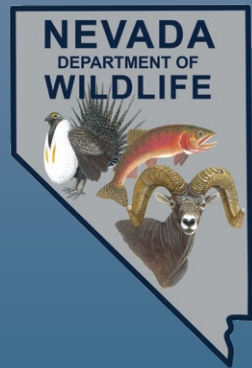


NEVADA WILDLIFE MIGRATIONS AND CONNECTIVITY

Challenges and Conservation Strategies



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Cartography and design by University of Oregon InfoGraphics Lab including student cartographers Dylan Blisard and Atticus Tong.

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References

Bissonette, J.A., & Adair, W. (2007). Restoring Habitat Permeability to Roaded Landscapes with Isometrically-Scaled Wildlife Crossings. *Biological Conservation*, 141(2), 482-488.

Kauffman, M.J., et al. (2020). *Ungulate migrations of the western United States, Volume 1*. U.S. Geological Survey Scientific Investigations Report 2020–5101, <https://doi.org/10.3133/sir20205101>.

Gagnon, J. W., Dodd, N. L., Sprague, S. C., Ogren, K. S., Loberger, C. D., & Schweinsburg, R. E. (2018). Animal-activated highway crosswalk: long-term impact on elk-vehicle collisions, vehicle speeds, and motorist braking response. *Human Dimensions of Wildlife*, 24(2), 132–147.

Nevada Department of Transportation. Traffic Crash Data. Available online at <https://www.dot.nv.gov/safety/traffic-crash-data>.

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The mission of the Nevada Department of Wildlife is to protect, conserve, manage and restore wildlife and its habitat for the aesthetic, scientific, educational, recreational, and economic benefits to citizens of Nevada and the United States, and to promote the safety of persons using vessels on the waters of Nevada.



Nevada Department of Wildlife
<https://www.ndow.org/>

Nevada's Ungulate Species

Nevada's vast and diverse habitats are home to various species of ungulates (hoofed mammals) including: mule deer, bighorn sheep, pronghorn, moose, and elk. Mule deer and pronghorn migrate long distances seasonally to access better forage and escape harsh winters. Bighorn sheep may make short-distance or elevational movements throughout the year depending on the availability of water and the quality of forage. Elk may migrate seasonally or stay close to their annual home range depending on conditions and resources. The lands these species occupy and the corridors they use to migrate are threatened by both ecological and human influences.

Nevada's ungulate species often intersect with man-made developments such as roads, interstate highways, and fences. While fencing may be removed or modified, roads and highways pose permanent challenges to wildlife connectivity and, consequently, public safety. This report focuses on the migration corridors, habitat distributions, and wildlife collision hotspots across Nevada.

Ensuring the protection of migratory corridors for Nevada's ungulate species is a critical, but challenging task. The scattered and crisscrossed nature of wildlife migration in Nevada complicates conservation efforts, requiring a comprehensive approach that addresses both ecological and socio-political factors. Dedicated programs focused on habitat restoration, wildlife crossing structures, and riparian habitat improvements are essential to mitigating the impacts of land use changes, habitat degradation, and climate variability. Funding is a crucial component in this effort. Funding supports projects to conduct research, create new mapping products, and facilitate improvements to existing barriers for wildlife movement.

Relationships with local communities and stakeholders are also important in ensuring the protection of migration corridors. Engaging community and industry leaders can ensure more sustainable land use practices and long-term protection of the migration corridors used by Nevada's wildlife.

Addressing the challenges to the protection of migration corridors through the multifaceted strategy of funding, legislation, and fostering relationships with local and industry leaders will drive the process of keeping the ecological integrity of the region and conserving the migration corridors vital to Nevada's wildlife.



PHOTO BY CODY SHROEDER

Mule Deer (*Odocoileus hemionus*): Widely distributed across western North America, with significant populations in the sagebrush ecosystem.



PHOTO FROM SHUTTERSTOCK

Pronghorn (*Antilocapra americana*): Migratory herds occupy the northwest and northeast portions of the state, with higher population densities in the sagebrush ecosystem.



PHOTO FROM SHUTTERSTOCK

Bighorn Sheep (*Ovis canadensis*): Prefers rugged terrain, such as mountainous regions and steep canyons along with bunch grasses, forbs, and shrubs.



PHOTO BY CHRIS VASEY

Mule Deer: Deer density is higher in the northern and eastern portions of the state where migratory herds often intersect with rural highways and county roads.

Elk (*Cervus canadensis*): Occupy diverse habitats, including sagebrush, forested mountains, and meadow systems. Elk populations are primarily distributed in the northeastern, eastern, and central portions of Nevada.



PHOTO BY SCOTT STOUT

Habitats

Nevada's ungulates inhabit diverse landscapes from deserts to sub-alpine forests. Habitat requirements can vary for different ungulate species but generally provides forage, thermal cover, water and a place of refuge from severe weather.



PHOTO BY TIM TORELL



PHOTO BY CODY MCKEE



PHOTO BY TIM TORELL

Pinyon and juniper woodlands provide cover and forage for elk and mule deer. Riparian areas supply water and forage in summer, while low sage shrublands serve pronghorn during winter migrations.

Sagebrush is a crucial component of ungulate diets, especially in winter, with different species of sagebrush varying in preference and nutritional value. The quality of ungulate habitat is strongly linked to the presence and condition of shrub components, which thrive in early successional stages.

Native grasses and forbs are essential forage for ungulates, particularly in spring and early summer when they are most nutritious and abundant. Elk, mule deer, and pronghorn may especially rely on grasses for energy and forbs for protein and essential minerals, which support growth, reproduction, and overall health.

