

# High-Risk Zones for Ungulate-Vehicle Collisions during Montana's Fall Migration Season



Photo: R. Callahan

**Tyler Creech, PhD**  
**Meredith McClure, PhD**  
**Renee Callahan, JD, MESM**

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## INTRODUCTION

Wildlife-vehicle collisions (WVCs) represent a serious threat to human safety and property and to wildlife populations. More than a million WVCs with large mammals occur each year in the United States, resulting in more than 200 human fatalities and 29,000 injuries<sup>1</sup>. The total cost of the average deer-vehicle collision has been estimated at more than \$6,000, and costs are even higher for other large animals (>\$17,000 for elk and >\$30,000 for moose)<sup>2</sup>.

Collisions with wildlife and associated injuries to vehicle occupants have increased in Montana in recent years<sup>3</sup> (Fig. 1). Nearly 3,000 wildlife-related crashes were reported to law enforcement in Montana in 2015, of which more than 200 resulted in injuries. The actual number of WVCs is likely significantly higher than this because as many as half of WVCs are never reported<sup>4</sup>. According to a recent analysis by State Farm insurance company, Montana now ranks second highest among U.S. states for risk of vehicle collision with a large animal. Montana drivers have a 1 in 58 chance of hitting a deer, elk, or moose in 2016, representing a 9.1% increase over last year<sup>5</sup>.

Fall is a period of increased risk of collision with large ungulates (such as deer, elk, and moose), which account for the majority of large animals hit by vehicles<sup>1,6</sup>. Many ungulates migrate seasonally between higher-elevation summer range and lower-elevation winter range, crossing highways in the process and increasing risk of WVCs. Even in areas without large elevational gradients (e.g., plains habitat in eastern Montana), ungulates often exhibit increased movement across the landscape during fall as males search for and tend to females during the breeding season<sup>7,8,9</sup>. Hunting seasons for many ungulate species also occur during fall and may further increase movement rates and WVC risk<sup>10</sup>. Increased driver awareness of specific high-risk areas for fall WVCs could help to reduce these collisions and their associated costs to humans and wildlife, but information on the spatial distribution of WVC risk across Montana is not widely available to the public.

This report identifies short sections of highway that present the highest risk of collisions between vehicles and large ungulates during fall (hereafter, “high-risk zones”). We utilize data on the frequency of wildlife carcasses recorded along highways by the Montana Department of Transportation (MDT) as an indicator of the relative risk of WVCs across Montana (although we note the limitations of this dataset; see Discussion section). We aim to increase driver awareness of highway sections with particularly high risk of WVCs as we enter the fall migration season.

## METHODS

We used a database obtained from MDT containing locations, dates, and species identifications for animal carcasses collected by maintenance personnel along major roads during 2010-2015. To determine how WVC risk varied by species and throughout the year, we calculated the percentage of wildlife carcass records associated with each species and the frequency of carcass records in each month.

We focused our analysis on the data most relevant to WVC risk during fall migration by considering only the following types of carcass records: (1) carcasses of six migratory ungulate species (whitetail deer, mule deer, elk, moose, pronghorn, and bighorn sheep) that are involved in the majority of WVCs<sup>11</sup>; (2) carcasses collected during the fall months of October, November, and December, when these species are most likely to encounter vehicles while migrating between summer and winter ranges<sup>6</sup>; and (3) carcasses found along MDT On-System Routes (including National Highway System [NHS] interstate, NHS non-interstate, primary, secondary, and urban routes) where the greatest vehicle traffic and carcass collection effort occur.

We calculated the number of carcasses recorded within each highway mile (i.e., between consecutive mileposts) along all On-System Routes to map the spatial distribution of WVC risk. We identified the top ten high-risk zones, which we defined as ten-mile-long highway sections with the highest mean frequency of recorded carcasses per mile (i.e., the highest “carcass rate”), using a moving-average approach. High-risk zones were constrained to be non-overlapping, although multiple zones along a single route were allowed.

## RESULTS

A total of 36,940 wildlife carcasses were recorded by MDT along Montana highways during 2010-2015. The six ungulate species considered in this analysis represented >97% of all wildlife carcasses in the database (Fig. 2). Whitetail deer was the most frequently recorded species (67% of wildlife carcasses), followed by mule deer (25%). Numbers of elk, pronghorn, moose, and bighorn sheep carcasses were much lower.

