Executive Summary

Research Results and Mitigation Strategies

to Improve Wildlife Connectivity and Human Safety along I-40 in the Pigeon River Gorge

June 2022

A herd of elk grazes on grasses of Great Smoky Mountain National Park. Photo: Bella B Photography

Liz Hillard - Ph.D., Senior Wildlife Biologist, *Wildlands Network*

Steve Goodman - Conservation Biologist, *National Parks Conservation Association*

Ron Sutherland - Ph.D., Chief Scientist, *Wildlands Network*

Jeff Hunter - Southeast Regional Program Manager, *National Parks Conservation Association*

Introduction

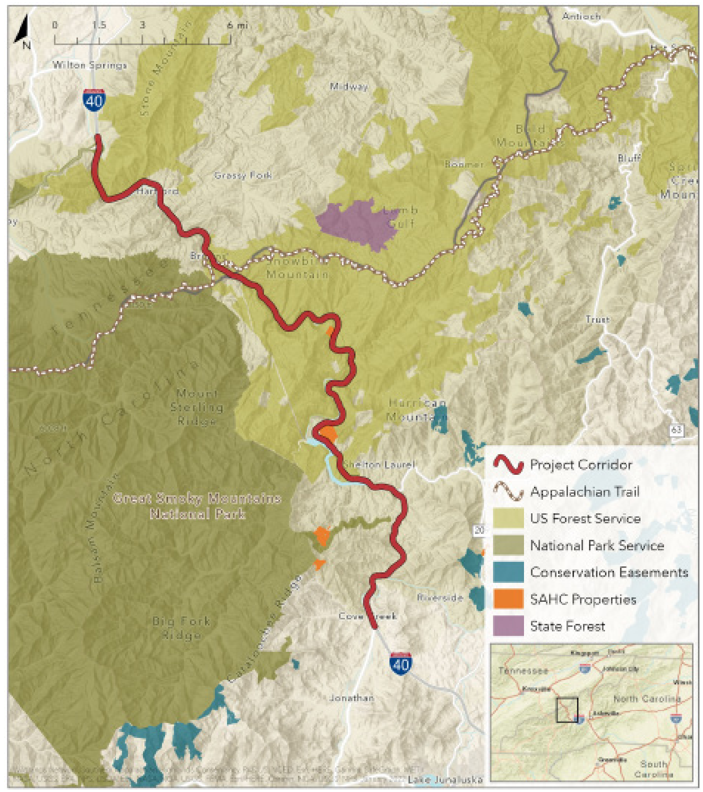
Roads are now recognized as one of the most important and most lethal barriers to wildlife movement around the world. In the mountainous region at the border of Tennessee and North Carolina, Interstate 40 winds through the steep and rocky Pigeon River Gorge. The busy highway divides the 522,427-acre Great Smoky Mountains National Park from the Pisgah and Cherokee National Forests to the northeast (512,758 and 650,000 acres, respectively). These protected areas are home to a growing and dispersing elk population, a large and robust black bear population, numerous white-tailed deer, and diverse species of mammals, reptiles, amphibians, birds, and other taxa. Under current climate change predictions, the nationally significant habitat network formed by the national park and national forests will be critical for the long-term northward flow of regional plants and animals. Due to the abundance of large-bodied wildlife in the region, wildlife-vehicle collisions are frequent and pose a significant threat to driver safety along this already dangerous stretch of highway. Taking all these factors into consideration, the burden imposed by I-40 on wildlife habitat connectivity and transportation safety makes the Pigeon River Gorge a national priority site for mitigating wildlife-vehicle collisions (WVCs).To address these concerns, we conducted multifaceted field research along I-40 to meet the following objectives for our target species of black bear, elk, and white-tailed deer:

1. **Identify locations** with high incidences of target species WVCs and determine factors that influence WVC along the roadway.

2. **Index target species** activity rates along the roadside, compare activity rates to WVC occurrences, and determine factors that influence wildlife activity adjacent to the highway.

3. **Evaluate roadway permeability** by monitoring target species use of existing roadway structures (i.e., culverts, bridges, and land bridges.

Figure 1.1 (below) *-The study area, a 28 mile section of Interstate 40 that winds through the steep and rocky Pigeon River Gorge between Great Smoky Mountains National Park and Pisgah and Cherokee National Forests near the Tennessee and North Carolina border.*



4. **Determine elk crossing locations**, where elk approach the roadway, and where elk are most likely to cross the interstate using GPS collar technology and subsequent analyses.