Key Habitats for Ungulate Species

Sagebrush Dominated Shrublands

Dominated by sagebrush species (*Artemisia spp.*) with an understory of native grasses and forbs. This habitat provides critical forage for all the ungulate species, especially in winter for mule deer and pronghorn.

Salt Desert Shrublands

Lower elevation areas with sparse vegetation, including creosote bush and saltbush. These are important for pronghorn and as migration routes for other species.

Pinyon-Juniper Woodlands

These woodlands provide cover and forage but are managed to prevent over-encroachment, which can reduce sagebrush and other forage availability for species like mule deer and elk.

Forest (*forest edges and meadows*)

Transitional areas between forest and open land. Elk and mule deer frequently use these habitats for cover and foraging.

Mountain Shrublands

Higher elevation areas with shrubs such as mountain mahogany, serviceberry, and bitterbrush. These areas provide essential forage during various seasons for mule deer, elk, and bighorn sheep.

Riparian and Wetland

Areas along streams and rivers with diverse plant communities. These zones are crucial for providing water and high-quality forage during summer months for all ungulates.



Winnemucca

Wells

Elko

Carlin

West Wendover

Lovelock

Reno

Fernley

Sparks

Fallon

Eureka

Ely

Carson City

Yerington

Tonopah

Caliente

Mesquite

Pahrump

Las Vegas

Henderson

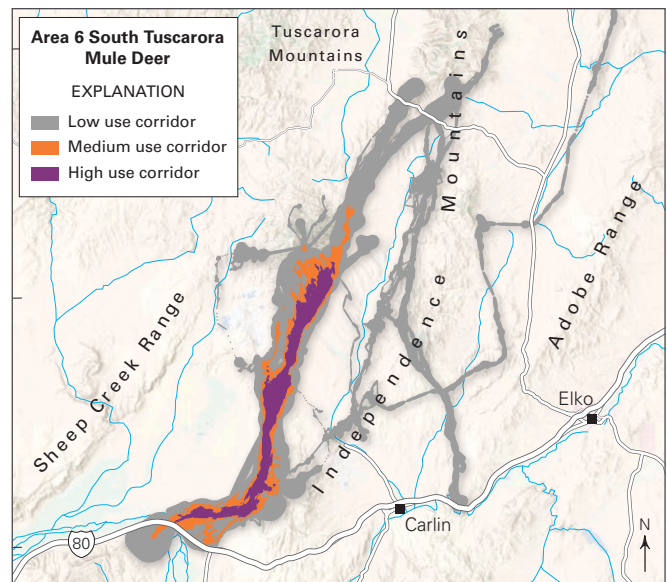
Boulder City



Mule Deer Ranges and Seasonal Movement

Mule deer occupy a wide variety of diverse habitats and ecological niches throughout Nevada. The habitats they live in are often driven by their seasonal migrations to and from their summer and winter ranges. Some mule deer sub-populations migrate up to 150 miles between their seasonal ranges, while others live in the same habitat year-round and do not make substantial migrations.

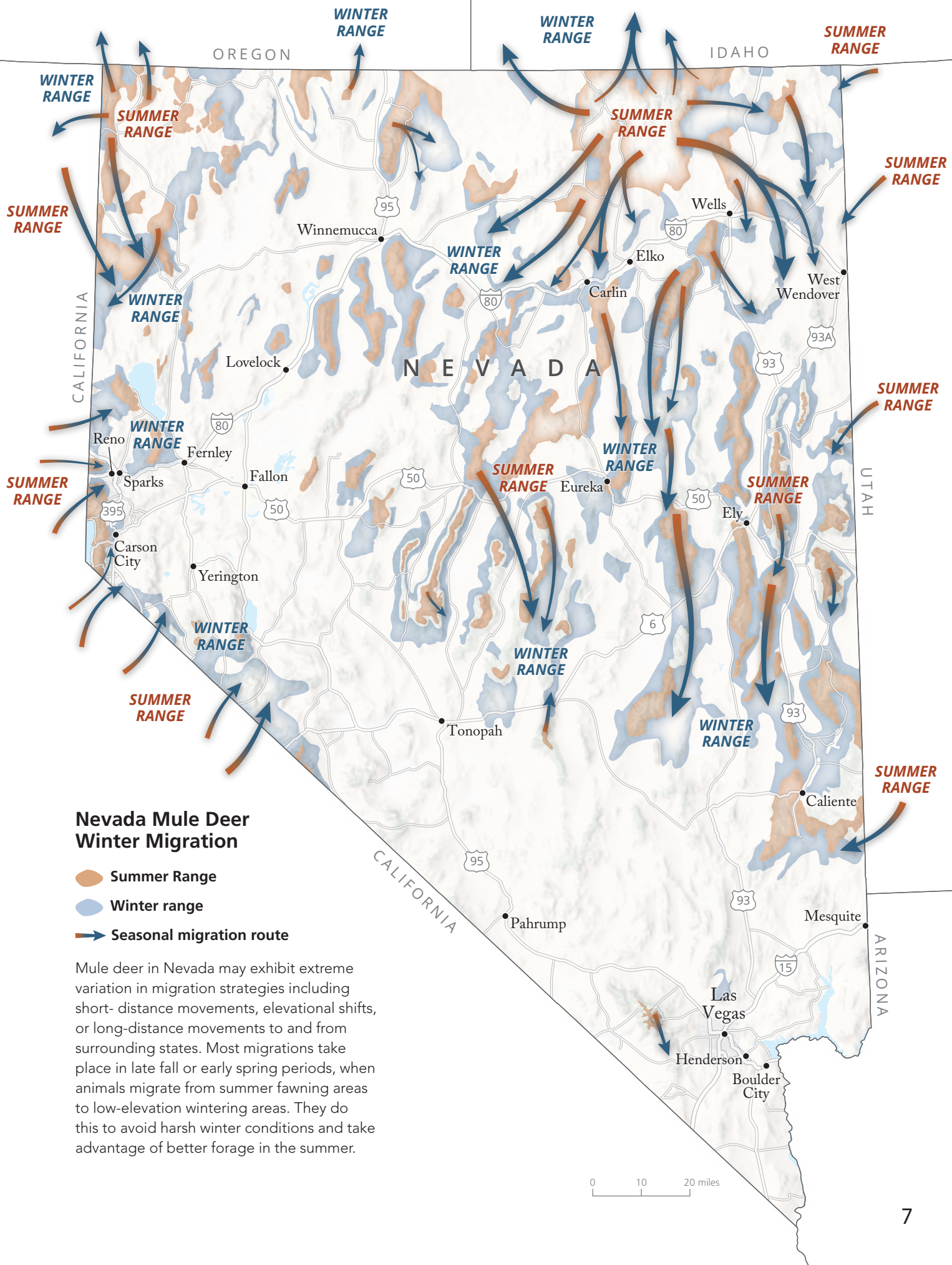
Historical distribution data including observations from wildlife surveys, harvest records, track surveys, and telemetry studies were used to create the map of mule deer distribution and seasonal movement in Nevada. While historical data provides valuable insights, habitat conditions and population dynamics may have changed over time due to factors such as land-use changes, habitat degradation, and climate variability. More recent migration maps represent modern technological methods used to depict migration corridors, including the use of GPS radio collar technology and advanced statistical models such as the Brownian Bridge movement model used to characterize high, medium, and low use corridors.



