Jackson Hole Wildlife Foundation's
Teton County Wildlife-Vehicle Collision Database
Summary Report

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Table of Contents

List of Figures

List of Tables

Abstract

Wildlife-vehicle collisions (WVCs) are a serious safety concern for motorists and can be a significant source of mortality for wildlife. Teton County, Wyoming is renowned for its biodiversity and abundance of wildlife; however, many roadways cut across important wildlife habitat and migration corridors, putting both wildlife and motorists at risk for collisions. Understanding where and when WVCs occur, wildlife species involved, and trends over time are crucial in developing comprehensive mitigation strategies for future transportation planning and development. Many governmental agencies and non-profits in Teton County collect data on WVCs, but we have lacked a central, standardized database to house this information. To fill this need, the Jackson Hole Wildlife Foundation (JHWF) contracted Teton Science Schools Teton Research Institute to compile data from 7 existing WVC data sources, identify and remove duplicate observations and errors, and standardize the data into one format. The resulting Wildlife-Vehicle Collision Database contains 3,838 unique roadkill observations from 1990-2012. This database is now the most comprehensive and accurate source of WVC data for Teton County. There are 26 wildlife species represented in the database. Ungulate-vehicle collisions, including mule deer, elk, moose, white-tailed deer, bighorn sheep, and pronghorn, comprise 98% of observations. Of these, mule deer account for 69%. The number of annual WVCs has increased steadily from 1990 to 2012, with an average of 242 WVCs occurring each of the last 3 years. The majority of WVCs occur during the winter, in December and January. We performed a density analysis using this database for the purpose of locating road segments in Teton County that have consistently high densities of WVCs. We conducted this analysis for all species combined, and deer, elk, and moose separately. This analysis was similar to one produced by the Western Transportation Institute in 2011, but our analysis identified several additional hotspot locations due to our improved database. The Wildlife-Vehicle Collision Database is housed and administered by the JHWF. It is now available for requests associated with transportation planning, wildlife management, and research. The JHWF intends to update the Wildlife-Vehicle Collision Database annually.

Introduction

Wildlife-vehicle collisions (WVCs) are a serious safety concern for motorists and can be a significant source of mortality for wildlife (Huijser et al. 2008). The total number of large mammal-vehicle collisions has been estimated at one to two million in the United States annually (Huijser et al. 2008). Many of these collisions are economically costly; on average, a collision with a deer costs $6,617, an elk costs $17,483, and a moose costs $30,760 (Huijser et al. 2009). Collisions with small mammals or birds are rarely tracked and few studies have addressed these species (*although see* Barthelmess 2014). Studies usually do not take into account the added economic value of wildlife to communities for tourism or hunting, the intrinsic value of wildlife to the public, or the potential effect of WVCs on population viability, migration, and habitat connectivity (Huijser et al. 2009).

Teton County, Wyoming, is home to abundant wildlife populations, including many large mammals such as elk, mule deer, and moose. Many roadways in Teton County cut across important wildlife habitats and migration corridors (Biota Research and Consulting 2003, Huijser et. al. 2011, Riginos et al. 2013). Both the human population and traffic volume have increased over the past decade. Permanent residents grew by 16.7% between 2000 and 2010 (U.S. Census Bureau 2010) and traffic volumes along certain road segments have increased over the same time period. The necessity to identify and mitigate WVCs in Teton County is a priority for local wildlife managers, the public, and local and state governments (Jackson/Teton County Comprehensive Plan 2012). However, information on WVCs is collected and stored by various agencies and non-profit organizations, making it difficult to use for planning and research. There have been several efforts to evaluate WVCs in Teton County (Biota Research and Consulting 2003, Huijser et al. 2011), but each has relied on only a portion of the existing data. Therefore, compiling all available WVC data from the multitude of data sources to create a comprehensive database for Teton County is crucial to evaluating and reducing road impacts on wildlife.

The Jackson Hole Wildlife Foundation (JHWF) began a project in 2011 to develop a comprehensive WVC database for Teton County, with assistance from the Teton Science Schools Teton Research Institute (TSS-TRI). The goal was to collate available WVC data and standardize them so that they could be viewed and utilized in their entirety. Obtaining a comprehensive concept of the WVC situation in Teton County has historically been difficult and required significant time to make data requests to numerous agencies and non-profits that collect and store their own data. We expect that JHWF's Wildlife-Vehicle Collision Database will serve as a hub to bring together data for use by town and county planners, wildlife managers, elected officials, state transportation planners, scientific researchers, and others. The database serves as a tool to make scientifically-based decisions regarding WVC mitigation and transportation management.

This summary report describes the sources of data and contributing partners, the content of the database, basic summary statistics, an analysis of WVC spatial patterns in Teton County, a plan for future updates, and instructions for requesting data.

Methods

Roads

The Wildlife-Vehicle Collision Database contains data for the following highways and roads in Teton County (Figure 1):

U.S. Highways

- U.S. Highways 189/191 (Hoback Junction to Teton County line in Hoback Canyon)
- U.S. Highway 26/287 (Eastern boundary of Grand Teton National Park to Teton County line near Togwotee Pass)
- U.S. Highway 26/89 (Hoback Junction to Teton County line in Snake River Canyon)
- U.S. Highway 26/89/189/191 (Hoback Junction to Jackson)
- U.S. Highway 26/89/191 (Jackson to southern boundary of Grand Teton National Park)

State Highways

- Wyoming Highway 390
- Wyoming Highway 22

Teton County Roads

- Alta Ski Hill Road
- Buffalo Valley Road
- Elk Refuge Road
- Fall Creek Road
- Fish Creek Road
- Henry's Road
- South Park Loop Road
- Spring Gulch Road

The database does not contain WVC data within Grand Teton National Park (GTNP). For WVC data within GTNP, requestors should contact the park directly.