Carcasses were most frequently recorded during the fall months (Fig. 3), although this pattern varied by species. Whitetail deer and mule deer exhibited strong fall peaks in carcass frequency, while elk and bighorn sheep exhibited weaker fall peaks. In contrast, carcass frequency was highest during spring and summer for pronghorn and moose (Fig. 4). However, because deer species account for >90% of all recorded wildlife carcasses, the overall pattern of WVC risk showed a clear fall peak.

Carcass rates for individual highway miles ranged from 0 to 12.17 carcasses/mile/fall (Fig. 5). Carcass rates were generally higher in the mountainous western portion of the state, although some areas of locally elevated carcass rate were present in eastern Montana (e.g., near Billings, Havre, and Glendive). The top ten high-risk zones were clustered in southwestern Montana, with the exception of one high-risk zone near Kalispell (Figs. 6, 7). Multiple high-risk zones were identified near the cities of Hamilton and Red Lodge.

Two high-risk zones identified in our analysis stood out as having considerably higher carcass rates than the remainder of the state (Table 1). MDT recorded 357 carcasses on US-93 between mileposts 94 and 104, along the northwest shore of Flathead Lake near Kalispell, during the fall months of 2010-2015 (mean carcass rate: 5.95 carcasses/mile/fall). US-191 between mileposts 72 and 82, south from Four Corners near Bozeman, had the second highest carcass rate during this period with 242 recorded carcasses (4.03 carcasses/mile/fall). All other ten-mile-long highway sections had carcass rates under 2.67 carcasses/mile/fall.

## **DISCUSSION**

We identified ten short sections of highway in Montana that present the highest risk for WVCs, as indicated by the large numbers of roadside ungulate carcasses recorded in these areas. Our analysis suggested that the risk of WVCs is unequally distributed across Montana and throughout the year. The months of October, November, and December had the highest frequencies of recorded carcasses, indicating that WVC risk is indeed elevated during the fall ungulate migration and breeding season in Montana. Most of the top ten high-risk zones were located in southwestern Montana, a region experiencing rapid population growth in proximity to large ungulate populations. Much lower carcass rates were observed for the eastern half of the state, a result that we suspect is driven by some combination of two factors: (1) vehicle traffic and resulting WVCs are likely lower in most of eastern Montana because human population density is lower, and (2) reporting of carcasses by MDT may be less consistent in eastern Montana, as evidenced by long stretches of highway with no recorded carcasses that appear to be defined by administrative boundaries. We discuss the issue of incomplete carcass sampling in greater detail below.

We explored WVC risk specifically during fall to focus on seasonally dangerous areas for drivers and wildlife, but we emphasize that the carcass rates reported here represent only a subset of the ungulates killed along roads each year. Approximately two thirds of carcasses were recorded by MDT outside of the fall months (Fig. 3), and we observed annual carcass rates as high as 25 carcasses/mile for individual highway miles in the state.

Drivers can reduce their risk of a WVC by taking the following actions recommended by MDT<sup>12</sup>: (1) continually scanning the road and shoulders for signs of animals and movement; (2) using high beams when there is no oncoming traffic; (3) being extra attentive around dawn and dusk when animals tend to be most active; (4) slowing down around curves; and (5) always wearing a seatbelt. Drivers that encounter wildlife on the road should slow down and watch for other wildlife to appear, and use brakes rather than swerving if a collision is imminent. Wounded animals can cause injury to humans and should never be approached or touched. Although extra caution is warranted when traveling through high-risk zones identified in this analysis, drivers should be aware that the potential for WVCs exists on all highways.

In the long term, mitigation measures may be able to dramatically reduce WVCs in the high-risk zones that we identified in this analysis. For instance, research suggests that measures such as animal detection systems and fenced underpasses or overpasses with jump-outs can reduce ungulate-vehicle collisions by 80% or more<sup>2</sup>. Many mitigation measures allow wildlife to safely cross highways, as opposed to simply restricting individuals to one side, thus preserving crucial landscape connectivity for wildlife populations while reducing WVC risk. Although mitigation measures may require large initial investment and maintenance expenses, the threshold collision rate at which these measures become cost effective is surprisingly low in some cases. For example, the benefits of installing fencing with underpasses and jump-outs outweigh the costs over a 75-year period for sections of highway with at least 3.2 deer-vehicle collisions per kilometer per year<sup>2</sup>.