Map of the South Tuscarora Mule Deer Herd in Nevada.

The detailed movement corridors are based on GPS radio collar data that have been analyzed using the Brownian Bridge movement model. Understanding the density of the movement patterns allows conservation efforts focus to focus on the most important corridor segments and linkages.

Map from [Ungulate Migrations of the Western United States Volume 1](#). Data and story on South Tuscarora Mule Deer [here](#).



Barriers to Migration

Linear barriers including roadways and fences can significantly impact the movements of large mammals such as mule deer, elk, pronghorn antelope, and black bears. These structures create physical barriers that fragment habitats and disrupt migration routes essential for accessing seasonal resources, breeding grounds, and primary foraging areas. Other potential barriers to migration include mineral extraction, livestock fencing, and other human development and infrastructure.

Roads cover approximately 1% of the U.S. land surface, and are a primary cause of habitat fragmentation. They not only physically block animal movements but also increase the risk of wildlife-vehicle collisions, which can be fatal for both animals and humans. The constant threat of crossing roads reduces the connectivity between different habitat patches, leading to isolated populations with diminished genetic diversity and resilience (Bissonette and Adair 2007).

Highways often create significant barriers to wildlife migrations due to the direct and indirect consequences of vehicles traveling at high speeds along highways, and the fencing associated with keeping livestock from entering the right-of-way. For example, mule deer from the South Tuscarora Herd (*at right*) are faced with barriers from Interstate 80 which bisect portions of their winter range.



