in Pacific newt roadkill on Alma Bridge Rd, 2018 and 2024.

The number of roadkilled newts per hour of volunteer effort has been significantly declining at a rate of ~10%/year since 2018 (Figure 2, P=0.045). At the same time, there has been no statistically-significant trend in traffic or precipitation, both of which can influence newt roadkill rates. In most systems, absent changes in environmental influences and traffic, a decline in roadkill indicates a proportional decline in the size of the animal population.

Local scientists, the US Geological Survey and the Road Ecology Center tried between 2018 and 2020 to initiate a fix for this ongoing problem. Santa Clara County started a planning process in 2022, involving consultant biologists and engineers. This process is ongoing and is coming up with alternative mitigations for the continuing, but declining roadkill.

The Alternative 4 mitigation action is shown and would include 6,390 feet of elevated road in 3 sections. (Figure 3). If fully implemented, this alternative would prevent about 70% of road mortality, leaving thousands of newts to die on the road. Other roadkill-reducing approaches that have been successfully used in other areas include: 1) reducing travel from highway 17 traffic spill-over, 2) moving recreational uses and traffic away from the hotspots; and 3) closing the road to non-residential traffic during newt-crossing times. It seems likely that an elevated road that encompasses all of the roadkill areas, or Alternative 4 combined with traffic control could help save the newts from a natural disaster.

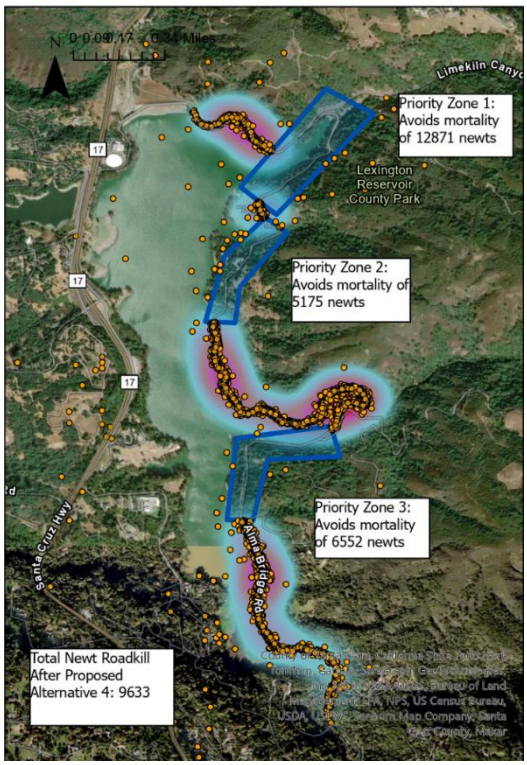

Figure 3. locations of newt roadkill hotspots and Alternative 4 mitigation actions (blue boxes). For more information: https://storymaps.arcgis.com/stories/a423a0810f384a3d890754e4b9d2bcf6

Impacts to Mule Deer

More than 50,000 WVC involving large mammals across California were reported to the CHP or through CROS during 2016-2023, inclusive. However, these data do not reflect all large mammal WVC occurrences 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 (Donaldson 2008), meaning that at least 22,000 and up to >100,000 deer/annually could be hit by vehicles in California on all roadways.

For the first time in California we have used collision data between 2016-2023 to estimate the number of mule deer annually killed on all California paved roads. We used rates of collisions on highways/roadways with frequent reporting and used these to estimate the rates on roads and highways that were similar (in terms of traffic and location). We corrected observation rates using the rate at which carcasses disappear and the frequency of reporting.

We estimate that 48,442 mule deer were killed by vehicles in 2023 on California roads and highways. This is the first scientific calculation of the number of individuals of a species killed by traffic in an area the size of California. This number is over 2 times the rate at which deer were killed by hunting in 2019 (21,333, CDFW, 2019) and >10% of the 475,000 mule deer estimated to be in California (WAFWA, 2023). Previous research and reviews have suggested that natural loss due to predation of mule deer is in the single digit percents and that habitat loss, especially winter range, is the primary cause of mule deer declines (Bergman et al., 2015). Habitat loss from development is usually accompanied by traffic.

Mule deer mortality on US 395, photo courtesy Bartshe Miller

Impacts to Mountain Lions

Like most species at the top of the food web, mountain lions are especially vulnerable to WVC because they have large home ranges and can move several miles per day across the landscape, thus encountering numerous roads among their movements. Mountain lions are important ecologically because they are a keystone predator, the only large, widespread predator in most California ecosystems, and have been proposed for listing in southern California and the Central Coast under the California Endangered Species Act (Center for Biological Diversity, 2019). They are also important socially, with great interest in their well-being in Southern California and Bay Area urban regions.

A critical problem for mountain lions and other wildlife 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. There is no way of knowing the actual WVC impact to these important and charismatic species. Between 2016 and 2023, inclusive, 613 mountain lions were killed on roads, as reported by a combination of CROS volunteers, CHP, CDFW, and biologists in Southern California (Figure 4). Duplicates records were carefully removed prior to analysis. These were incidental reports and **do not represent all mountain lions killed** on the state's roads and highways.

