CENTER FOR LARGE LANDSCAPE CONSERVATION

A science-based decision support tool for prioritizing mitigation of road impacts on Western Governors' Association wildlife corridors

Project Coordinator:
Rob Ament, Center for Large Landscape Conservation, Western Transportation Institute, and Western Governors' Association Wildlife Council Stakeholders Advisory Group, Bozeman, MT
(406) 586-8082, rament@climateconservation.org

Project PI:
Meredith Rainey, Center for Large Landscape Conservation, Bozeman, MT
(406) 586-8082, mlmrainey@gmail.com

Project Partners:
Marcel Huijser, Western Transportation Institute, Bozeman, MT
(406) 994-7198, mhuijser@coe.montana.edu
Deb Wambach, Montana Department of Transportation, Helena, MT
(406) 444-0461, dwambach@mt.gov
Rob Brooks, Montana Fish, Wildlife & Parks, Helena, MT
(406) 444-5786, robrooks@mt.gov
Renee Callahan, Montanans for Safe Wildlife Passage, Bozeman, MT
(406) 586-8082, renee@climateconservation.org

Project Summary

This project aims to provide large landscape practitioners of the U.S. Northern Rockies with a decision support tool for prioritizing conservation action to mitigate road impacts on wildlife corridors. We will overlay analyses of corridor network centrality with analyses of wildlife-vehicle collision risk to identify where high-importance corridors meet high-impact road segments. Our findings will establish a rigorous, transparent basis for focusing road mitigation efforts where they will yield the greatest benefits to region-wide connectivity, and will be conveyed in the form of web-based map tools, a comprehensive written report, and a workshop for large landscape practitioners.

Need

The Great Northern Landscape is one of the last best places supporting iconic wildlife populations and their movement. In the Rocky Mountain ecotype, elk and pronghorn continue to migrate tens to hundreds of kilometers between seasonal ranges, and grizzly bears, wolverine, and lynx roam vast home ranges, their young dispersing over stunning distances. However, as natural amenities-driven residential development rapidly expands across the region (1, 2), bringing with it a burgeoning road network, this formerly large, intact landscape is becoming increasingly fragmented, posing a growing threat to the wildlife movements that make it so unique and that are crucial to ecological function and resilience.

Roads have been named the single most destructive driver of habitat fragmentation (3). While less than 1% of the land area of the United States is covered by roads, roads' zone of influence occupies an estimated 20% of U.S. land area (4). Approximately 80% of all lands in the conterminous U.S. fall within 1 km of a road, and only 3% lie more than 5 km away from a road (5). The impacts of this road network on wildlife movement are clear. Approximately 1-2 million wildlife-vehicle collisions (WVCs) occur annually in the United States, with an additional 45,000 collisions in Canada, and these numbers have been on the rise over the past decade (6). In most cases, animals die immediately or shortly after a collision (7). Road mortality, in conjunction with habitat fragmentation, impacts wildlife at the population level (*e.g.*, 8), disrupting genetic connectivity (*e.g.*, 9) and, in some cases, threatening population survival (10,11).

For the first time, practitioners now have both clear means and opportunity to confront this devastating landscape stressor. Wildlife crossing structures have recently been shown to effectively reduce or eliminate WVCs in a win-win outcome for wildlife and people. These structures not only enable wildlife to cross roads safely (6, 12), thereby improving landscape permeability for wildlife, but also yield safety and monetary benefits for people (6). The recently passed *Moving Ahead for Progress in the 21st Century* (MAP-21) transportation Act (13) includes novel provisions supporting installation of roadway infrastructure to reduce or eliminate wildlife-vehicle collisions, as well as programs to assess impacts of future transportation projects on wildlife habitat and connectivity. These advances have set the stage for action; our project will provide a rigorous, comprehensive answer to practitioners' lingering and crucial question of *where* to mitigate roads to yield the greatest positive impact for wildlife and people.