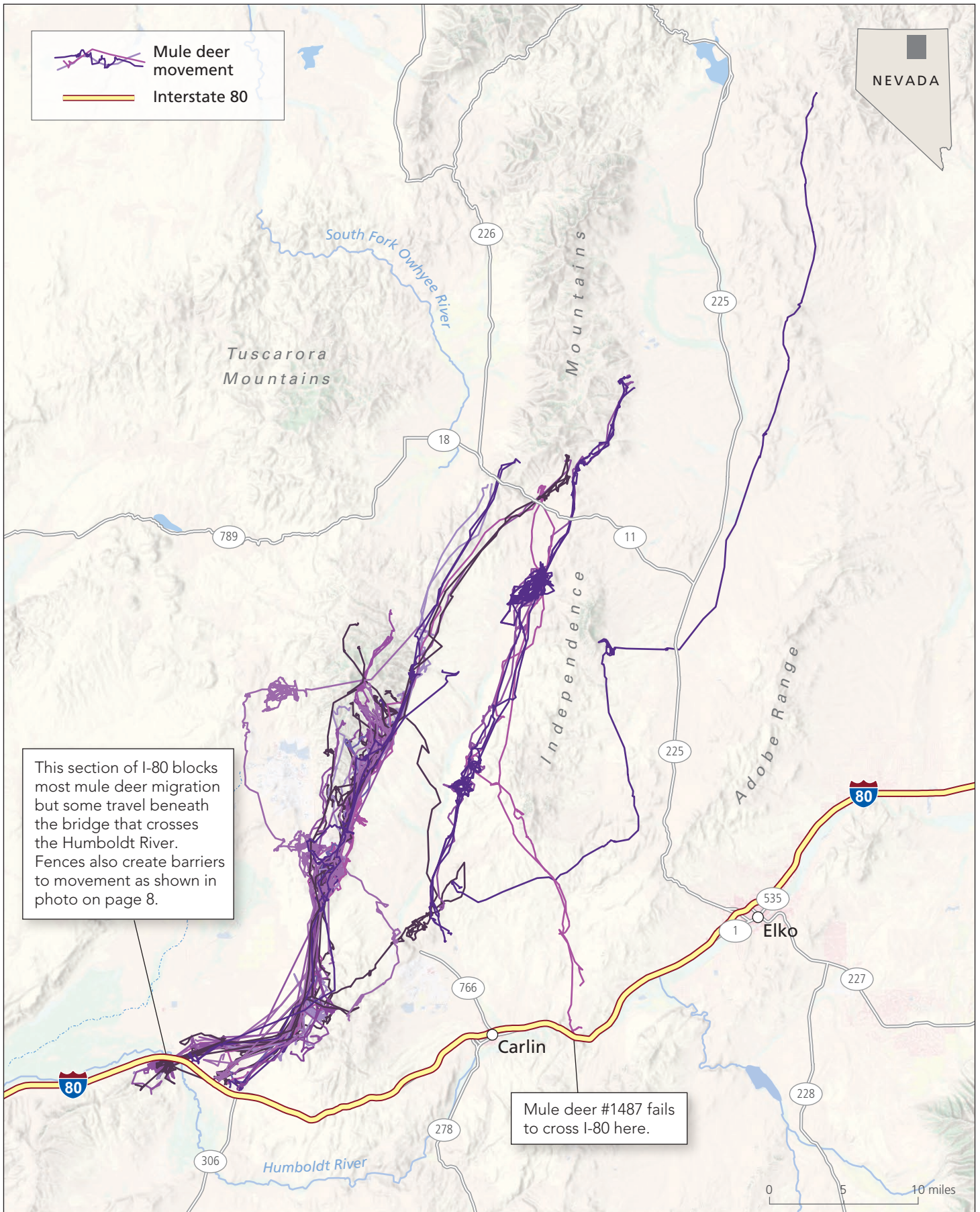
PHOTO BY TRAVIS ALLEN



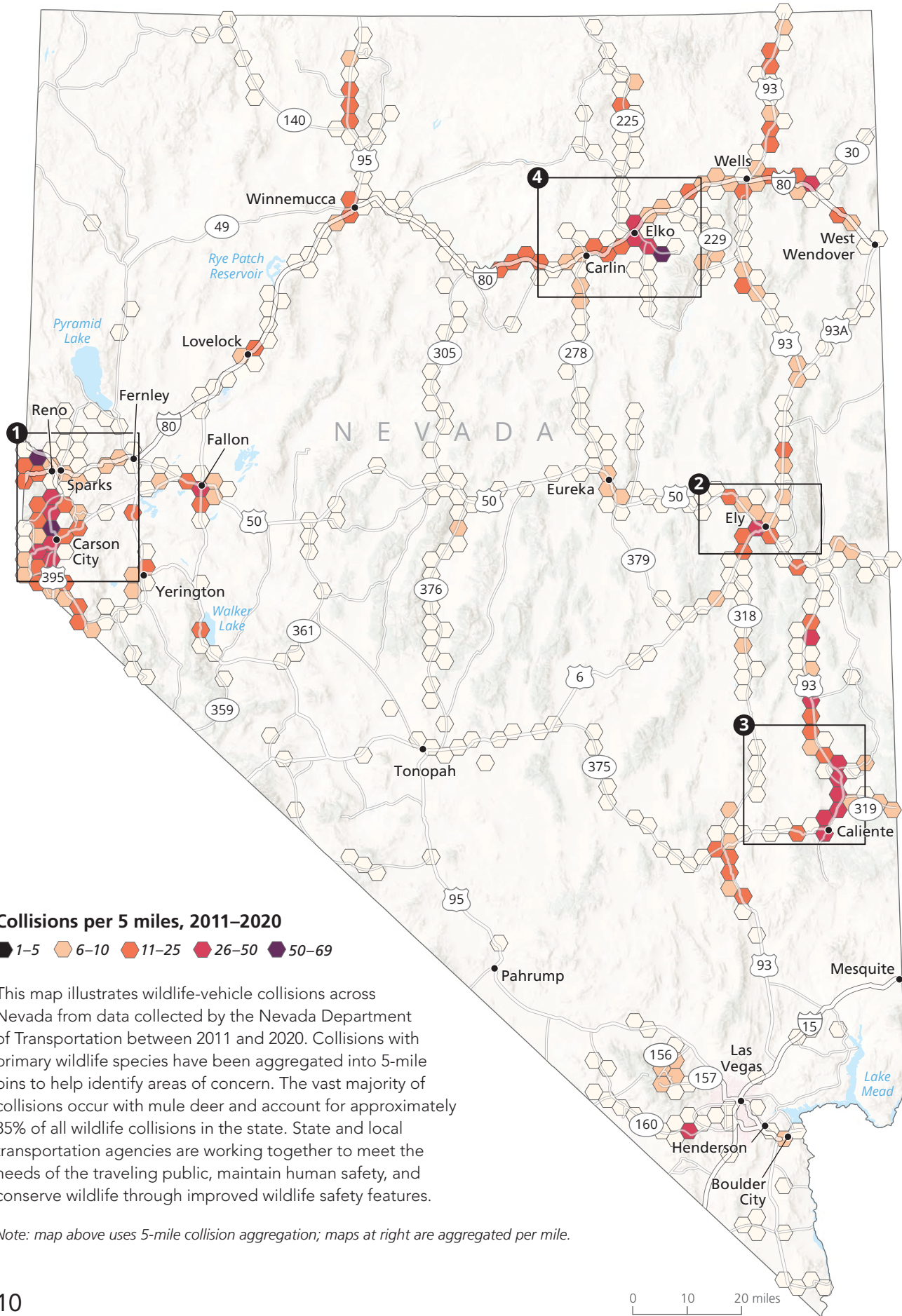
PHOTO BY TRAVIS ALLEN

Mule deer attempting to cross an older-style, woven-wire fence that bisects the south Tuscarora migration corridor near the Humboldt River in Elko County, Nevada.