Data Acquisition

The Wildlife-Vehicle Collision Database is a collection of data from 7 sources (Table 1). The JHWF contracted the TSS-TRI to acquire data via formal requests in 2012. These datasets range from 1990-2012 (Table 1). Formal interviews were conducted with each agency or non-profit that shared data to fully understand each dataset's capabilities and limitations.

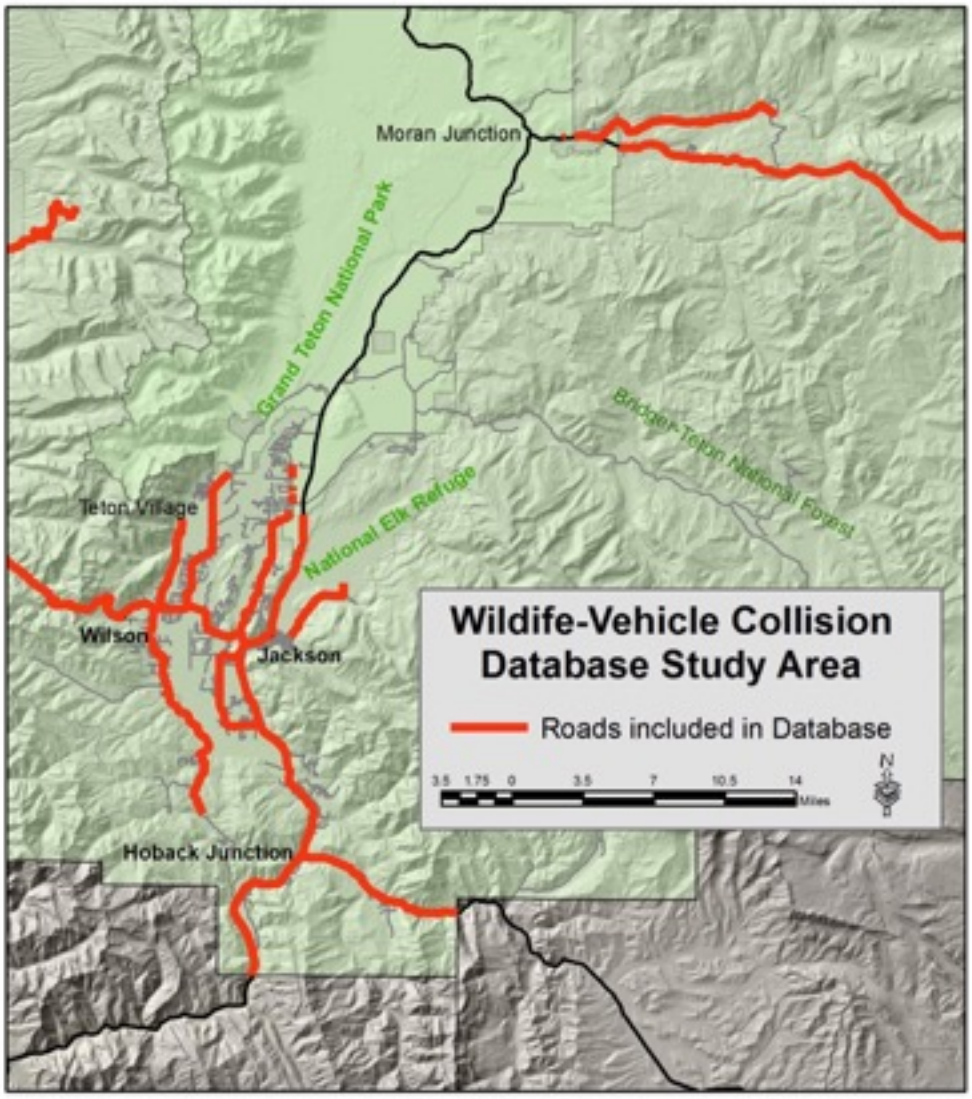

Figure 1. Roads included in Jackson Hole Wildlife Foundation's Wildlife-Vehicle Collision Database for Teton County, Wyoming (red lines).

The method of data collection varies with each data set (Table 1). For example, JHWF Roadkill Hotline and Nature Mapping Jackson Hole rely on volunteers and trained citizen scientists, respectively, to collect data. Most of these observers acquire WVC locations by using an aerial photo from either the Teton County Geographic Information System (GIS) Server or Google Maps. Wyoming Game and Fish Department employees generate observed WVC locations from coordinates acquired using a Geographic Positioning System (GPS) device or aerial photo from the Teton County GIS Server. Wyoming Department of Transportation employees estimate the WVC location to the nearest tenth, half or whole mile, depending on whether the location was from a carcass pick-up or a reported vehicle crash. All of these datasets are included in the

Source	Database	Observers	Method	Start Date	End Date	# Records	% Contribution	Notes
Wyoming Department of Transportation (WYDOT)	Crash data	WYDOT employees	Nearest one tenth mile marker	1/2/1994	12/28/2012	1080	28.1	• Locations collected from police reports from WVCs with over $1,000 of damage • Data is accurate to nearest one tenth mile marker
Wyoming Department of Transportation	Carcass pick-up data	WYDOT employees	Nearest mile marker	1/6/1996	12/28/2012	967	25.2	• Locations collected by maintenance crews that pick-up carcasses from roads • Data is accurate to nearest mile marker
Wyoming Game and Fish Department (WGFD)	Wildlife Observation System	WGFD biologists and game wardens	GPS coordinates	3/22/1990	8/18/2012	159	4.1	• Coordinates found using GPS or aerial photo • Data is entered by WGFD employees
Jackson Hole Wildlife Foundation (JHWF)	Nature Mapping	Trained citizen scientists	GPS coordinates/ aerial photo	6/11/2010	12/16/2012	73	1.9	• Local trained citizen scientists enter observations via online entry form • Coordinates found using GPS or aerial photo
Jackson Hole Wildlife Foundation	Roadkill Hotline	Volunteers	GPS coordinates generated from verbal description	1/7/2012	12/25/2012	22	0.6	• Hotline where community members call to report roadkill • Coordinates generated from aerial photos via the caller's verbal description
Jackson Hole Wildlife Foundation	Biota Research & Consulting Report	Mixed	Mixed	1/2/1990	12/31/2003	1130	29.4	• Report contracted by the JHWF to compile WVC data in 2003
Jackson Hole Wildlife Foundation		Mixed	Mixed	11/26/2002	12/8/2010	407	10.6	• JHWF database with mixed data sources

Table 1. Information about sources and databases incorporated into the Jackson Hole Wildlife Foundation's Wildlife Vehicle Collision Database (1990-2012). Types of observers, method of data collection, date ranges, number of records, and percent contribution to the database are included for each data source. Number of records and percent contribution were calculated after data cleaning occurred (removal of duplicates and other errors).