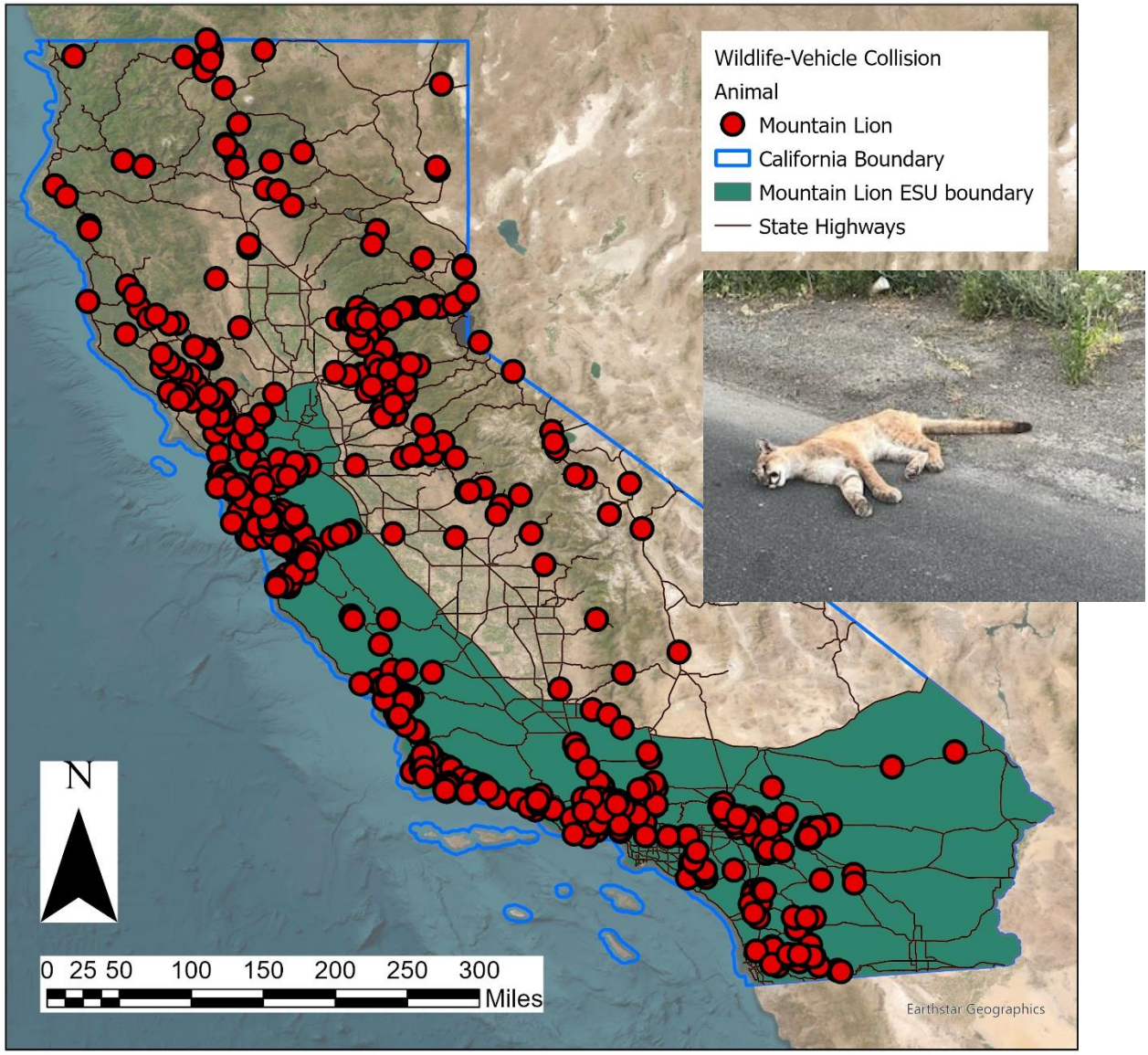

Figure 4. Locations of mountain lion mortality on roads, overlaid on the area of the state where mountain lion are proposed for listing as threatened. ESU map courtesy Center for Biological Diversity. Photo courtesy Santa Clara Valley Open Space Authority.

Locations of WVC Hotspots

Two ways to identify hotspots of WVC include: 1) density of WVC for all wildlife, or for classes of wildlife (e.g., large mammals) along roadways, and 2) statistically-significant clusters of WVC. Both methods have utility when trying to characterize threats and consequences of WVC, and plan mitigation of WVC. We use the number of large, wild mammals killed per mile per year as one indicator of WVC density. The reporting of this type of WVC is fairly consistent across the State, despite under-reporting. The consistency comes from CHP officers responding to crashes with wildlife and animal carcasses in roadways. This allows us to compare WVC rates across different parts of the state. Finally, if locations of high WVC density occur consistently, they may result in statistically-significant clusters on highways, suggesting these as defined areas to apply mitigation measures.