Interstate 80 and South Tuscarora Mule Deer Herd Migration



Wildlife-Vehicle Collisions Statewide (All Species)



Across Nevada, there were more than 3,500 reported collisions between vehicles and wildlife species, domestic animals, and feral horses between 2011 and 2020 (NDOT). More than sixty percent of those collisions were with ungulate species. Urban development, expanding road systems and high speed limits have exacerbated these collisions. As Nevada's population continues to grow, the frequency of encounters between animals and vehicles on roadways will continue to increase, and infrastructure will continue to expand and encroach on wildlife habitats and migration routes. There is an urgent need for effective mitigation strategies to protect both wildlife and human populations.

Highways with Highest Collisions for Maps Below

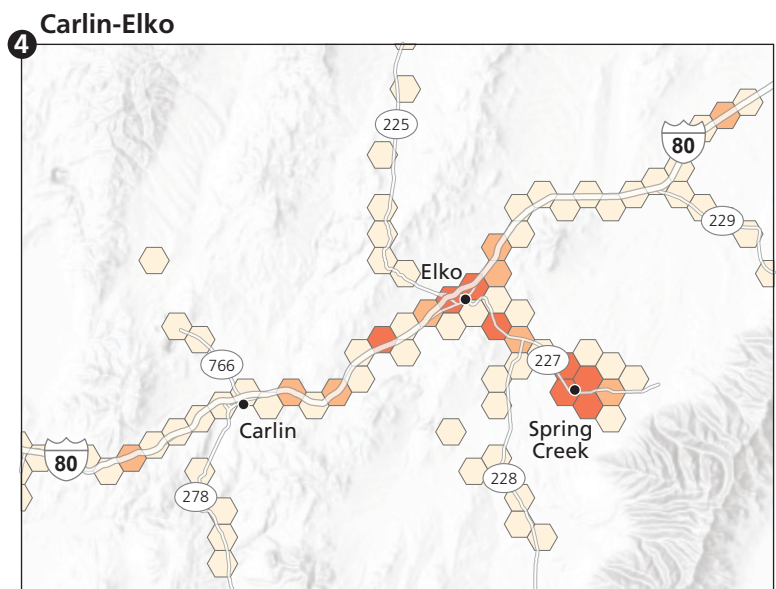
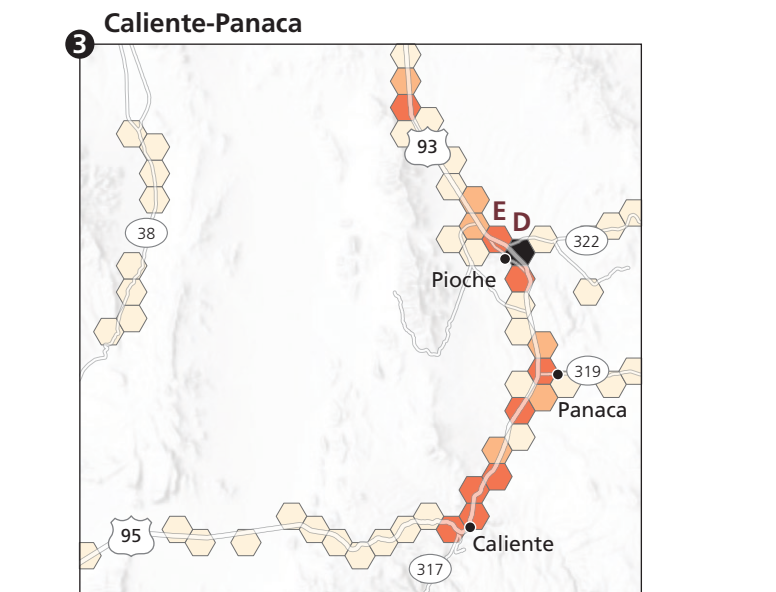
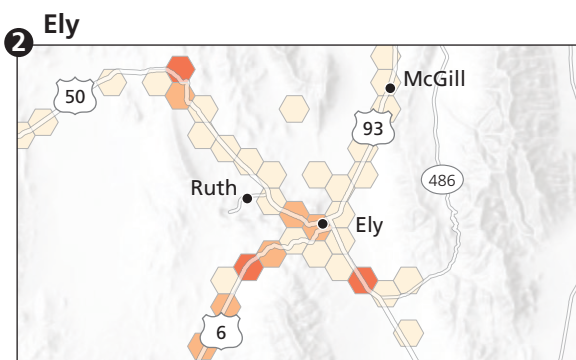
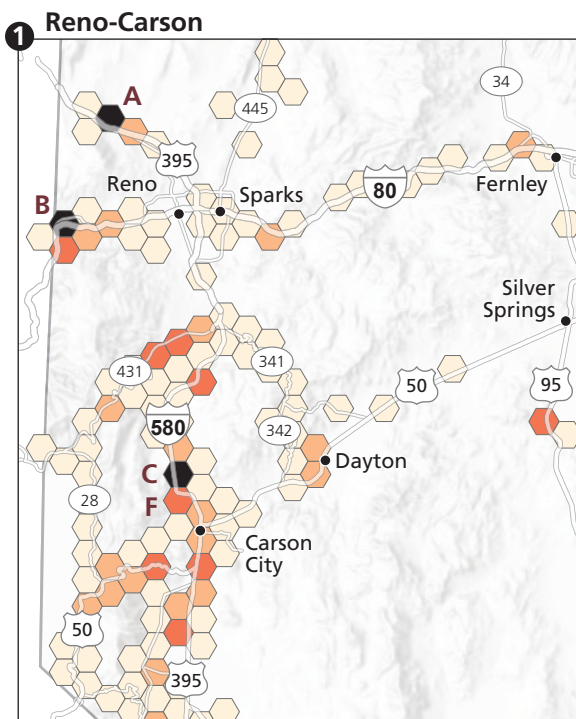
Route	Milepost	Collisions	Map Location
395	38	45	A
80	45	33	B
580	1	31	C
93	117	27	D
93	120	24	E
580	9	22	F