We will identify intersections between high-impact road segments and high-importance wildlife corridors as priorities for conservation action. We will focus on the U.S. Northern Rockies, comprised of the Greater Yellowstone, Salmon-Selway/Central Idaho Wildlands, and Crown of the Continent Ecosystems. Impact analyses will utilize corridors identified by the Western Governors' Association (WGA) Wildlife Corridors Initiative, which constitutes the most extensive, ambitious effort to inventory wildlife corridors in the United States to date and is likely to form the foundation for upcoming corridor conservation efforts throughout the west. We will first use graph theory analyses to prioritize networks of corridors that are most central to maintaining region-wide connectivity (14). We will then map risk of wildlife-vehicle collisions throughout the region by modeling the relationship between existing WVC data and underlying road- and wildlife-related factors. Overlaying these analyses, we will identify sites that are both crucial for connectivity and highly threatened with road impacts, and then recommend site-appropriate land use planning, management, and highway design action. A barrier restoration analysis using newly released tools (15) will further allow us to identify sites with the highest potential importance for connectivity if current road impacts are mitigated. Results of our analyses will be presented through web-based decision support tools, a printed report geared toward large landscape practitioners, workshops and meetings introducing these products to practitioners, and constructive feedback on relevant planning and management documents.

Roads are disrupting landscape connectivity *now,* and their impacts are expected to worsen as road networks expand and carry increasing traffic loads. It is imperative that we act quickly to capitalize on the opportunities provided by recent data and legislation to minimize escalation of one of the most insidious threats to connectivity in one of the last best places for iconic wildlife movements. Our work will support practitioners in establishing priorities and strategies for effective near-term action and will guide future growth of transportation infrastructure that is smart for both wildlife and people.

Objective

The primary objective of this project is to prioritize conservation action to mitigate the impacts of road networks on wildlife corridors. Our analyses will provide:

- An **inventory** of the condition of corridors with respect to road impacts by overlaying road impact estimates on corridor importance scores.

- A much-needed **decision support tool** to help practitioners focus road mitigation efforts where they matter most by pinpointing actual and potential high-value corridors that are bisected by high-impact road segments.

Methods

a. Model wildlife-vehicle collision risk

Data on wildlife-vehicle collisions (WVCs) has been collected in the focal region, but these data are patchy and do not provide a complete picture of the impacts of roads and traffic on wildlife and connectivity. What is clear is that collision locations are clustered and that these spatial patterns are often correlated with characteristics of roads and the landscapes that they bisect (12, 16). We will develop a regression model to predict WVC risk based on road- and wildlife-related explanatory variables. Marcel Huijser, Project Partner, will provide collision data and serve as advisor on model development.

Traffic volume has repeatedly been identified as a key indicator of wildlife-vehicle collision risk (12, 16), and annual average daily traffic (AADT) is a common measure of the effects of a road on wild animals that is routinely collected by state Departments of Transportation. We will use AADT data collected from a subset of road segments throughout our study region to interpolate traffic volume across unmonitored road segments and create a continuous estimate of resistance to movement presented by road networks. Interpolation has been shown to produce more accurate estimates of traffic volume than regression modeling based on additional road attributes (16).

Other candidate variables will include speed limit, road width, integrity of surrounding habitat, and deer herd unit size (most WVCs in the United States involve deer; 6). We will allow for nonlinear relationships between explanatory variables and collision numbers in order to detect potential threshold values at which WVCs decline because animals are no longer attempting to cross roads, indicating that attributes of the road segment make it an absolute barrier to movement. Our model will therefore capture the full spectrum of road impacts on movements of a suite of wildlife species of interest, supporting identification of highest-impact sites as priorities for road mitigation efforts.

b. Assess corridor network centrality

In order to focus road mitigation efforts where they matter most, practitioners are in need of a rigorous scientific basis for ranking the relative importance of the hundreds to thousands of corridors emerging from the Western Governors' Association Corridors Initiative. Graph theory (17, 18) provides a means of representing complex landscape networks as a simple web of nodes and lines and supports use of highly efficient algorithms to quantify patterns of connectivity. Network centrality is a measure of the relative importance of a given patch or corridor to connectivity of the landscape as a whole (14, 19). Based on centrality metrics, we will rank relative importance of WGA-identified corridors. This analysis will allow us to identify the central 'backbone' of the vast WGA network as the set of corridors expected to most efficiently maintain connectivity of the U.S. Northern Rockies as a whole.