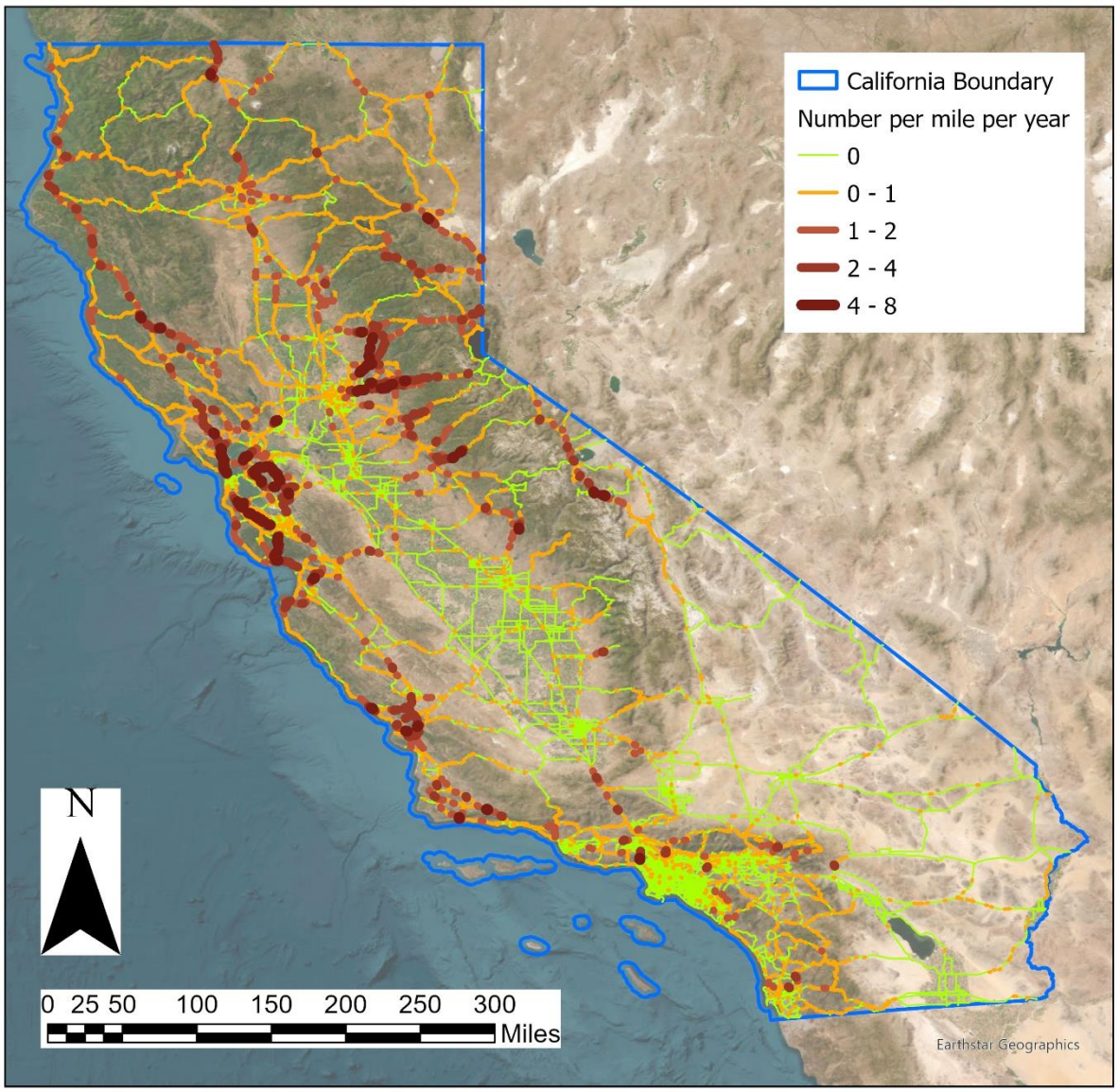

Figure 5. Annual density of large-mammal WVC per mile of state highway.

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 5), 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 627 statistically-significant clusters ($P<0.05$) throughout California, where clusters were usually in the same places as high densities of WVC. This suggests that mitigation actions here (fencing plus crossing structure) could cost-effectively reduce WVC. We also found 1,368 miles where costly crashes were occurring (>$13,000/mile-year), meaning that fencing these highway segments would pay for itself in reduced costs associated with crashes.

Special Case: Costliest Regions for WVC on Highways in California

One of the more common questions for studies like this is "where are the worst places in California for roadkill?" One way to answer that is using the cost of WVC to society. The highways with the consistently highest rate and cost of WVC per mile in any given year in the last eight have included I-680 in Contra Costa and Alameda Counties and I-280 on the San Francisco Peninsula. Others on the highest cost list include US 101 in Marin County, US 50 in Eldorado County, SR17 in Santa Cruz County, and SR 49 in Placer/Nevada County.

The total costs of WVC can also be summarized by region (Table 1). The regions are different sizes, but the total WVC cost can help inform planning for future mitigation, especially fencing, to reduce crash costs to society, as well as to wildlife. The San Francisco Bay Area has had the highest preventable costs from collisions with large wildlife (>$21 million/year), possibly because it has high-traffic highways next to large areas of protected habitat without fencing.

Table 1. Regional WVC hotspots and costs on state highways.

Region	Average Cost ($/year)	Total Cost ($, 2016-2023)	Total Large Wild Mammals **Reported** Killed (2016-2023)
San Francisco Bay Area (Solano, Napa, Sonoma, Marin, Contra Costa, Alameda, San Francisco, San Mateo, Santa Clara)	21,463,596	193,172,364	7,704
Northern California mountains (Del Norte, Humboldt, Mendocino, Siskiyou, Modoc, Lassen, Shasta, Tehama, Butte, Plumas, Sierra)	19,676,586	177,089,275	7,791
Sierra Nevada foothills (Nevada, Placer, Eldorado, Almador, Calaveras, Tuolumne)	13,725,770	123,531,926	5,933
Southern California (Ventura, Los Angeles, Orange, San Diego, San Bernadino, Riverside, Imperial)	7,564,185	68,077,661	3,031
Central Coast (Monterey, San Benito, San Luis Obispo, Santa Barbara)	7,443,405	66,990,646	3,523

New State Support for Restoring Wildlife Movement

In the 2022-23 legislative session (2022-23), the Safe Roads and Wildlife Protection Act allocated funding over several years to the Wildlife Conservation Board (WCB), CDFW, and Caltrans to plan and build new wildlife crossings. This is a remarkable turn-around by the state and has allowed California to jump to the top tier of states working to reduce the impact of traffic and roadways on wildlife and improve connectivity. Twenty-three WCB-funded projects worth >$85 million have primarily been located within CDFW wildlife movement priority barriers (CDFW 2020, 2022). These projects are shown in Figure 6 and are taking place in many areas of the state and to benefit many native wildlife. As these projects are implemented and result in new fencing (and crossings), it will be possible to estimate the total benefit in reduced wildlife mortality and increased connectivity.