The areas of highest risk of wildlife vehicle collisions are generally located near urban or suburban areas where high traffic volumes occur in close proximity to surrounding habitat for migrating ungulates.

Collisions per milepost, 2011–2020

1-5 6-10 11-25 26+

All maps on this page: 0 5 10 20 miles



Wildlife-Vehicle Collisions by Species

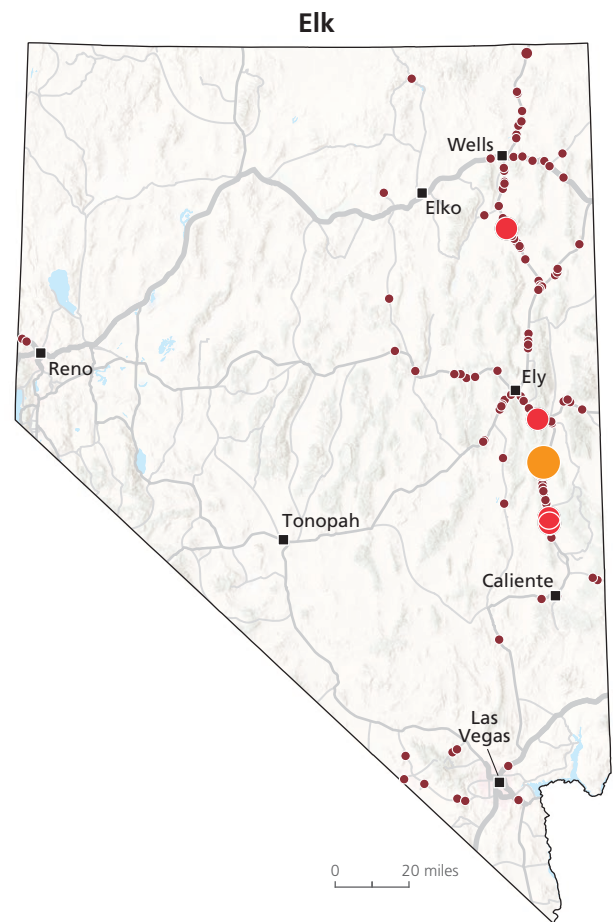
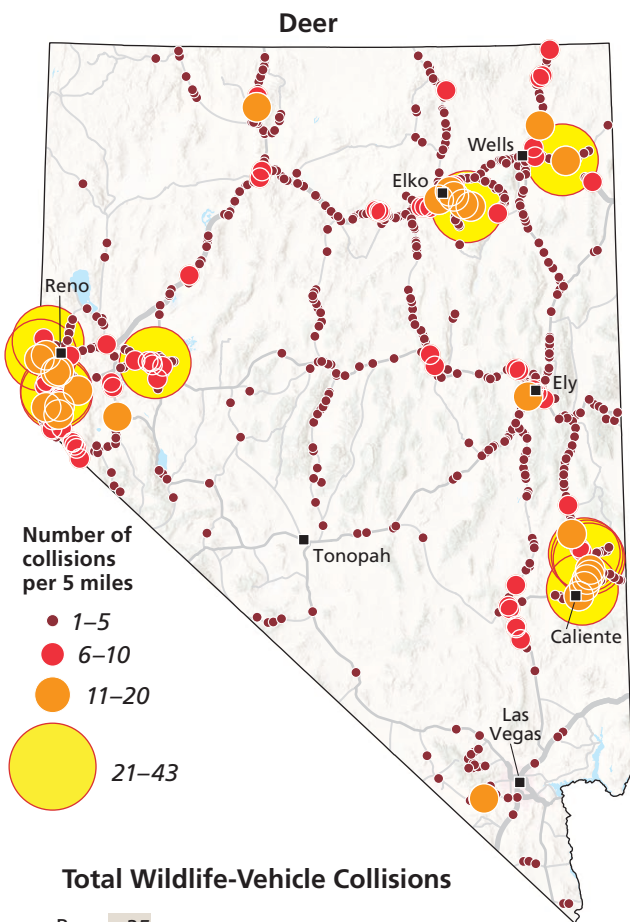
Nevada has fewer wildlife-vehicle collisions per capita than many other states in the western United States. However, ungulate collisions comprise the majority of wildlife-vehicle collisions. The maps below show the distribution and quantity of vehicle collisions with ungulate species from 2011–2020 in Nevada.

Mule deer collisions were the most abundant, primarily concentrated along major highways and rural roads intersecting their migratory paths. Elk collisions occurred frequently in eastern Nevada where elk habitat and distribution is concentrated. Collisions with pronghorn were predominantly in open sagebrush flats and valleys where two-lane highways and pronghorn habitat often intersect. Bighorn sheep

encountered vehicles in narrow canyons and near rugged terrain or cliffs where they often co-occur with busy highways.