Our use of ten-mile-long highway sections for high-risk zone identification was somewhat arbitrary, but we selected this length to strike an appropriate balance between high-risk zones that were too spatially focused (e.g., individual highway miles, in which case nearly all of the top ten high-risk zones would have been located along a short stretch of US-93 south of Kalispell) and those that were too spatially diffuse (in which case drivers would not have been provided specific enough information on high-risk areas). Repeating the analysis using different lengths (5- and 15-mile-long highway sections) resulted in similar sets of high-risk zones, suggesting that our analysis was not overly sensitive to zone length. We note, however, that there are regions of elevated WVC risk apparent in Figure 5 that were not identified in the top ten high-risk zones; for instance, long stretches of US-83 near Seeley Lake and US-89 between Livingston and Gardiner had moderate to high carcass rates, but no single ten-mile-long section had enough recorded carcasses to qualify as a top ten high-risk zone.

Several limitations of this analysis should be noted. First, we did not directly analyze data on reported WVCs because MDT declined to release collision data due to privacy concerns. Instead, we used data on recorded wildlife carcasses along highways as an index of WVC risk. In doing so, we assumed that wildlife carcasses found in or adjacent to highway right-of-ways

were killed by WVCs, but this cannot be confirmed, and it is possible that in rare cases animals may have died of other causes. We believe carcasses are a reasonable and meaningful index of collisions because the vast majority of large animals found dead along highways likely died from collisions, and any carcasses that may have resulted from mortality sources other than WVCs are sufficiently rare as to have negligible impact on our analysis of WVC high-risk zones. Furthermore, we believe that any large animal on or immediately adjacent to a roadway, regardless of its cause of death or the extent of WVC-related damage, presents a serious human safety risk and thus warrants increased driver alertness.

A second limitation is that uneven carcass collection effort across the state meant that carcass data may have been a biased sample of WVC risk. MDT has issued this disclaimer regarding use of carcass data:

*“The MDT carcass database contains information on carcasses collected by MDT maintenance personnel; however, not all carcass collection is reported consistently or on a regular schedule. This makes the information provided by the carcass database useful for pattern identification, but not statistically valid.”*

The main implication of this limitation is that additional high-risk zones may exist in unidentified areas where collision rate is high but reporting rate is low, and our rankings of high-risk zones could have been biased by missing carcass data. At a minimum, however, we identified known highway sections with high WVC risk based on available reporting, and these areas deserve further attention. Because carcass reporting is inconsistent (as acknowledged in the above disclaimer), our analysis may also have underestimated the rate at which ungulates were killed on highways in some areas.

Third, the MDT carcass database likely did not include carcasses that were removed by residents who were issued roadkill salvage permits by Montana Fish, Wildlife and Parks starting in 2014. More than 2,000 of these permits were issued in the past two years<sup>13</sup>, suggesting that the carcass database could have been missing up to 7% of carcasses. However, unless the spatial distributions of salvaged carcasses and MDT-recorded carcasses differed dramatically, this limitation would have had little impact on our high-risk zone identification, other than to lead us to slightly underestimate carcass rates across the state.

Finally, the MDT carcass database may have contained errors. For instance, the database included records of grizzly bear carcasses along highways that are outside of grizzly bears' current known range, suggesting that the species of these carcasses was misidentified. We believe such errors had little influence on our high-risk zone analysis because (1) we did not distinguish between ungulate species when determining high-risk zones, and (2) we expect that there are relatively few such errors among the >36,000 carcass records.

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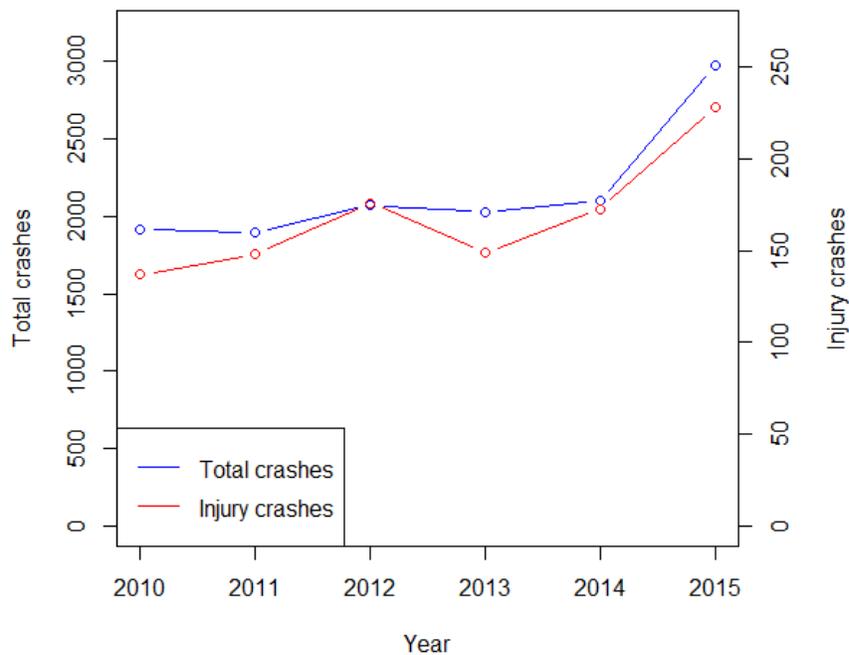
**Table 1.** Ten-mile-long highway sections (“high-risk zones”) with the greatest number of recorded ungulate carcasses during fall months of 2010-2015.