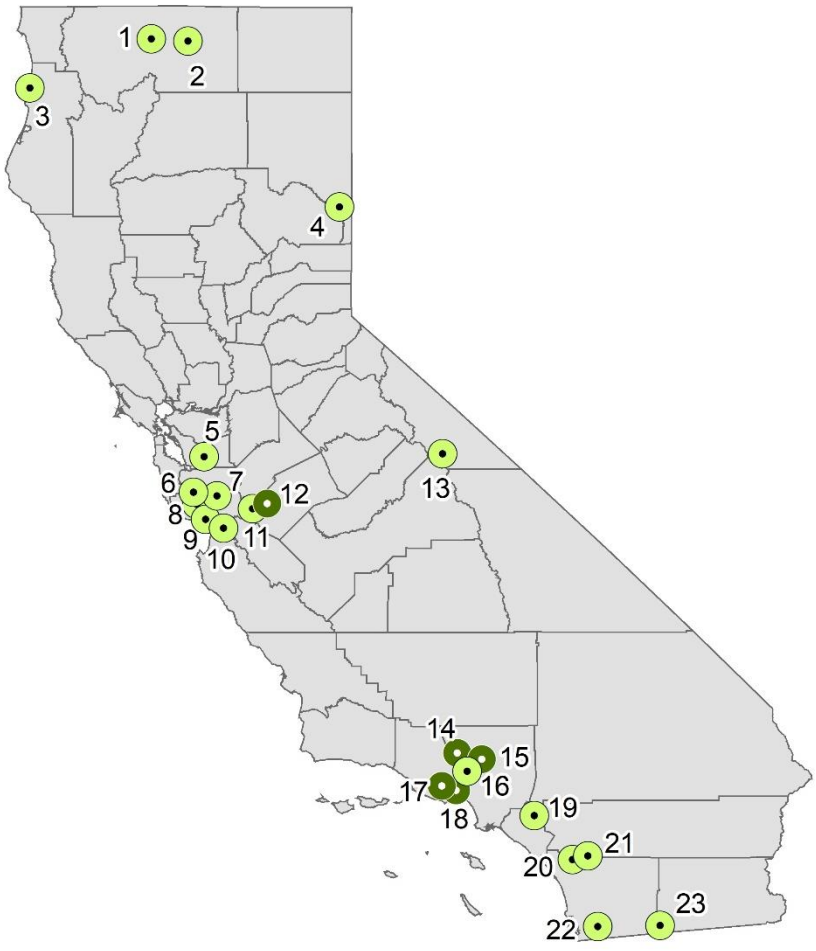

Figure 6. Locations of WCB-funded wildlife connectivity and crossing planning projects. Map courtesy Don Crocker, Wildlife Conservation Board.

Table 2. Project numbers and names of WCB-funded wildlife crossing and connectivity planning projects. Numbers are the same as in Figure 6. Table courtesy Don Crocker, Wildlife Conservation Board.

PROJECT	NAME	BOARD APPROVAL
1	Siskiyou I-5 Wildlife Overpass	February 2024
2	State Route 97 Wildlife Migratory Corridor	August 2021
3	Stone Lagoon Wildlife Connectivity	February 2021
4	United States Highway 395 Wildlife Overpass	August 2023
5	Restoring Connectivity for East Bay Ranges	August 2023
6	Highway 17 Crossings Planning and Design	February 2021
7	Coyote Valley Wildlife Connectivity	November 2023
8	Alma Bridge Road Newt Passage Designs	November 2023
9	Santa Cruz Long-toed Salamander Connectivity	February 2020
10	San Benito County US-101 Wildlife Crossing	November 2023
11	Pacheco Pass Wildlife Overcrossing	February 2022
12	SR-152 at Pacheco Creek Wildlife Connectivity and Corridor Enhancement	February 2021
13	Mammoth 395 Wildlife Crossing	November 2022
14	Agua Dulce Creek SR 14 Wildlife Undercrossing	May 2021
15	Marple Canyon Wildlife Crossing Enhancement	February 2020
16	Newhall Pass I-5 Wildlife Crossing Design	November 2022
17	Liberty Canyon Wildlife Underpass	August 2019
18	Wallis Annenberg Wildlife Crossing	August 2020
19	State Route 91 B Canyon Wildlife Crossing	August 2022
20	Santa Ana to Palomar Mountains Linkage	May 2020
21	Rainbow Canyon Wildlife Crossing	August 2021
22	State Route 94 Wildlife Corridor,	May 2021
23	I-8 Peninsular Bighorn Sheep Crossing	August 2023

Authored In the current session by assemblymember Laura Friedman, the Room to Roam Act (A.B. 1889) requires city and county governments to consider and implement measures to protect wildlife connectivity as part of their general planning. There have been previous efforts to include wildlife connectivity in general planning, most notably Eldorado County's General Plan Update 2010, to which Road Ecology Center director Shilling contributed. However, actions by counties such as Eldorado, Ventura, and Los Angeles have been discretionary and lacked a state mandate. Friedman's bill makes a big step forward in regulatory protection of protecting wildlife populations from excess mortality on roads and to be able to roam freely.

AB 2344 (2022) was an important first step in increasing the requirement for and rate of projects to reduce the impact of traffic on wildlife and its co-authors and supporters should be

applauded. As happens during the passage of many bills, during the last days of passing AB 2344, the bill was weakened, reducing the requirement for a certain amount of activity by Caltrans and local transportation agencies to mitigate the legacy and continuing impacts of traffic on wildlife. Legislation is still needed that: 1) protects wildlife movement by requiring retrofit of ALL 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 fast enough to prevent local extinctions and restore wildlife populations where they have been impacted by past infrastructure.

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 trends in roadkill rates and thus health of iconic wildlife species (e.g., mule deer), successful methods for monitoring WVC in California, the areas of most frequent WVC statewide; and costs of WVC to wildlife and drivers and the general public.

In terms of wildlife mortality on state highways and major roads, the Road Ecology Center has some knowledge about where the greatest impacts to wildlife are occurring. We also can make educated guesses about the impact this mortality is having on iconic, special-status, and common species in California. However, going forward, we need greater investment in data collection (the California Roadkill Observation System, Caltrans Maintenance, County Animal Services data collection), data sharing by state agencies, data analysis, estimation of the impact of roadkill on wildlife populations, use of this information in decision-making, and maintenance of regular funding to support construction and maintenance of wildlife fencing and crossings.

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 analytical methods and one-click roadkill 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 (https://wildlifecrossingcalculator.org). Thanks to the concerted and coordinated efforts of thousands of volunteer roadkill observers over the last 14 years who contribute to CROS and parallel systems, as well as similar efforts by CHP, CDFW, Caltrans and other agency staff to report on WVC. Through their endeavors, they have so far (6/2024) collected >200,000 observations of >400 species, representing the largest roadkill reporting system of its kind in the US and one of the largest and most comprehensive wildlife monitoring programs in California and the US. The accuracy rate of volunteer-observers 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). Finally, we thank several expert peer reviewers for their insightful comments and critiques.

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: Roadkill Contributes to Pacific Newt Population Crash in Santa Clara County

2024

Roadkill Contributes to Pacific Newt Population Crash in Santa Clara County

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"Thousands of newts each year, dead on the road, before they reach their destination: the mating habitats on the other side of the road."

Executive Summary

Thousands of Pacific newts are observed dead on Alma Bridge Road each year. While these observations have been declining at a statistically significant rate, it is not due to a change in traffic, precipitation, or survey efforts. The decline in mortality observations is signaling that the Pacific newt populations surrounding the Lexington Reservoir is drastically declining as well. Some studies suggest that the populations are at risk of extirpation within the next 50 years (H. T. Harvey & Associates 2021).