Wildlife-Vehicle Collision Database, regardless of data collection method. However, understanding how the data were collected is important for future analyses.

Database Development and Content

The JHWF contracted TSS-TRI to acquire, visualize, review, and combine data from all available sources for Teton County into one comprehensive database (Table 1). Since some data were reported as GPS coordinates and others as tenth, half, or whole mile markers, an effort was made to standardize the data spatially. The TSS-TRI created a 1/10th mile marker reference shapefile in ArcGIS (version 10) to accomplish this. All WVC observations with route and milepost information were spatially joined to the 1/10th mile shapefile. Observations without route and milepost information (mostly GPS coordinates) were snapped spatially to the nearest major road, and then to the nearest 1/10th mile marker. Observations located more than 500 feet from a major road were considered errors and removed. The resulting product is a database containing WVC observations that are standardized spatially to the nearest 1/10th mile marker.

Because the same WVC may be recorded by multiple sources, we checked for potential duplicate observations in the database. We also checked for large errors in spatial location and species names. The following methodology was used:

1) Observations with "Other", "Other wild" or "Unknown" listed as the animal species were removed.
2) Fields from multiple datasets were standardized.
3) If multiple observations had the same carcass number (for WYDOT data), they were considered duplicates. The observation with the most complete information was retained and others were deleted.
4) Observations were flagged as potential duplicates if they occurred within 0.2 miles of each other and had the same date and species. WGFD WOS records were checked for duplicates within 0.5 miles.
5) All flagged potential duplicates (or triplicates) were individually checked. If accompanying information, such as sex and age were the same, the observation with the most complete information was retained and others were deleted.

The resulting database has a standardized format with potential duplicates removed. Each record has accompanying information such as date, time, carcass number (for WYDOT observations), species common name, age, sex, route number, mile post number, 1/10th mile marker number, road name, etc. The date and time refer to when the carcass observation was made, not necessarily when the WVC occurred.

Wildlife-Vehicle Collision Density Analysis (Hotspots)

Using the new database, we completed a density analysis to identify locations in Teton County with relatively high, moderate, and low densities of WVCs. We followed the methodology used in a report prepared for the Jackson Hole Conservation Alliance by the Western Transportation Institute, titled "Highway Mitigation Opportunities for

Wildlife in Jackson Hole, Wyoming" (Huijser et.al. 2011). We identified and quantified WVC clusters or "hotspots" for 1/10th mile road segments. We chose to omit WYDOT carcass pick-up data from this analysis because these data are only accurate to the nearest whole mile and would have strongly biased the results to whole mile markers. (However, WYDOT carcass pick-up records are retained in the overall Wildlife-Vehicle Collision Database.) We completed a density analysis on the resulting shapefiles for all species (3,838 observations), elk-only (748 observations), deer-only (2,680 observations), and moose-only (353 observations). Deer included mule deer, white-tailed deer, and "deer" (species not identified). We produced a raster image with color variance representing the relative density of wildlife-vehicle collisions along the routes within the study area for all species, deer, elk, and moose. The rasters exclude U.S. Highway 26/287 (Togwotee Pass area) and Alta Ski Hill Road due to minimal WVCs present in the database along these routes. We did not analyze how WVCs have changed over time at these "hotspot" locations.

Results and Discussion

Wildlife Species

In total, we received 7,398 raw WVC observations from 7 separate datasets spanning 1990-2012. After identifying and removing errors and duplicate observations, the final database contains 3,838 WVC records (a 48% reduction). Most of this reduction was caused by duplicate or triplicate observations that appeared in datasets from different sources. This demonstrates the importance of screening for duplicate observations. The database has many capabilities due to its large amount of data, universal format, and the effort taken to remove duplicate records and errors. This database is now the most comprehensive and accurate source of WVC data for Teton County.

There are 26 species with at least one WVC record in the database (Table 2). Ungulate-vehicle collisions—including bighorn sheep, mule deer, white-tailed deer, moose, elk and pronghorn—comprise 98 percent of the data, with mule deer equaling 69% (Table 2). This bias toward ungulate WVC observations is for several reasons. The majority of records (53%) are from WYDOT crash data and carcass pick-up data, which are almost always large mammals. Collisions with large animals are more likely to result in significant vehicle damage, leading to a police report and a record of the event in the WYDOT crash dataset. Also, WYDOT maintenance crews are more likely to remove large mammal carcasses from the roadway than smaller mammals or birds, leading to a record in the WYDOT dataset (Wyoming Department of Transportation, *pers. comm*.). Furthermore, large animals are easier for citizen scientists (JHWF-Nature Mapping) and biologists or game wardens (WGFD) to notice and identify, leading to more recorded observations. Undoubtedly, small and medium-sized mammals, birds, amphibians, and reptiles are underrepresented in the database. Additional efforts to record WVCs for these species will be important in the future to assess impacts of roadways on all wildlife, not just ungulates.

In general, it is well-recognized that reported WVCs are an underrepresentation of the true number of WVCs that occur (Huijser et al. 2008). The 3,838 WVCs recorded in this database should be considered a minimum estimate of the actual number of WVCs in Teton County, even for species such as mule deer. Continued efforts by WYDOT crews, WGFD biologists and wardens, JHWF volunteers, and trained Nature Mapping citizen scientists to accurately record WVCs are vitally important to making this database the best resource possible.