Rank	Highway	Section <sup>1</sup>	Carcasses recorded <sup>2</sup>	Carcass rate <sup>3</sup>
1	US-93	MP 94 - 104	357	5.95
2	US-191	MP 72 – 82	242	4.03
3	US-212	MP 83 – 93	160	2.67
4	US-212	MP 70 – 80	153	2.55
5	Route 269	MP 8 – 18	152	2.53
6	I-90 E	MP 373 – 383	144	2.40
7	US-287	MP 79 – 89	134	2.23
8	US-93	MP 43 – 53	130	2.16
9	MT-287	MP 25 – 35	125	2.08
10	MT-41	MP 47 – 57	125	2.08

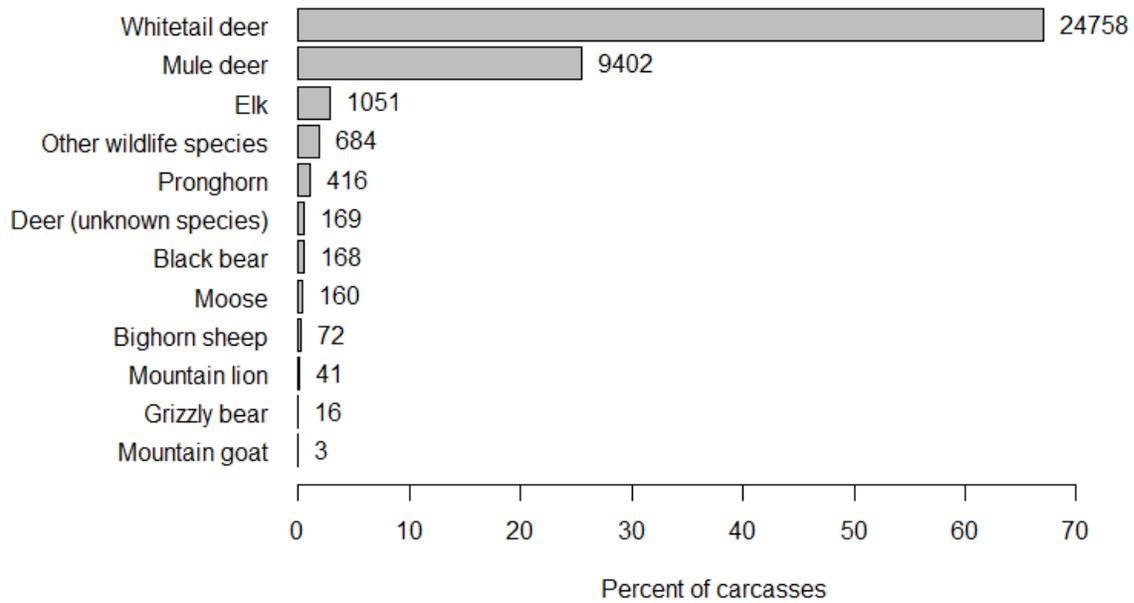
<sup>1</sup> Beginning and ending mileposts of ten-mile-long section

<sup>2</sup> Total number of carcasses recorded during fall months (Oct.-Dec.) of 2010-2015 within ten-mile-long high-risk zone