Midpeninsula Regional Open Space District and Santa Clara County are currently collaborating with AECOM on the Alma Bridge Road Newt Passage Project to design and implement structures that would alleviate newt mortality due to vehicle collisions. While planning is taking place, the problem of thousands of roadkilled newts continues, leaving the populations of Pacific newts at risk of extirpation. The planning efforts underway may be considering mitigation cost as a higher priority than fate of the newt population. This prioritization risks allocation of resources to a failing project if Pacific newt mortality is not decreased enough for population stabilization.

Rough-skinned newt in defensive pose, revealing its bright underbelly. Many dead newts on Alma Bridge road are found in a variation of this pose as newts assume this pose when they feel threatened. (Photo credits: Brome McCreary)
(Cover photo credits: Robin Loznak/Alamy)

It is essential to both the Pacific newt populations and the concerned public that the Alma Bridge Road project is a success. Allocating necessary funds now to ensure the stabilization of the Pacific newt populations surrounding the Lexington Reservoir would prevent future projects that could arise if the populations continue to crash due to ineffective mitigation efforts.

Authors

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Introduction to Study

Roads and land development can be major barriers for wildlife movement and connectivity. The ability of wildlife to freely move is critical to their adaptation to changing climatic, vegetation, and disturbance conditions. Pacific newts (*Taricha*), which includes the California (*T. torosa*) and Rough-skinned newts (*T. granulosa*), migrate seasonally from moist upland forest/shrub habitat (summer) to ponds, streams, or reservoirs/lakes (winter) to mate. These species are thought to be long-lived and repeatedly return to the same areas to mate. Movement is typically throughout the winter and may be triggered by first and early rains.

Rough-skinned newt. (Photo credits: Kim Cabrera)

The California newt is a Species of Special Concern in California. It is vulnerable to drought, predation by invasive crayfish, poisoning by cyanobacteria blooms, and other environmental hazards. In its 20+ year adult stage it is an intrepid migrator, moving from upland habitat to ponds and lakes to reproduce. During this migration, it is especially vulnerable to traffic, having no natural knowledge of, or adaptation to vehicles. Rough-skinned newts are more widespread, ranging from Alaska to Santa Cruz County, its southern-most home. They

are vulnerable locally to many of the same threats as California newts, including to traffic when migrating to reproduce.

Alma Bridge Road in Santa Clara County bisects the summer and winter habitats of populations of Pacific newts surrounding the Lexington Reservoir. These newts must cross the road during their migration between habitats multiple times in their lifetime both as a juvenile and as a breeding adult. The traffic on this road from local residents, recreational activities, and highway 17 commuters skirting clogged traffic, results in thousands of newts being killed each year during the migration season.

Dead Pacific newt on Alma Bridge Road. (Photo credits: motherpurina via iNaturalist (2024))

Between the 2018-19 and 2023-24 winters, over 34,000 Pacific newts have been recorded as roadkill on Alma Bridge Road. Studies prompted from the thousands of mortality observations estimated that 40% of the adult California newts attempting to cross the road for breeding are killed (H. T. Harvey & Associates 2021). Using the Gibbs and Shriver (2005) population model, applying this mortality rate, the California newt population surrounding the Lexington Reservoir could be extirpated within 50 years (H. T. Harvey & Associates 2021). Newt mortality must be reduced in order for this population of Pacific newts to survive. With the 2023-2024 migration season coming to an end, the latest surveys suggest that mortality trends indicate that the Pacific newt population is crashing, suggesting the need for immediate mitigation efforts.


Dead Pacific newt on Alma Bridge road recorded by volunteer. (Picture credit: anudibranchmom via iNaturalist (2024))

Monitoring methods

Volunteers of the Lexington Reservoir Newt Patrol conduct surveys yearly on the Alma Bridge Road. Surveys coincide with the migration of newts to and from breeding sites. This is the most intensive

roadkill monitoring project in California. They begin at the start of the rainy season, around mid-November, and last through April or May. Volunteers walk along either side of a 4.1 mile stretch of Alma Bridge Road looking for Pacific newts both alive and dead. When a newt is found, a picture is taken, and GPS coordinates are recorded. If able to, volunteers also record which species of Pacific newt is found and if the individual is a juvenile or adult. Total number of surveys, hours spent surveying, and miles traveled surveying are also recorded to quantify effort. Vehicle traffic along the road and additional roadkill are also tracked during surveys. Survey data is uploaded and managed through iNaturalist (Pacific Newt Roadkill project page).

Spatial Distribution of Mortality

Figure 1 shows a satellite view of Alma Bridge Road overlaid with dead Pacific newt observations and mortality hotspots for all observations recorded from 2018 to 2024. The mortality hotspot maps reveal three key areas of recurring newt mortality: the hairpin curve on the northeast section of the road, the smaller hairpin curve on the upper section of the road, and the south end of the hairpin curve on the lower half of the road.