Table 2. Number of observations by species in the Wildlife-Vehicle Collision Database.

Common Name	**Count**
American marten	4
American mink	1
Barrows goldeneye	1
Bighorn sheep	1
Black bear	3
Black-billed magpie	1
Common raven	1
Coyote	3
Deer (no species listed)	37
Deer mouse	1
Elk	748
Fox (no species listed)	3
Gray wolf	1
Great horned owl	1
Greater sage-grouse	1
Moose	353
Mountain lion	1
Mule deer	2634
North American porcupine	11
Northern raccoon	8
Pronghorn	4
Red fox	5
Ruffed grouse	1

Short-tailed weasel	1
Skunk	2
Snowshoe hare	1
Western tanager	1
White-tailed deer	9
Total	**3838**

Wildlife-Vehicle Collision Trends

The annual number of WVCs has increased steadily from 1990 to 2012 (Figure 2). The number of WVCs per year fluctuates, depending on winter conditions. During severe winters, more ungulates congregate at low elevations in close proximity to roads. When three-year averages are considered, there is clearly an increasing trend (Figure 3). From 2010 to 2012, there was an average of 242 WVCs per year.

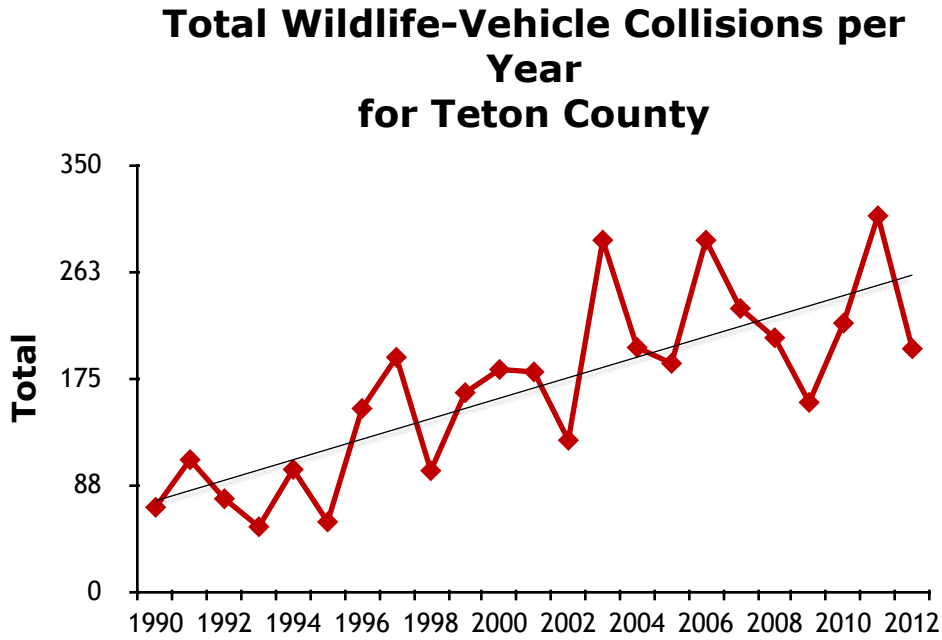

Figure 2. Total annual wildlife-vehicle collisions for Teton County from 1990-2012, from Jackson Hole Wildlife Foundation's Wildlife-Vehicle Collision Database (red line). The black line represents the linear trend.

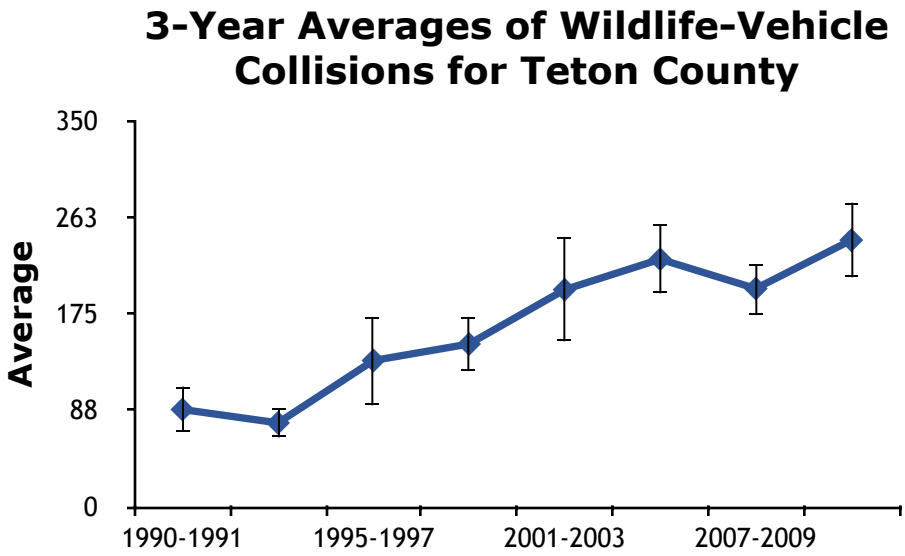

Figure 3. Three-year averages of total annual wildlife-vehicle collisions for Teton County from 1990-2012, from Jackson Hole Wildlife Foundation's Wildlife-Vehicle Collision Database. Error bars are ± 1 standard error.

Seasonal Trends

Most WVCs occur during the winter months (December-January). Conversely, the summer months (July - September) see the fewest wildlife-vehicle collisions (Figure 4). In the past, much attention has been focused on reducing WVCs during the migratory periods of spring and fall when ungulates are making long distance movements between their summer and winter ranges. However, this database and recent results from a local mule deer study (Riginos et al. 2013) indicate that most WVCs occur during the winter. In fact, Riginos et al. 2013 found that only 4.7% of road crossings by GPS-collared mule deer were during migration. In Teton County, much of the winter range for moose, mule deer, and elk is located at low elevations in close proximity to roads. Animals often cross roads on a daily or weekly basis to access resources and habitats that they need to survive (Riginos et al. 2013), increasing the chances of WVCs.