These maps highlight the need for targeted mitigation measures, such as wildlife crossings and warning signage, to reduce wildlife-vehicle collisions and enhance safety for both wildlife and motorists. Ensuring the protection of these migration corridors presents challenges, including the need for dedicated funding, the implementation of targeted conservation programs, and supportive legislation. Collaboration with local communities and stakeholders is also crucial to gaining the necessary support for preserving these vital habitats.

Wildlife-Vehicle Collisions, 2011–2020



Total Wildlife-Vehicle Collisions

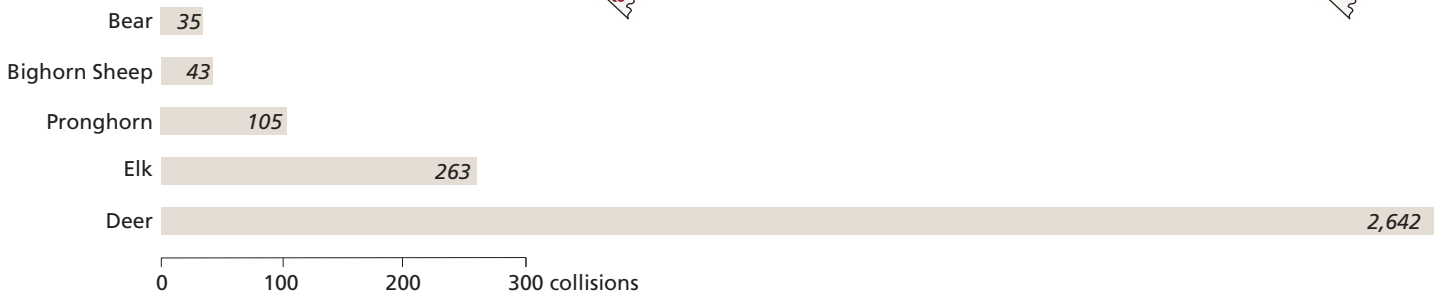
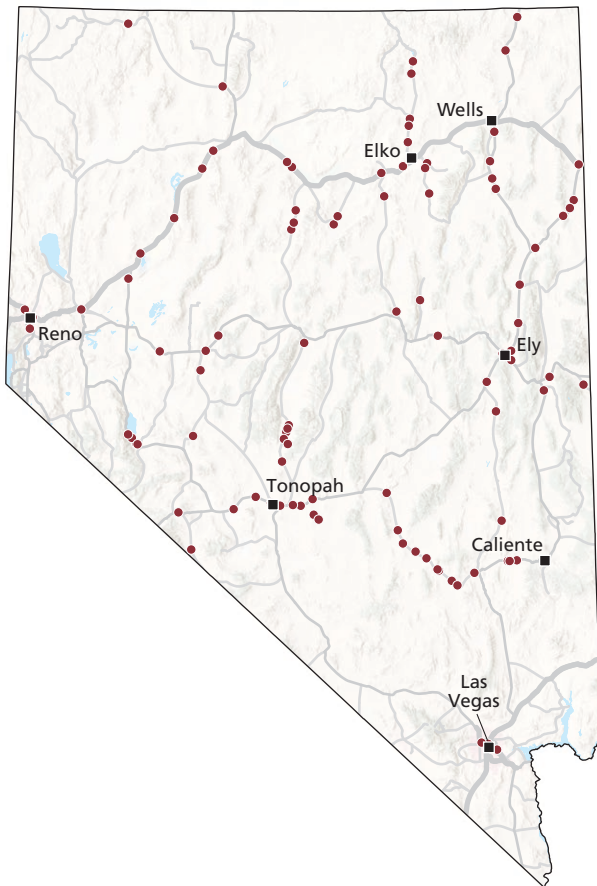




PHOTO BY CODY SHROEDER

Pronghorn



Bighorn Sheep



Mapped data is from the Nevada Department of Transportation records. These records likely underrepresent the true mortality incurred on Nevada highways, due to a known under-reporting bias of minor crashes that don't involve filing formal police reports or crashes to Nevada State Highway Patrol.

Future Directions

Conserving migratory pathways for species like mule deer and pronghorn requires more than protecting isolated areas of habitat. It involves a broad and integrated effort that addresses habitat fragmentation, highway crossings, fencing, land-use planning, and seasonal resource needs. Effective conservation depends on collaboration among wildlife agencies, land managers, transportation departments, private landowners, and local communities to ensure these animals can move freely across the landscape and access the habitats they rely on throughout the year.

To enhance mapping of ungulate migrations in Nevada, it is crucial to collect comprehensive data using advanced technologies such as GPS satellite tracking collars, vegetation imagery, and remote sensing products where possible. These tools will

provide detailed insights into the movement patterns of mule deer, elk, pronghorn antelope, and bighorn sheep, as well as changes in habitat quality and land use. Utilizing GIS tools and predictive modeling would enable the creation of dynamic maps that visualize migration routes and forecast changes due to climate and urban development. Stakeholder collaboration is essential to this process, involving interagency cooperation, public-private partnerships, and local community engagement to ensure comprehensive planning and support.

Public engagement and education play a vital role in successful connectivity planning. Community involvement through workshops and public forums will raise awareness and gather valuable input. Educational campaigns can inform the public about the



Pequop Wildlife Overpass: Beginning in 2015, planning for wildlife overpasses and modified underpasses on I-80, 18 miles east of Wells, Nevada, aimed to protect migrating mule deer and other wildlife. GPS collar and crash data identified the Pequop Summit corridor, where 60–80 deer were hit annually. The wildlife overpass and new fencing at several underpasses was completed in 2019, reducing wildlife-vehicle collisions by an estimated 90%.

importance of ungulate migrations and the impacts of human activities. Protecting and restoring critical migration corridors and habitats are paramount, involving projects like wildlife overpasses and underpasses. Advocacy for supportive policies and securing funding through grants and partnerships are necessary to sustain long-term connectivity efforts. Continuous monitoring and adaptive management will allow for strategies to be refined based on scientific advancements, ensuring effective conservation of key species and their habitats in Nevada.