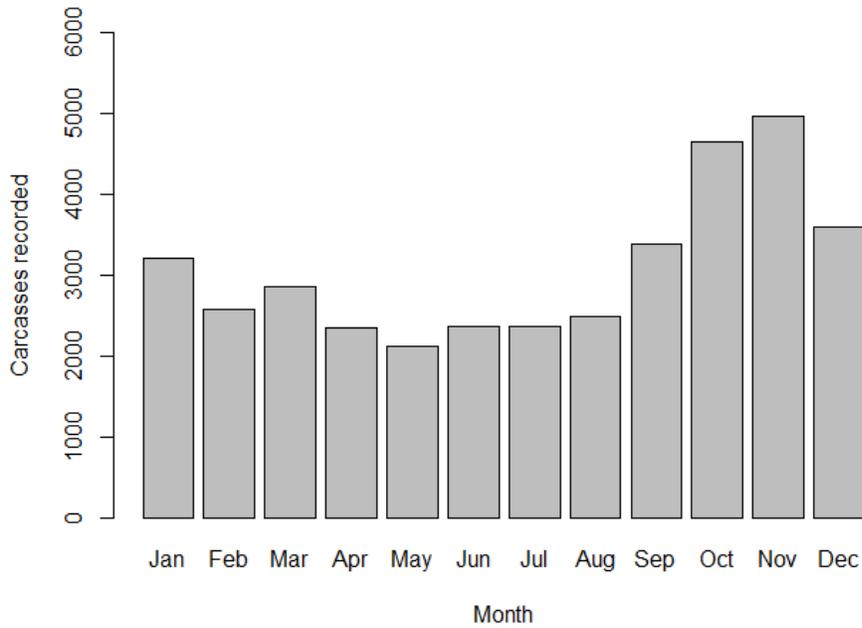
<sup>3</sup> Mean number of carcasses recorded per mile each fall within ten-mile-long high-risk zone



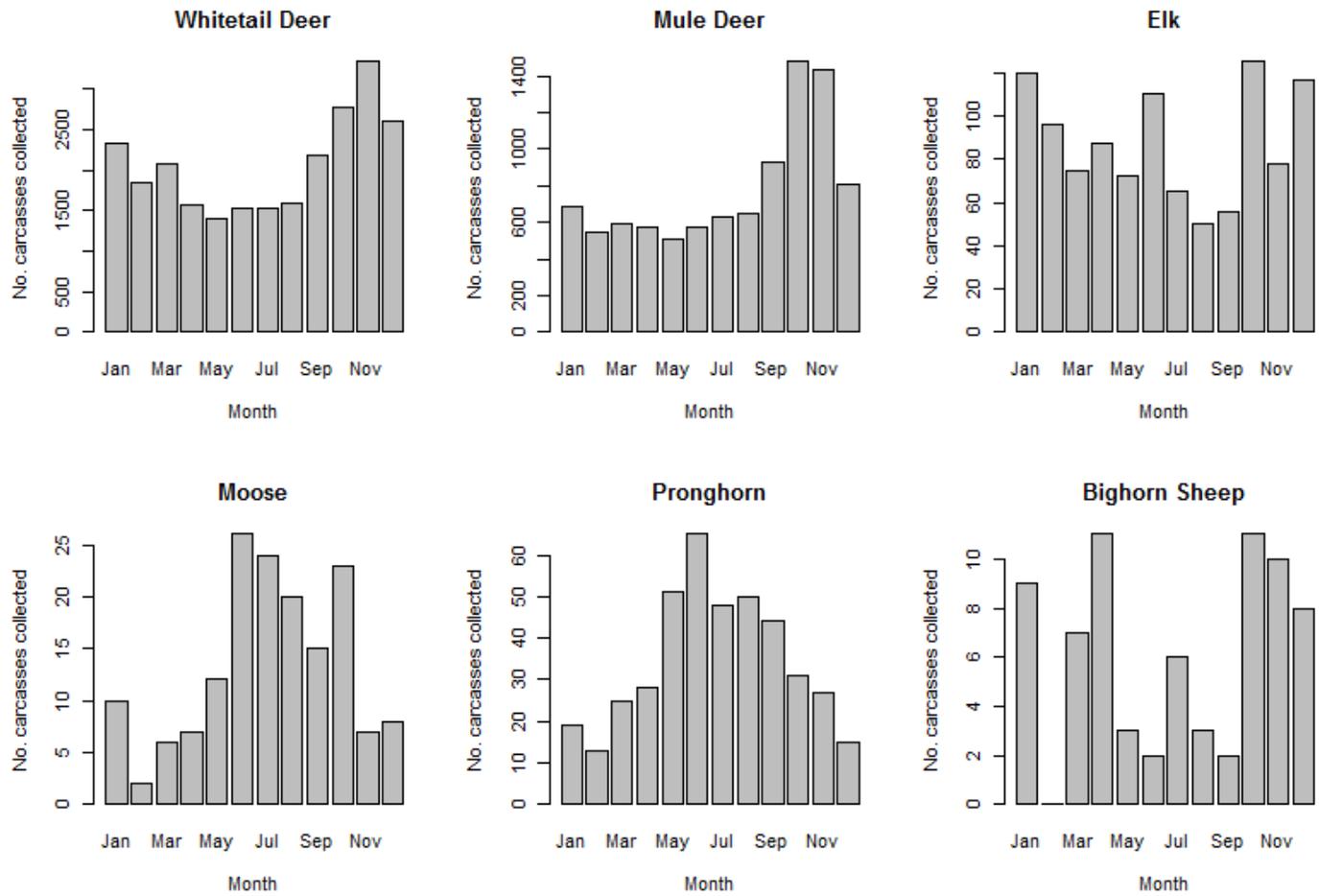
**Figure 1.** Reported crashes during 2010-2015 in which collision with a wild animal was the first harmful event. Source: Montana Highway Patrol Annual Reports, 2010-2015.