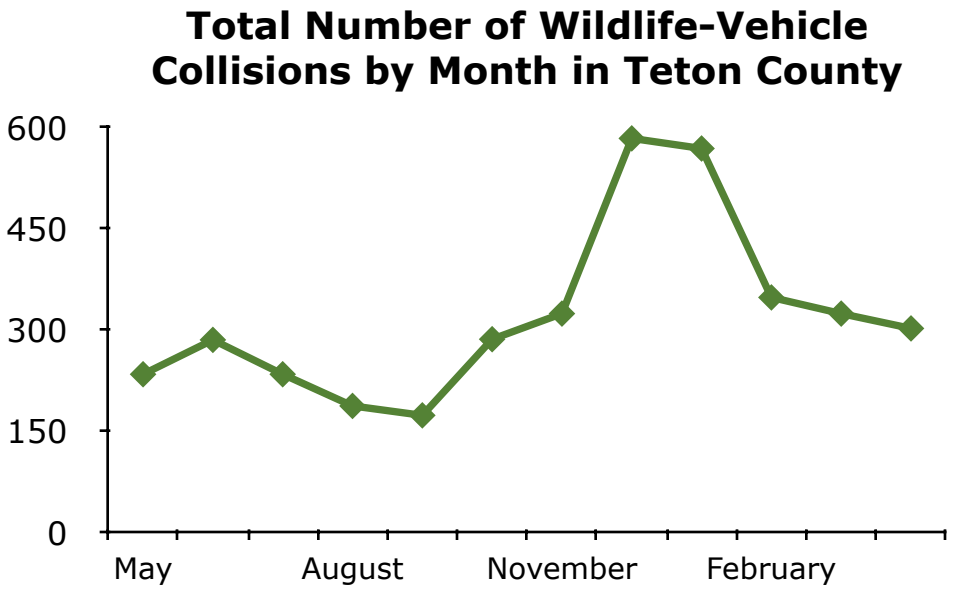

Figure 4. Monthly variation in average numbers of wildlife-vehicle collisions in Teton County, Wyoming.

All Wildlife-Vehicle Collision Densities (Hotspots)

Our analysis revealed there are several areas with relatively high WVC occurrence (when combining all species) (Figure 5). However, it is important to note that these "hotspots" are heavily influenced by mule deer collisions since these represent 69% of WVCs in the database. The highest densities occurred along Broadway Avenue (U.S. Highway 26/89/189/191) between Albertson's and Staples, at several locations between Jackson and Hoback Junction (U.S. Highway 26/89/189/191), and near Fish Hatchery Hill (U.S. Highway 26/89/191). These locations are similar to those identified by Huijser et al. 2011. However, our analysis identified additional moderate hotspots just north of the Jackson Hole and Greater Yellowstone Visitor Center on U.S. Highway 26/89/191 and near Kmart on U.S. Highway 26/89/189/191.

Deer-Vehicle Collision Densities

We found interesting differences in WVC hotspots when analyzing elk, moose, and deer separately. The highest densities of deer-vehicle collisions were similar to the all-species analysis, with the highest densities occurring on Broadway Avenue (U.S. Highway 26/89/191) between Albertson's and Staples (Figure 6). Deer-vehicle collision hotspots identified by our analysis generally coincide with those identified by Riginos et al. 2013 in a recent mule deer study using GPS collars. Interestingly, Riginos et al. 2013 identified additional crossing locations using by GPS-collared mule deer that do not show up as WVC hotspots in our analysis. These crossing locations do not seem to result in many deer-vehicle collisions. These locations are on South Park Loop Road on the south side of High School Butte, Wyoming Highway 390 by the Aspens subdivision, and several on Spring Gulch Road.

Elk-Vehicle Collision Densities

The highest densities of elk-vehicle collisions occurred near Game Creek (U.S. Highway 26/89/191), near the Skyline subdivision (Wyoming Highway 22), along West Gros Ventre Butte (Wyoming Highway 22), and adjacent to the National Elk Refuge (U.S. Highway 26/89/191) (Figure 7). All of these areas are known crossing points for elk that are accessing winter feedgrounds.

Moose-Vehicle Collision Densities

The highest densities of moose-vehicle collisions occurred at several locations on the Teton Village Road (Wyoming Highway 390), on the west side of Teton Pass (Wyoming Highway 22), on the east side of Teton Pass above Wilson (Wyoming Highway 22), near the intersection of Wyoming Highway 22 and Wyoming Highway 390, and at several locations around the Town of Jackson (Figure 8).

Database Capabilities and Limitations

The JHWF Wildlife-Vehicle Collision Database is the most comprehensive source of WVC information for Teton County. The database will be useful for tracking trends in WVCs (especially for ungulates) over time county-wide and for specific road segments. It should serve as the best resource for town and county planners, local researchers, non-profits, and government agencies who are interested in answering questions about WVCs.