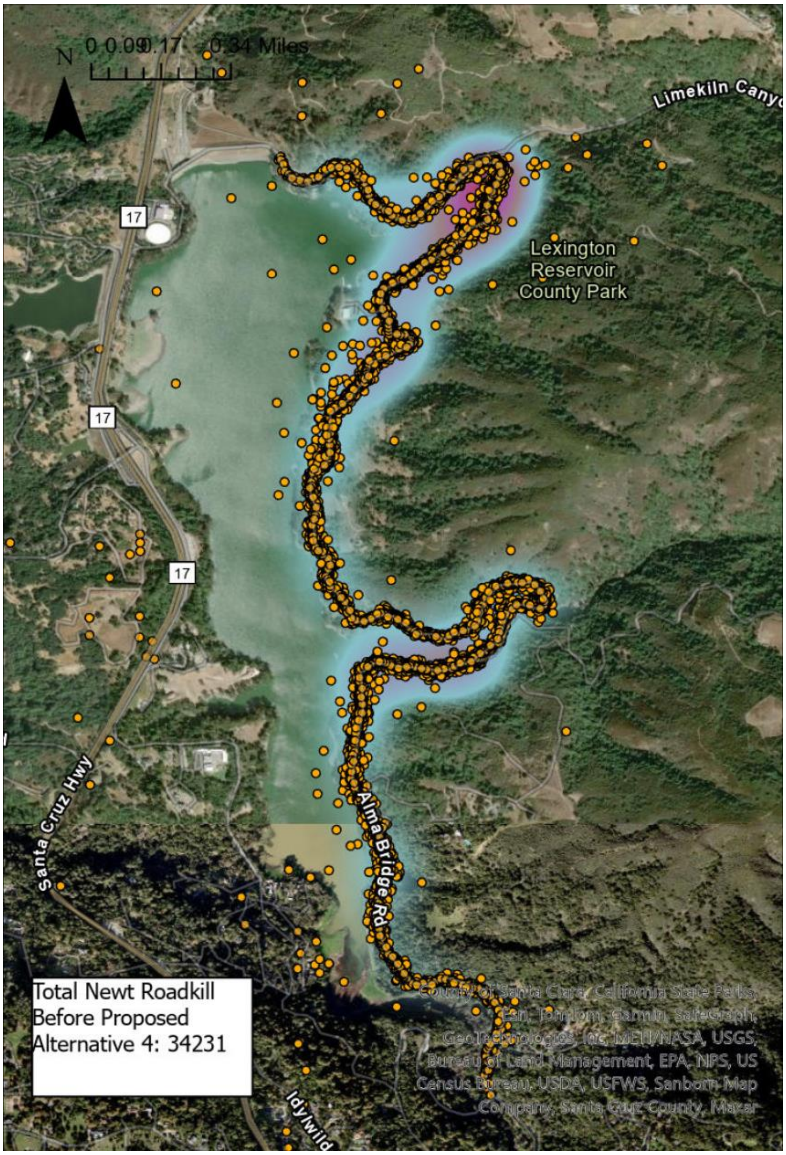

Figure 1. Satellite image of Alma Bridge Road overlaid with newt roadkill observations and resulting mortality hotspots for all observations recorded between 2018 and 2024. The yellow-orange circles represent individual newt roadkill observations retrieved from the iNaturalist Pacific Newt Roadkill database. The mortality hotspot overlay shows a gradient of mortality with areas of lowest mortality represented with cooler blue tones and areas of highest mortality represented by warm pink tones.

The Pacific Newt Roadkill Project: Lexington Reservoir StoryMap, prepared by Madison Morgan of the UC Davis Road Ecology Center, shows the spatial distribution of dead newt observations

and mortality over the years of surveys. The same three mortality hotspots are prominent every survey season signaling that all 3 of these areas of Alma Bridge Road should be the focus of conservation efforts as they are where the mortality of newts are concentrated. However, 30% of newts are killed outside these areas, representing thousands of dead newts.

Analysis of Newt Roadkill Trends

Volunteers completing newt surveys on Alma Bridge Road expressed that their observations of newt roadkill seem to be declining and asked us to test their assumption. A simple linear regression (SLR) was performed between total newt carcasses observed in a survey season and survey season. The total newt carcasses observed in a survey season were divided by total hours of surveying during the respective survey season to control for differing effort across survey seasons. The SLR showed that there is a statistically significant decline in dead newts recorded across the survey seasons (Figure 2) (p-value =0.04821).

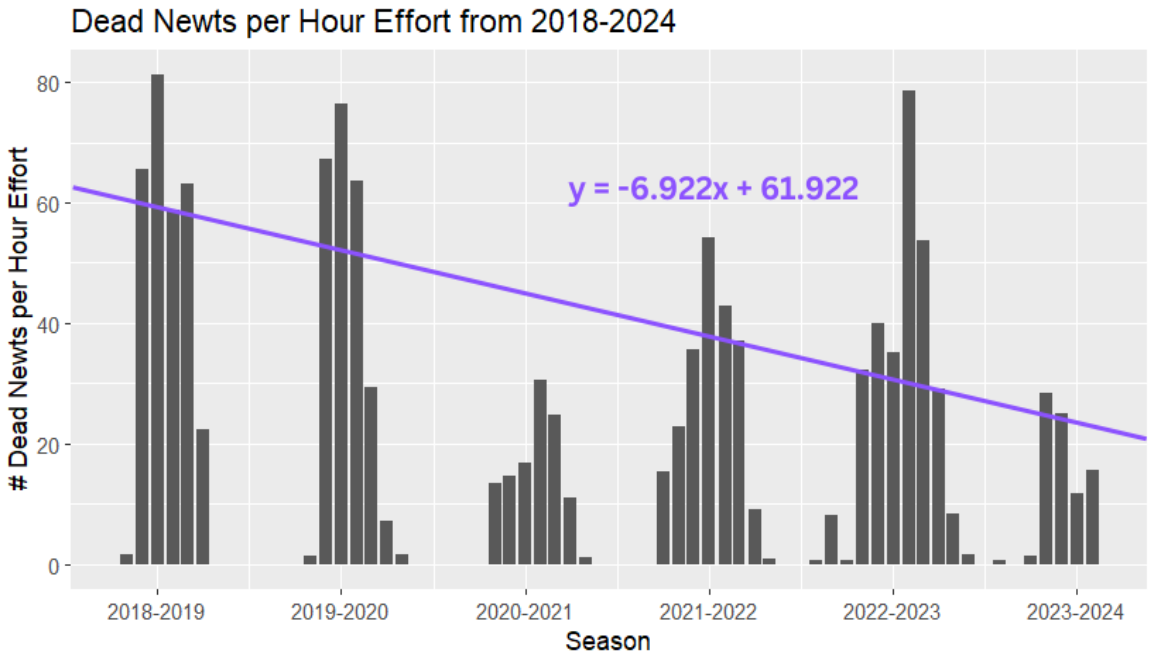

Figure 2. Number of total dead newt observations each month of a survey season divided by total hours spent surveying during the respective month over survey seasons. The trendline shows a negative correlation between number of dead newts observed and survey season. This negative correlation was found to be statistically significant.