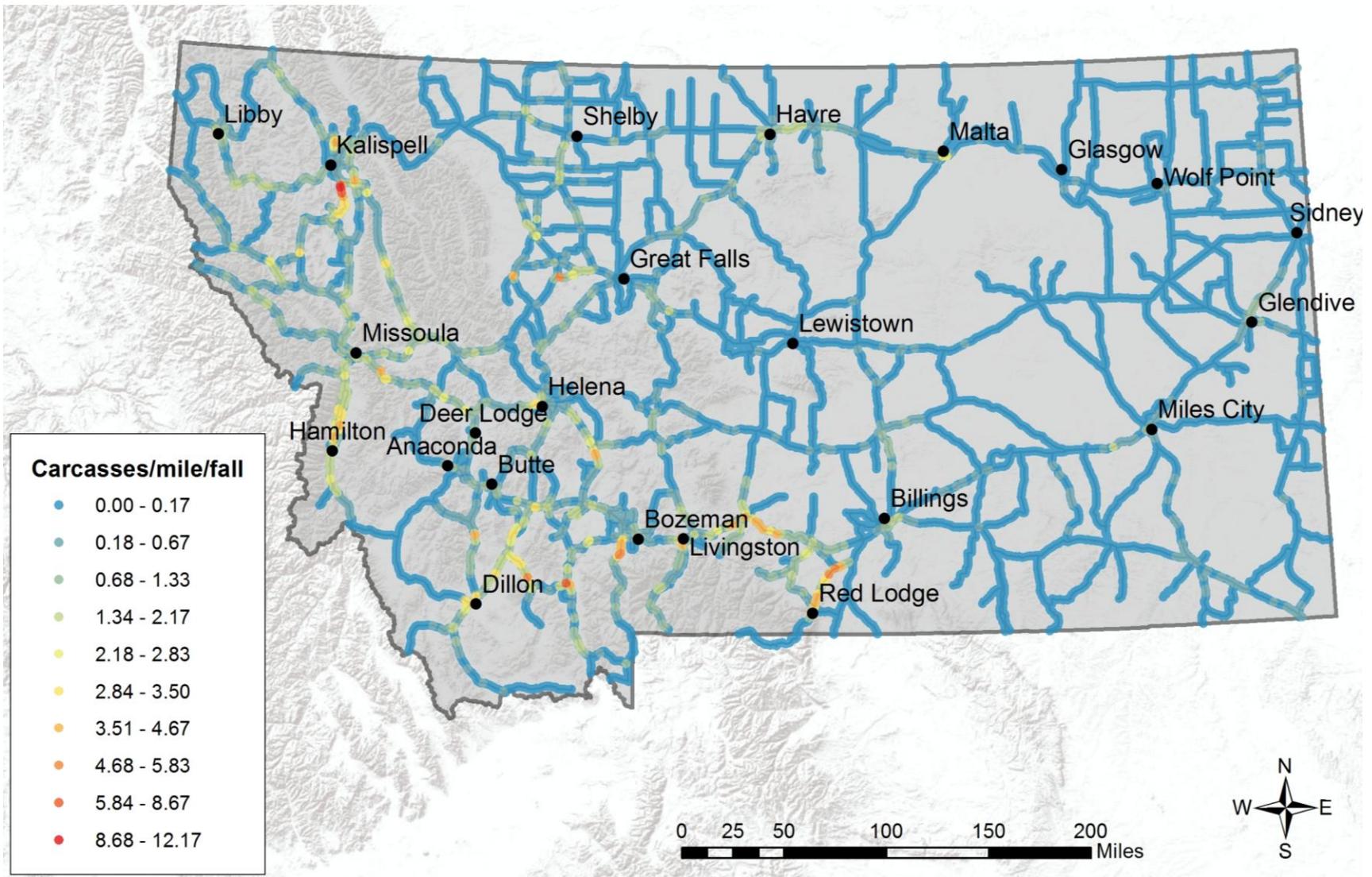
**Figure 2.** Wildlife carcasses of each species in the 2010-2015 MDT carcass database. Numbers to the right of bars show carcass counts for each species. Carcass records for domestic animals (n=157) and animals that could not be identified as wildlife species (n=319) were not included in the analysis.