Our research provides the framework for mitigation strategies to both improve existing structures in order to reduce wildlife-vehicle collisions and increase wildlife habitat connectivity.

Key Methods and Findings

Our target species and other wildlife were generally abundant throughout our study area, but patterns of wildlife mortality and activity were evident, driven by a variety of interrelated factors, including forest cover, rugged topography (natural and human made), location and appropriateness of existing structures, and presence of protected public and conservancy lands.

- **Road Mortality (Chapter 1)** —We curated wildlife WVC data from multiples state agencies (2001–2021) and supplemented those records with our own weekly driving surveys for roadkill (2018-2021). Through quartile ranking we identified 22 "hotspot" segments with the highest WVCs, which were clumped together in ten focal areas. Our top model indicated that allspecies

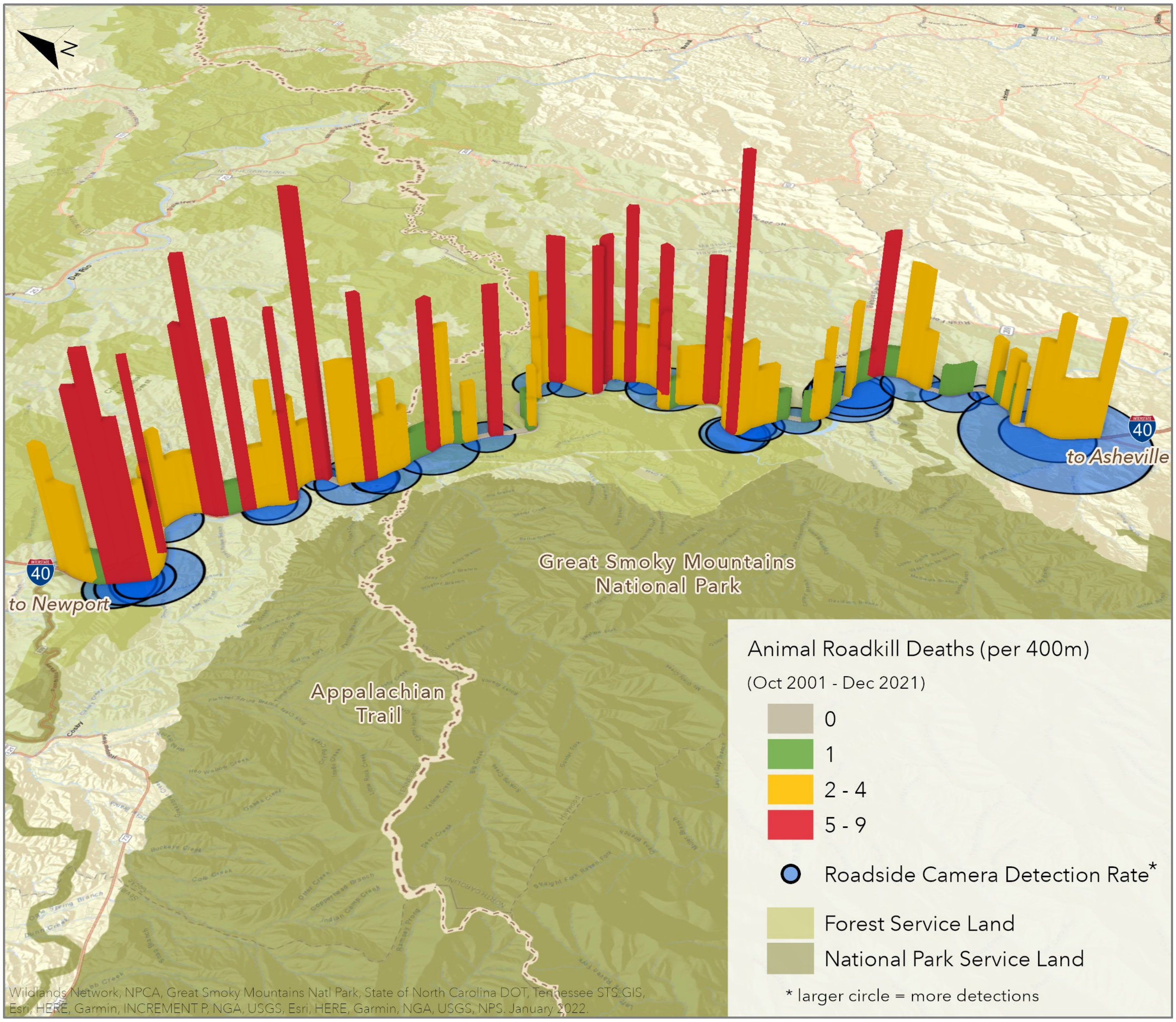


Figure 1.4. (above) - The number of wildlife vehicle collisions (2001-2021) in 400-meter road segments (n=115) categorized by zero (gray), low (green), moderate (yellow), and high (red) counts along a 28-mile section of Interstate 40 in the Pigeon River near Great Smoky Mountains National Park, Tennessee and North Carolina.

WVCs increased as distance to "usable" road structures decreased (p<0.01). Additionally, black bear vehicle collisions increased as forest area increased (p<0.05) and white-tailed deer vehicle collisions increased as ridge area decreased (p<0.001). Inference from the WVC models were limited to the roadway, and additional variables at a larger spatial scale are also likely wildlife use. For instance, it appears higher WVCs are occurring along the roadway nearest to public or private conservation lands. Also, steep rock cuts—developed during highway construction and ubiquitous throughout our study area—appear to be funneling wildlife and influencing WVCs. During 2018-2020, all WVC data combined (i.e. crash reports, carcass removals, and driving surveys) along our study corridor were 6.9 times greater than the crash report data only, indicating WVCs are highly underreported by typical reporting efforts and methodology (i.e. sheriff-generated crash reports).

- **Roadside Cameras (Chapter 1)** — We systematically and randomly deployed 66 wildlife cameras within the forested highway right-of-way, logging 43,958 trap days and obtaining 6,598 independent target species detections across two years (2019–2020). We found no significant linear relationship (p>0.05) between black bear or white-tailed deer detection rates and number of vehicle collisions. Our top models showed that black bear detection rates (i.e. activity) were higher at camera sites with greater forest area (p<0.05) and more protected land (p<0.001), and white-tailed deer activity was higher in areas with less highly rugged terrain (p<0.001).