SLRs were also completed for: 1. Traffic rates versus survey season; 2. Total newt carcasses divided by total hours of effort in the respective survey season versus traffic rates; and 3. Total newt carcasses divided by total hours of effort in the respective survey season versus precipitation. Multiple linear regressions (MLRs) were performed for: 1. Total newt carcasses

divided by total hours of effort in the respective survey season versus survey season and traffic 2. Total newt carcasses divided by total hours of effort in the respective survey season versus year and precipitation 3. Total newt carcasses divided by total hours of effort in the respective survey season versus year, traffic, and precipitation and 4. Total newt carcasses divided by total hours of effort in the respective survey season versus traffic and precipitation. None of these SLRs or MLRs were statistically significant indicating that the number of total newt carcasses divided by total hours of effort in the respective survey season was not influenced by year, traffic rates, average precipitation, or any combination of these three variables[1].

Discussion of Analysis

The number of Pacific newts being killed on Alma Bridge Road each year due to traffic is declining, but it is not due to a change in traffic rates, precipitation, or survey effort. Declining dead newt observations can then be attributed to less newts migrating across the road. Alma Bridge Road has been an active roadway for over 50 years (News-Press 2024). The rainy-season newt massacre has been happening much longer than the survey efforts to record it. Newt populations can show little response to sustained road mortality, due to other life-stage factors such as larval competition, until a particular threshold is crossed. Once the threshold is crossed, a rapid decline in populations can be seen as the populations speeds towards extirpation (Gibbs and Shriver 2005). The significant decrease in newt roadkill observations on Alma Bridge Road could be signaling the beginning of the end for the Pacific newt populations surrounding the Lexington Reservoir. It is imperative that mitigation efforts beyond the newt crossing signs that have already been erected be implemented. The fate of the populations depends on it.

Newt crossing sign on Alma Bridge Road. There is no evidence that warning signs such as this change rates of roadkill. (Photo credits: Brian Phan)

[1] All SLRs and MLRs that used traffic rates excluded the 2018-2019 survey season due to insufficient traffic data.

Alma Bridge Road Newt Passage Project

At the time of this report, AECOM, an infrastructure consulting firm, is partnering with Midpeninsula Regional Open Space District and Santa Clara County to complete the Alma Bridge Road Newt Passage Project (Midpeninsula Regional Open Space District 2024). The project is currently in Phase II where AECOM is starting the process of finalizing an infrastructure plan (Anderson and Hirst 2023).

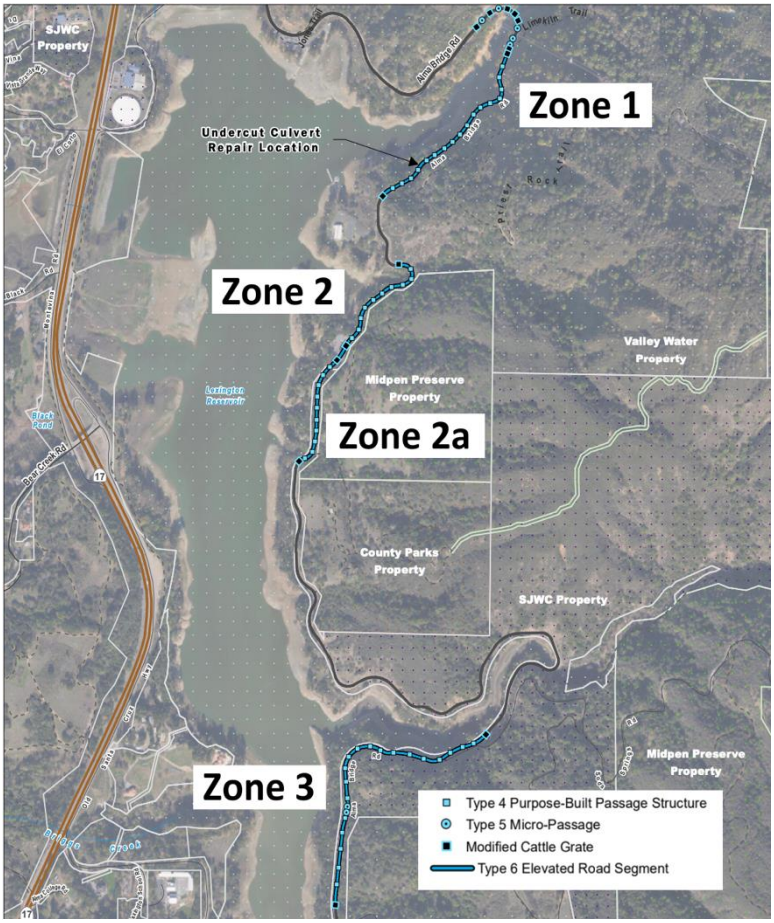

Figure 3. Proposed Alternative 4 for the Alma Bridge Road Newt Passage project (adapted from AECOM (2023)).

The advancement of the Alma Bridge Road Newt Passage Project seems to prioritize cost over effectiveness in reducing newt mortality. In Phase I of the project, the alternative that AECOM found would most effectively decrease newt mortality was not recommended due to its estimated cost of $64 million. Instead, a final design that combines proposed Alternative 3 and 4 is being assessed for cost effectiveness, despite Alternative 3 providing the least effective mitigation for newt mortality. In a current best-case scenario where Alternative 4 (Figure 3), which had the second most effective mitigation results for newt mortality, is implemented, the estimated cost of the project would be $33.76 million.

If Alternative 4 were to be implemented in its current state, then elevated roadway would be constructed on Alma Bridge Road totaling 1,800 feet in Zone 1; 1,030 feet in Zone 2; 900 feet in Zone 2a; and 2,660 feet in Zone 3 (Figure 3). While progress on the Alma Bridge Road Newt Passage Project is encouraging for these populations, the project may not sufficiently reduce

newt roadkill. If Alternative 4 had been implemented since the beginning of survey efforts and prevented 100% of the newt deaths in the mitigation zones the mitigation efforts would have prevented roughly 70% of newt mortality observed on Alma Bridge Rd since the start of the 2018-2019 survey season. This means that thousands of newts would still have become roadkill each year. Newts will not migrate towards a road crossing as they have no way of knowing they exist. So, while the current plan would provide partial relief to newt mortality, newt mortality from roadkill will continue to be a problem that threatens the viability of the populations of Pacific newts.