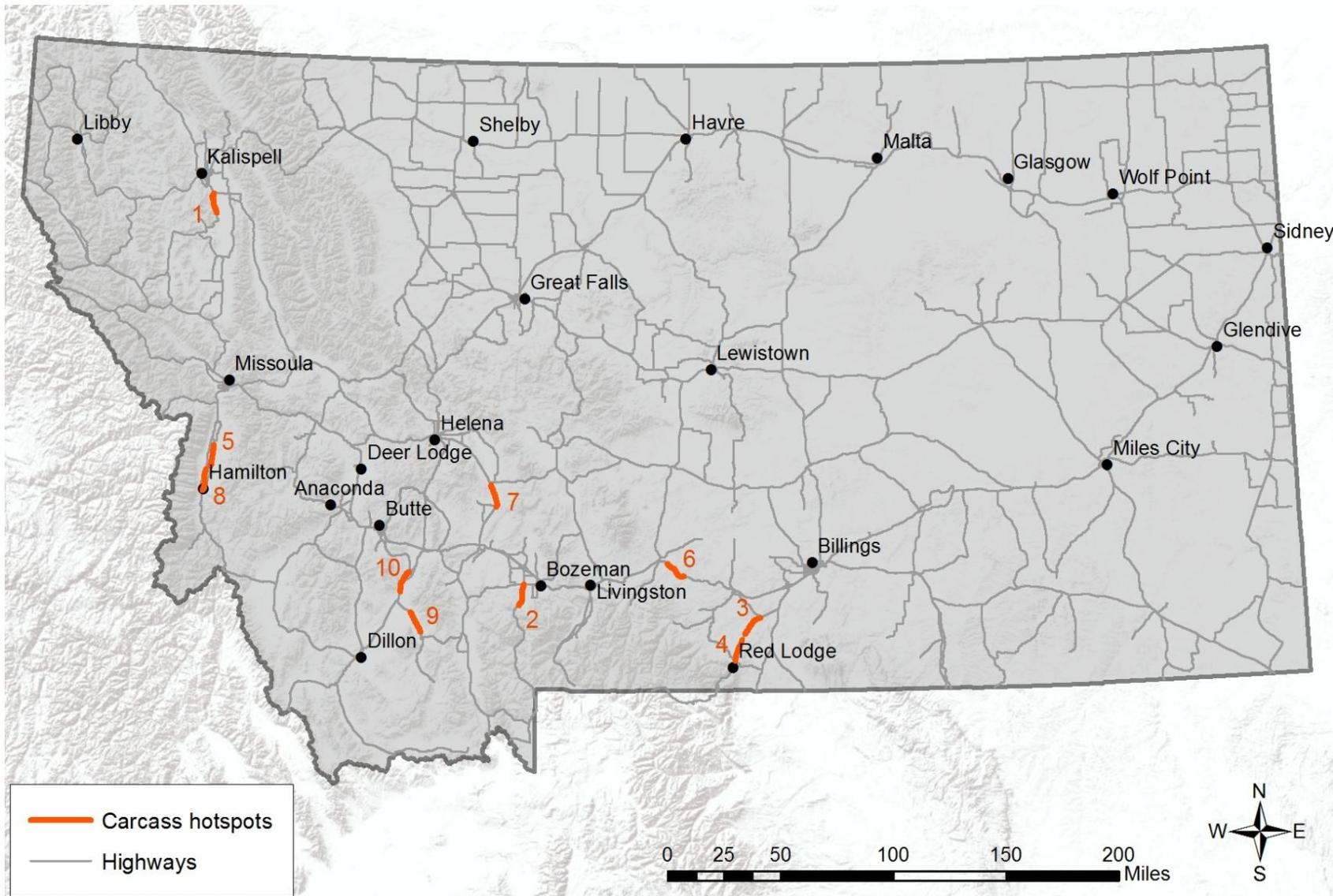
**Figure 3.** Wildlife carcasses (of all species) recorded by MDT during each month, 2010-2015.