- **Structure Cameras (Chapter 1)** — During the same period, we deployed 42 cameras at 21 existing structures, logging 22,305 trap days in order to monitor which structures were currently being used by wildlife. Only 64 confirmed crossing events were detected, excluding data from the two land bridges (Single and Double Tunnels), which had some of the highest detection rates of all project cameras. Only eight of 19 structures (42%) had confirmed crossings by one or or more

Although the culverts under I-40 were not designed with wildlife movement, some animals are already using them as safe routes to travel. Collecting this information is a key step in deciding where to add or enhance infrastructure to reduce collisions.

target species, with only one (5%) with crossings of all target species, two (11%) with crossings of both black bear and white-tailed deer or elk, and four (21%) with crossings of both white-tailed deer and elk.

- **Elk (Chapter 2)** — From 2018 to 2020, 123,606 elk locations were recorded and analyzed from 13 elk fitted with GPS radio collars. Three of the 13 monitored elk interacted with I-40. One elk crossed the interstate 107 times within 11 different road segments (majority: segment 24 (n=42)), segment 23 (n=18), segment 32 (n=17)). The three elk approached the road (<200 meters) 2,341 times within 23 road segment areas. We identified road segments with higher average elk movement probability values and higher connectivity values and considered those segments as important due to the higher probability of future elk movement and thus priority locations for mitigation.

Elk crossing a highway. Photo: Jeff Gresko

Recommendations

Based on our research findings, we provide 20 detailed mitigation recommendations for improvements to existing structures or creation of new structures throughout the Gorge in Chapter 3, and we call for the installation of a system of strategically placed wildlife fencing. Additionally, through consensus, we provide our seven "top priority" recommendations, including key opportunities to construct wildlife overpasses and install larger culverts under the highway. Finally, we note important opportunities for land acquisitions in key areas and request U.S. Forest Service special protection designation for the Double Tunnel land bridge.

Conclusion

Our study was one of largest road ecology research projects ever completed in the eastern United States. Through mortality observations, camera trapping, elk GPS-collar tracking, and analyses and modelling, we have accumulated tremendous insight into where wildlife are attempting to cross Interstate 40 in the Pigeon River Gorge, where species-specific wildlife activity levels are the highest along the roadside, how permeable existing structures are for wildlife, and how landscape and topographic features are driving all of these patterns.

Read the full report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