In Los Angeles County, the Wallis Annenberg Wildlife Crossing is currently being constructed across the 101 Freeway. The current cost for all phases of the project is estimated to be $92 million. The goal of this wildlife crossing is to provide a habitat corridor for ecosystems to the north and south of the 101 Freeway, based on the need to connect mountain lion habitat in order to conserve a mountain lion sub-population in the Santa Monica Mountains. Of the $92 million, approximately half comes from public funding and the remaining half comes from philanthropic fundraising (The Wallis Annenberg Crossing 2024). Los Angeles County is the 23rd wealthiest

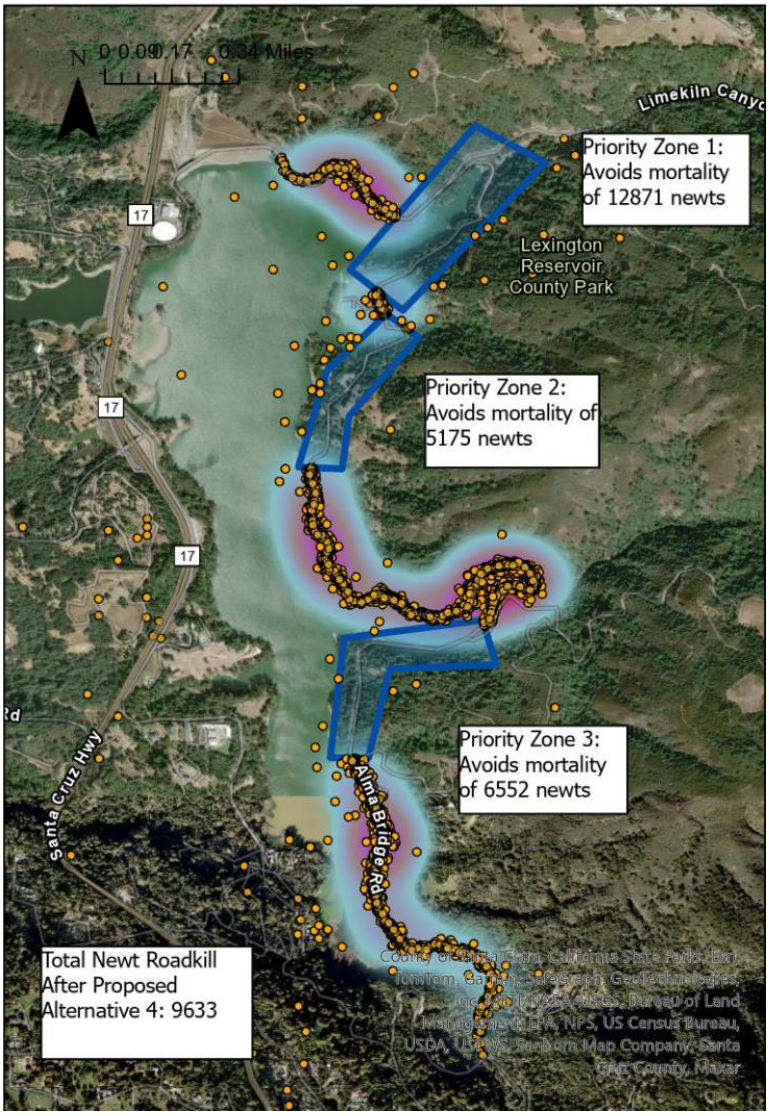

Figure 4. Satellite image of Alma Bridge Road overlaid with newt roadkill observations and resulting mortality hotspots for all observations recorded from the 2018-2019 survey season onward as if Alternative 4 elevated roads had been implemented and resulted in 100% survivorship. The yellow-orange circles represent individual newt roadkill observations retrieved from the iNaturalist Pacific Newt Roadkill database. The mortality hotspot overlay shows a gradient of mortality with areas of lowest mortality represented with cooler blue tones and areas of highest mortality represented by warm pink tones. The blue boxes represent areas of no mortality resulting from Alternative 4 structures.

county in California (Palm 2023). In comparison, Santa Clara County is the wealthiest county in California and the third richest in the United States (Johnson 2023). Yet, budgeting remains a constraint on the Alma Bridge Road Newt Passage Project, threatening the effectiveness of potential mitigation efforts. In addition, private consulting firms may have conflicts with planning mitigation, unless they are precluded from bidding on the implementation phase..

Illustration of Pacific newts utalizing elevated roadway segment. (Illustration credits: Selena Cao)

It is essential that fully-effective mitigation efforts are implemented to sustain the Pacific newt populations. It is better to allocate adequate funding and create lasting stability in the newt populations than allow a conservative budget to limit the effectiveness of mitigation efforts which would only result in the prolonged extirpation of the Pacific newt populations surrounding the Lexington Reservoir.

Additional Mitigation Options

To prevent the remaining 30% of roadkill after implementation of Alternative 4, additional actions should be considered. In other areas around the US and the world, traffic restrictions and speed limits are used to reduce wildlife mortality from traffic. While the road cannot be completely closed due to it being an alternative route to Highway 17, traffic can be limited to essential travel only. Under a newt-friendly traffic plan, between November and April, emergency vehicles, maintenance crews, and local residents with issued permits would be able to access the road. Recreational users and those using the road to avoid Highway 17 traffic would not have access to the road during this time. Implementing seasonal road restrictions from November to April during newt migration season would be inexpensive and prevent the vast majority of newt roadkill remaining after road elevation. Pacific newts are nocturnal. The road restrictions could go into effect from late afternoon until morning to also accommodate both newts and road traffic.

The speed limit on Alma Bridge Road could also be drastically reduced. The current speed limit is

25mph. If reduced, it would incentivize drivers to take alternative routes as well as reduce total capacity of cars driving on Alma Bridge Road. Enforcement of the lower speed limit would strengthen this mitigation effort. At the time of this report, there are no proposed physical speed inhibitors such as speed bumps on Alma Bridge Road (AECOM 2023). The addition of speed bumps, rumble strips, or other speed inhibitors could also be explored as additional mitigation effort.

Acknowledgements

We appreciate the continued efforts of Anne Parsons, Merav Vonshak, and the volunteers of the Lexington Reservoir Newt Patrol in bringing awareness to this ongoing issue. In what is the largest effort of its kind in California and possibly the US, this team has been carrying out consistent newt surveys for over five years, gathering data that was used in this report.

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