Wildlife crossing structures on Nevada's highways (such as the Pequop Summit overpass pictured on previous page) are crucial for mule deer migration, as they reduce vehicle collisions, and enhance habitat

connectivity. These crossing structures ensure safe passage for humans and wildlife, while promoting healthy populations and ecosystem resilience.

Wildlife-friendly fence designs are essential for habitat improvements and conservation easements, as they allow safe passage for species like mule deer, prevent entanglements, and promote uninterrupted movement and genetic diversity. Future directions for Nevada include adopting wildlife-friendly fencing standards with project proponents and partnering agencies, increasing the use of adjustable, low-wire fences, and integrating new designs that prioritize ungulate migrations, connectivity, and safety throughout key habitats.

Fence Modification Project

Stateline boundary fence between California and Nevada, northern Washoe County, Nevada.



Original Fence Design (left): Barbed wire fences with a bottom wire below 16 inches can be a barrier to migrating ungulates by obstructing movements and may cause injuries to pronghorn and mule deer. This type of fence design can trap legs or snag hides, leading to stress, physical harm, and lead to mortality in some cases.

Wildlife-friendly Fence Design: While fences help secure property and control livestock, they can also obstruct wildlife movement and access to resources. Simple, affordable improvements like wildlife-friendly fencing reduce harm, such as using smooth bottom wires on 4- or 5-strand fences positioned 16 to 18 inches above the ground and spacing strands at least 12 inches apart.



PHOTOS BY TORI CERNOCH

Top Recommendations to Increase Connectivity for Ungulates in Nevada

Protecting Nevada's migratory ungulates requires a coordinated set of actions that address both ecological needs and public safety concerns. Each year, wildlife-vehicle collisions cost millions in damages and result in the loss of thousands of animals, with mule deer being the most frequently impacted species in Nevada. In response, the Nevada Department of Wildlife, in partnership with stakeholders and constituents across the state, developed the following set of recommendations to guide strategic conservation efforts. These science-based actions aim to reduce habitat fragmentation, enhance connectivity, and improve highway safety. From constructing wildlife crossings to implementing innovative warning systems and improving fence design, these strategies reflect broad input and shared commitment to protecting Nevada's migratory species and landscapes for future generations.

2. Establish Dedicated Funding Sources for Wildlife Connectivity

RECOMMENDATION

Create or expand funding mechanisms (e.g., federal grant programs, new state recurring funding mechanisms, state appropriations) to support research, planning, construction, and maintenance of wildlife corridors and crossing infrastructure. Work with state legislatures, transportation department, and local planning organizations to ensure funding is appropriated for wildlife crossing structures.

RATIONALE

Reliable funding is essential to implement large-scale infrastructure and restoration projects, particularly in a state as ecologically diverse and geographically expansive as Nevada.

1. Prioritize Construction of Wildlife Crossing Structures in High-Risk Corridors

RECOMMENDATION

Expand investment in overpasses, underpasses, and fencing retrofits at key wildlife-vehicle collision hotspots—particularly along Interstate 80 and other critical routes intersecting migration paths.

RATIONALE

Collisions with ungulates, especially mule deer, comprise over 85% of wildlife-vehicle incidents in Nevada. Structures like the Pequop Summit overpass have reduced collisions by up to 90%, demonstrating clear conservation and public safety benefits.

3. Increase Multi-Stakeholder Planning Efforts

RECOMMENDATION

Prioritize cross-sector planning efforts that include state agencies, federal partners, Tribal governments, ranchers, and local communities to evaluate land-use decisions affecting migration corridors.

RATIONALE

The scattered nature of Nevada's migrations necessitates collaboration across jurisdictions. Engaging diverse stakeholders ensures conservation measures are feasible, supported, and sustainable over the long term.



4. Continue to Promote Wildlife-Friendly Fence Standards Statewide

RECOMMENDATION

Expand outreach on the use of wildlife-friendly fencing in new developments and retrofit existing priority barriers in known migration zones.

RATIONALE

Improper fencing obstructs ungulate movement. Adopting statewide design standards will ensure compatibility between livestock management and wildlife movement.

5. Investigate Animal-activated Wildlife Warning Systems

RECOMMENDATION

Investigate new and innovative technology in highway warning systems that can be programmed to flash and display warnings when animals are detected nearby, which have been proven to minimize wildlife vehicle collisions (Gagnon et al. 2019).

RATIONALE

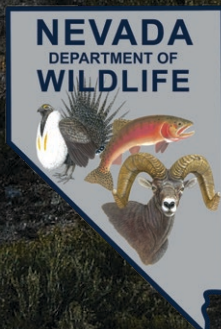
In some instances, a wildlife underpass or overpass may be impractical or cost prohibitive due terrain features, land ownership, or extended fencing to funnel animals to a wildlife crossing. Recent advances in research and technology in animal-activated alarm systems may be a better solution for reducing driver speeds and preventing wildlife vehicle collisions when animals are present on a roadway.





Created by:

Nevada Department of Wildlife. Reno, Nevada
InfoGraphics Lab, University of Oregon. Eugene, Oregon



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