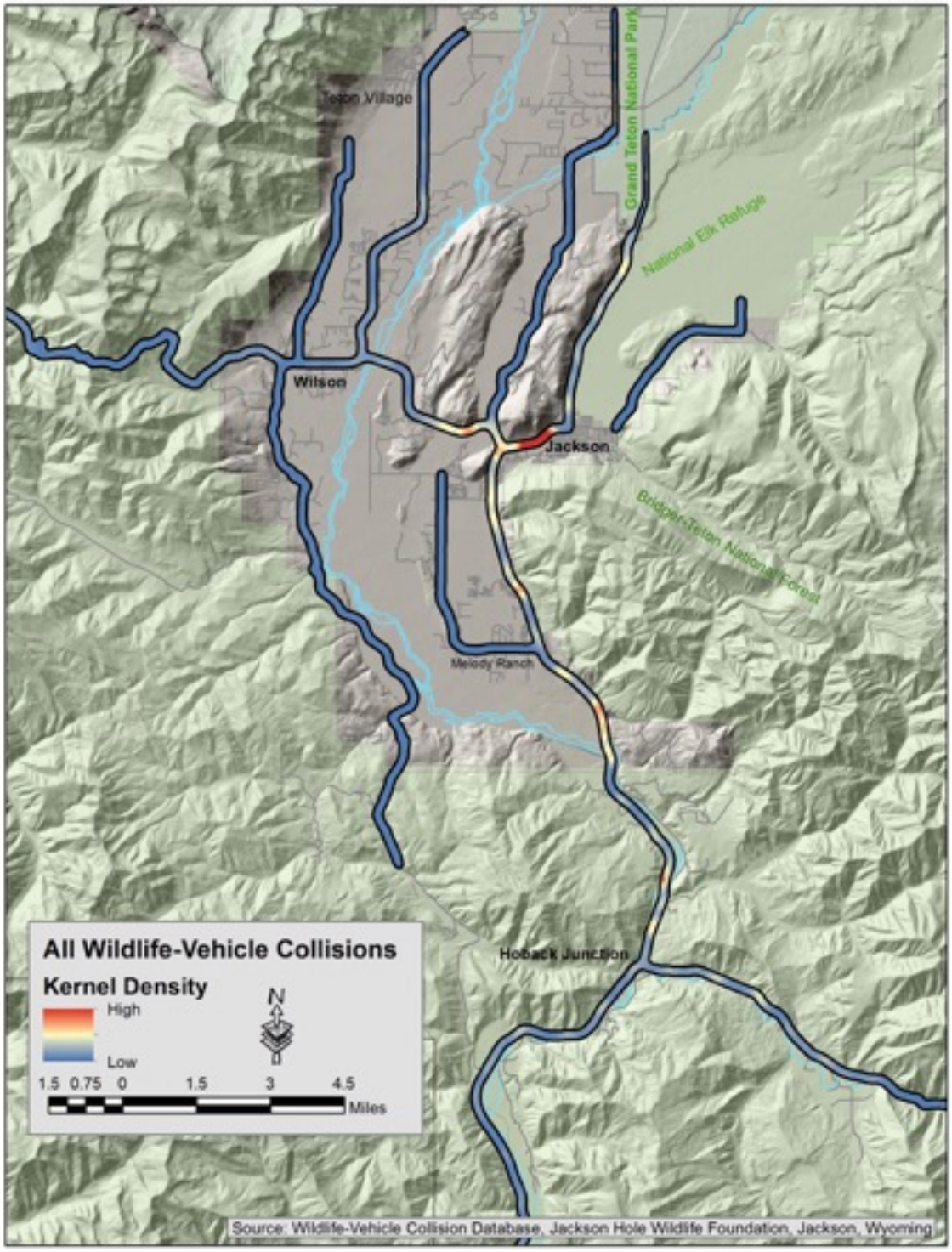

Figure 5. Relative density of all wildlife-vehicle collisions in Teton County, Wyoming from Jackson Hole Wildlife Foundation's Wildlife-Vehicle Collision Database. Road segments highlighted in red represent relatively high densities of wildlife-vehicle collisions (hotspots), and blue represents relatively low densities.