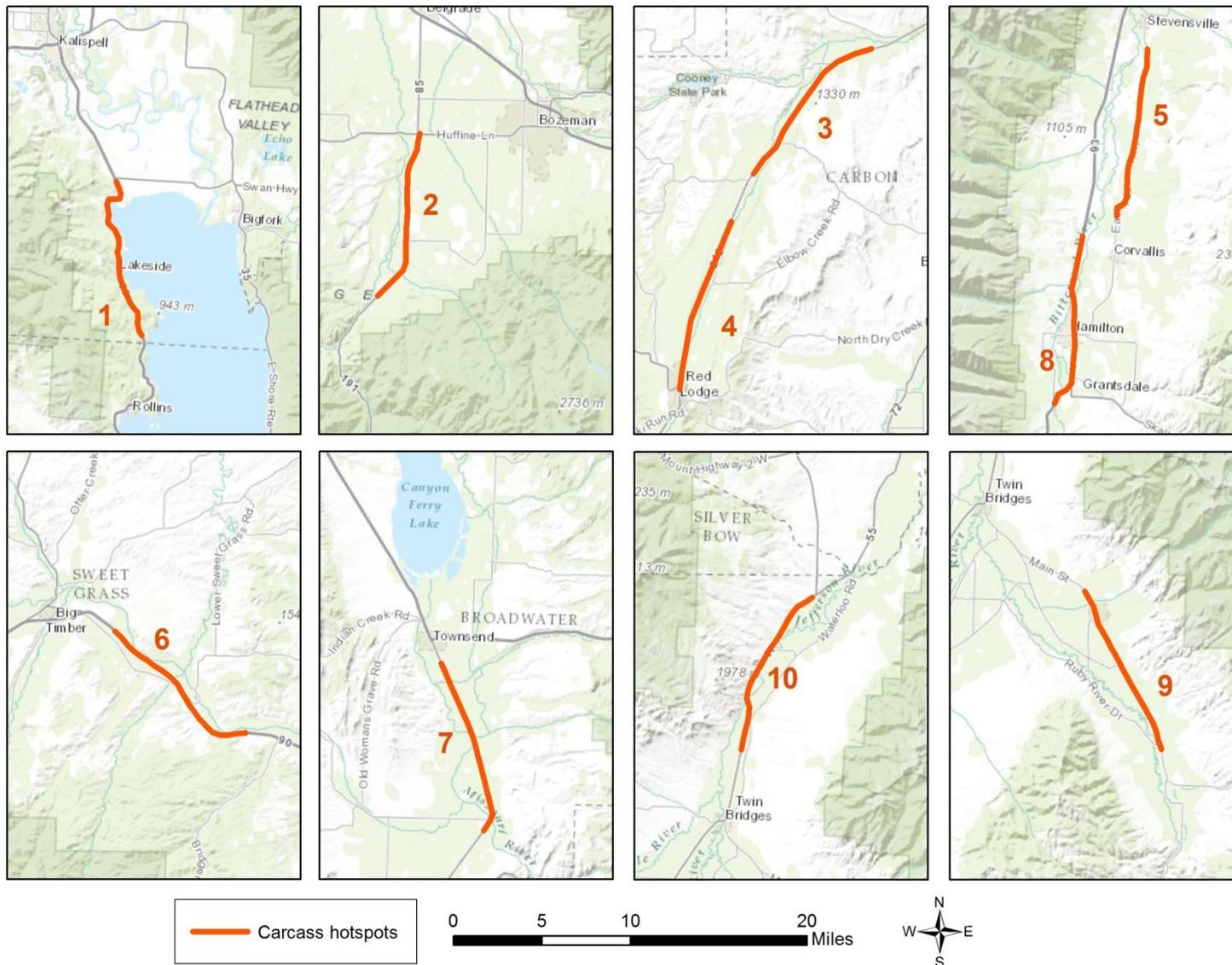
**Figure 4.** Wildlife carcasses recorded by MDT along highways during each month, 2010-2015, for six migratory ungulate species considered in this analysis.



**Figure 5.** Mean number of ungulate carcasses recorded per highway mile during fall (Oct.-Dec.) of each year, 2010-2015.



**Figure 6.** Top ten high-risk zones (ten-mile-long highway sections) for fall ungulate carcasses along highways in Montana, 2010-2015. High-risk zone numbers in map correspond to ranks in Table 1.



**Figure 7.** Fine-scale maps of top ten high-risk zones. High-risk zone numbers in maps correspond to ranks in Table 1.