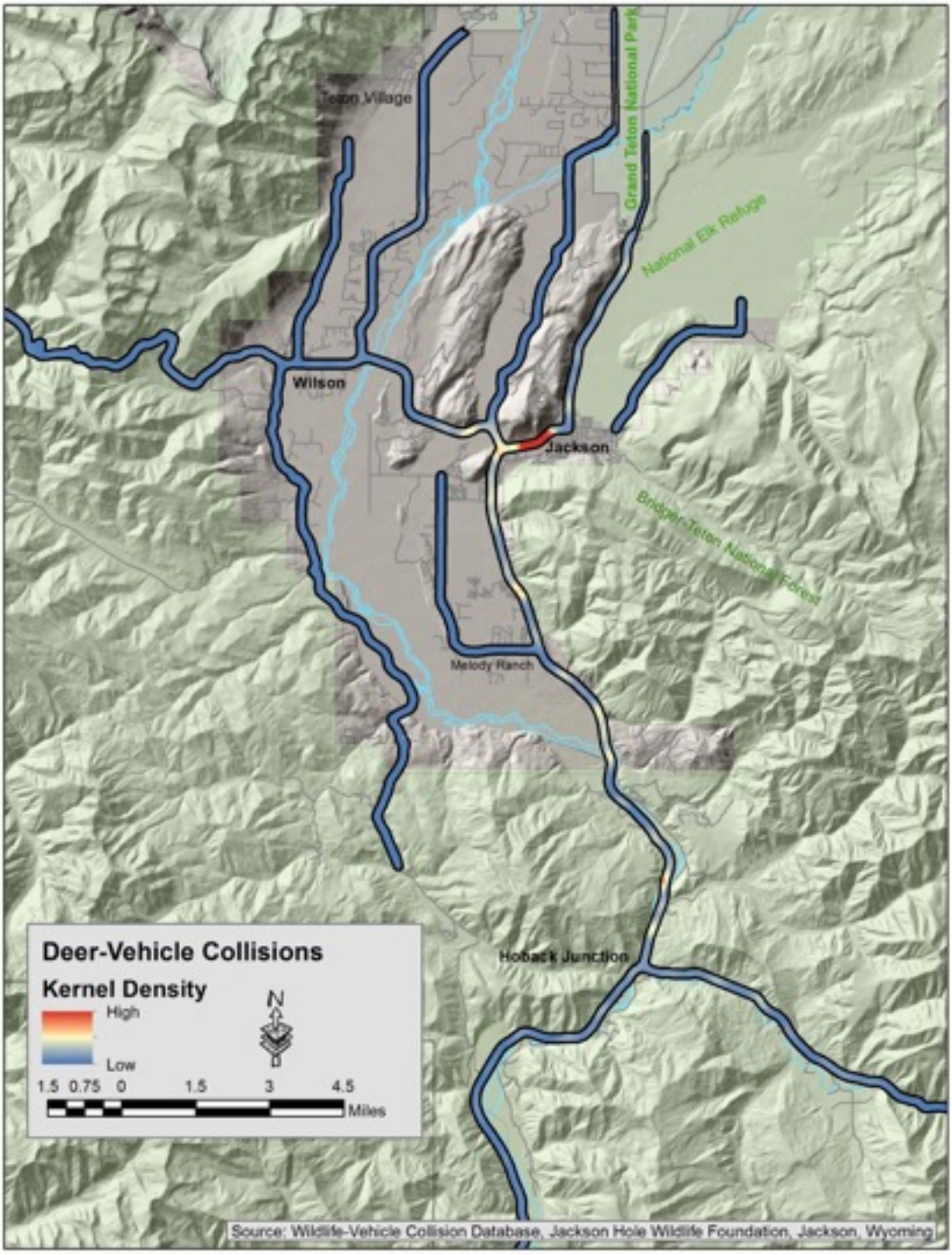

Figure 6. Relative density of deer-vehicle collisions in Teton County, Wyoming from Jackson Hole Wildlife Foundation's Wildlife-Vehicle Collision Database. Road segments highlighted in red represent relatively high densities of deer-vehicle collisions (hotspots), and blue represents relatively low densities.

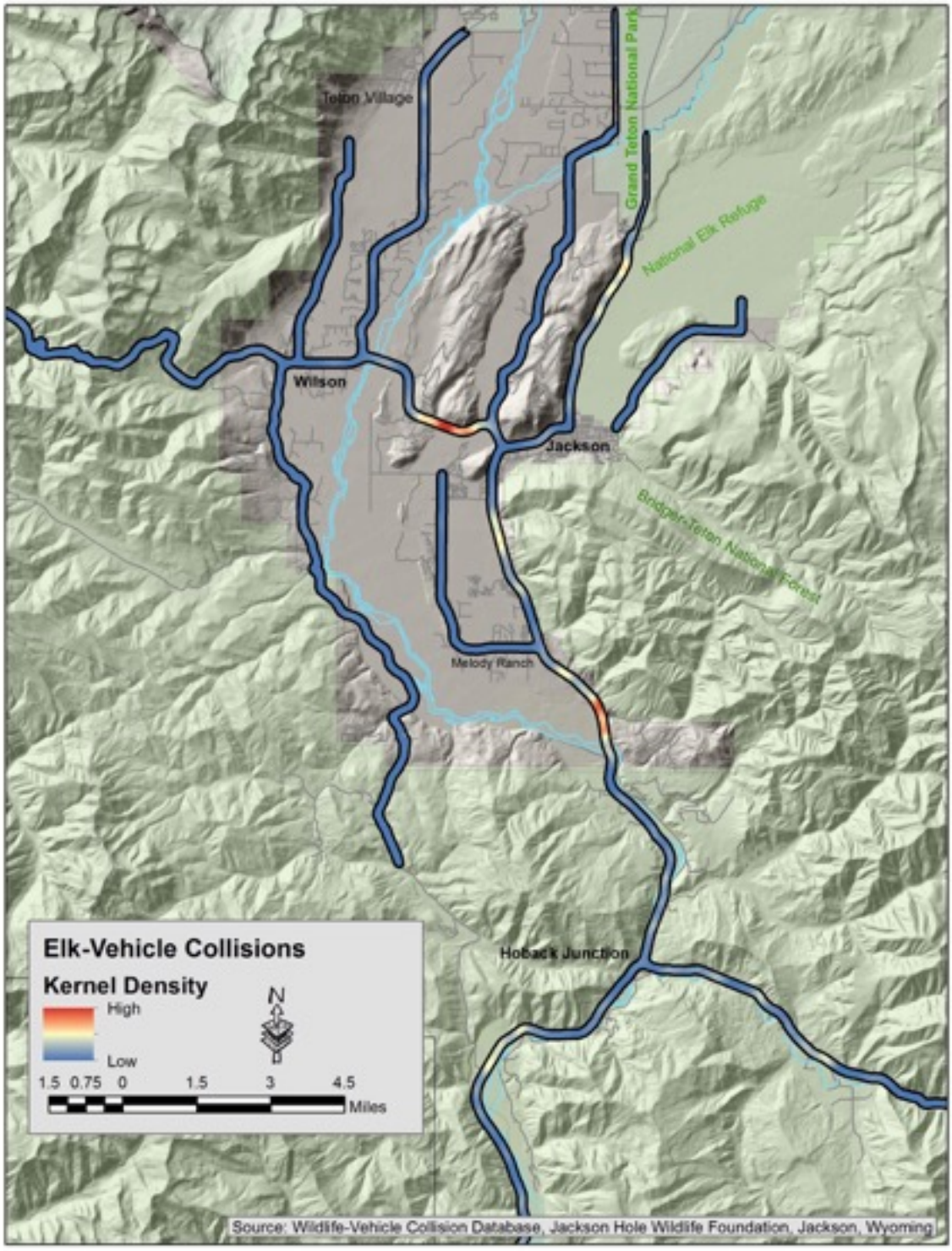

Figure 7. Relative density of elk-vehicle collisions in Teton County, Wyoming from Jackson Hole Wildlife Foundation's Wildlife-Vehicle Collision Database. Road segments highlighted in red represent relatively high densities of elk-vehicle collisions (hotspots), and blue represents relatively low densities.

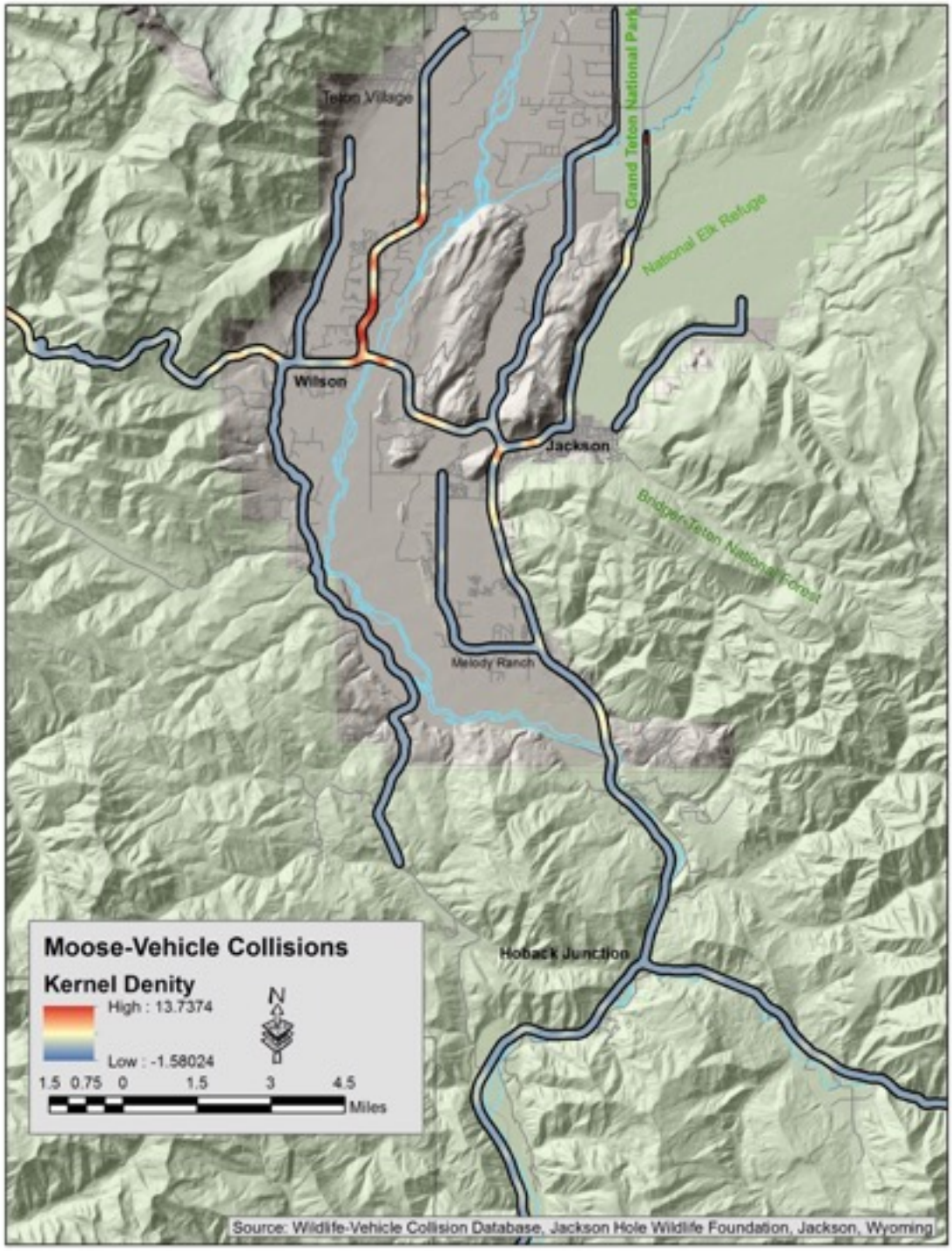

Figure 8.

Relative density of moose-vehicle collisions in Teton County, Wyoming from Jackson Hole Wildlife Foundation's Wildlife-Vehicle Collision Database. Road segments highlighted in red represent relatively high densities of moose-vehicle collisions (hotspots), and blue represents relatively low densities.

The database has limitations that need to be considered when using it in any circumstance. Numbers of reported WVCs should be considered a minimum estimate; many more animals die from WVCs than are ever observed or reported. Also, the

number of WVCs per year is strongly influenced by winter conditions. More ungulates congregate at lower elevations near roads during severe winters. Therefore, trends in WVCs should be examined over time, not just from one year to the next. The following are the main limitations and biases of the database:

- Roads in Grand Teton National Park are excluded.
- The database is comprised of data collected in various ways, with different spatial accuracies, and by observers with different levels of training. Database users may consider selecting data from certain datasets or dissolving data to the nearest mile marker, depending on their questions.
- Database development included a significant effort to remove potential duplicates among different sources; however, some duplicates may have escaped this effort.
- The date and time for each record is generally not the actual time of death, but rather when the carcass was observed (often a day later).
- Data is heavily biased toward ungulates, especially mule deer. Fifty-three percent of the database is comprised of data from WYDOT, which are almost exclusively large animals. WYDOT removes large animals from highways, and often collisions with these animals result in a Police Report for vehicle damage. Also, large animals are easier to see and identify by citizen-scientists.
- The data is likely a significant underestimate of road kill occurrences in Teton County, even for ungulates. Many road kill events go unreported or animals are hit and die out-of-sight from roads.
- Data is probably biased toward larger roads (more observers).
- Data is biased by year; WYDOT has been collecting data since 1990, but other groups started later. WYDOT has also improved their documentation methods in recent years.

Future Updates and How to Request Data

The Wildlife-Vehicle Collision Database is currently updated through December 31, 2012. Our intent is to update the database annually to maintain a comprehensive, up-to-date database for Teton County, Wyoming. However, annual updates are dependent on funding. Funding from the Teton Conservation District is being used for the current update using 2013 and 2014 data.

Data is available upon granted request to researchers, wildlife managers, town, county, and state planners and engineers, and non-profit organizations. Data requests will be reviewed by the Nature Mapping Scientific Advisory Committee, a group that includes the executive director of the JHWF, local biologists, naturalists, and science education specialists. Data requests will be granted for projects or inquiries that are shown to benefit the management or conservation of wildlife in Teton County. Approval is also based on whether the applicant demonstrates that the proposed use of the data is appropriate based on its inherent biases and limitations. Data can be requested by contacting the JHWF and completing an official data request form.

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