Our initial analysis will focus on landscape integrity-based (LI) corridors, which connect Large Intact Blocks of natural habitat via Important Connectivity Zones (WGA). These corridor networks have been defined based on continuity of natural land cover types and the occurrence of low housing and road density. They are meant to serve as a coarse-filter, non-species-specific approach to identifying landscape components providing connectivity for diverse terrestrial species groups, and are expected to serve well in a first-pass, rapid assessment of regional conservation priorities for maintaining connectivity of wide-ranging species. These data are expected to be released by November 2013, prior to or in conjunction with release of the WGA's west-wide regional Crucial Habitat Assessment Tool (CHAT). Later analyses may focus on prioritizing corridor networks for individual species of interest as they become available, including the wolverine, grizzly bear, and lynx, three Rocky Mountain ecotype priority species for which there is evidence of road impacts on habitat use (20, 21), genetic connectivity (9, 22), and species survival (11). These analyses would then be overlaid with and compared to LI central corridor networks. Rob Brooks, Program Partner, in collaboration with the WGA Wildlife Council, will advise use and interpretation of connectivity data.

c. Evaluate risks to central corridors

We will overlay our wildlife-vehicle collision risk maps on ranked corridor networks to determine where high-impact road segments intersect high-centrality corridors. We will plot centrality ranking versus impact ranking to guide actions to address road impacts. High-centrality corridors subject to high impacts will be considered primary targets for highway mitigation measures. High-centrality corridors that are minimally impacted by traffic will be considered targets of transportation planning efforts to maintain this status based on factors that emerge from our WVC risk model as contributing to low levels of risk.

Low-centrality corridors with high impacts will be subject to further analysis exploring restoration potential. New methods (15) allow quantitative assessment of the impact of barriers on patterns of connectivity, showing how removal of a given barrier may lead to improved connectivity and shifts in relative importance of individual corridors. Applying these tools will allow us to determine whether corridors currently deemed non-essential might have the potential to serve as primary conduits of connectivity if major road barriers bisecting them are mitigated. Such corridors may provide action alternatives in the event that mitigation of a current high-centrality corridor is not feasible.

Based on these impact/centrality groupings, we will recommend conservation actions appropriate to each cluster, advised by Program Partners Marcel Huijser, Deb Wambach, and Rob Brooks. These partners will further advise mitigation design recommendations for an illustrative sample of priority road segments. Program Partner Renee Callahan will coordinate a workshop presenting our analyses and recommendations to practitioners in conjunction with Montanans for Safe Wildlife Passage's existing effort to identify and address the Top 10 Spots for Wildlife Mitigation in Montana.

Deliverables

All deliverables are expected to be completed and distributed by August 2014.

- **A web-based decision support map tool.** Viewable and downloadable map products resulting from each analysis, along with transparent metadata and summary reports, will be made available via GNLCC's Landscape Conservation Management and Analysis Portal (LC MAP). We will also offer these data products through Data Basin and make them available to be hosted on state and west-wide WGA CHAT viewers.

- **A comprehensive report geared toward large landscape practitioners.** Our report will be distributed to a wide range of partners and stakeholders, presented to practitioners via a workshop and smaller group meetings, and will further guide comments on land management and wildlife planning documents as well as public outreach and communications concerning local and county planning efforts.

Statement of Compliance

The Project Coordinator and Principal Investigator have read and agree to comply with the Great Northern Landscape Conservation Cooperative Information Management, Delivery, and Sharing Standards if this proposal is selected for support.

Schedule

	2013				2014							
Task	09	10	11	12	01	02	03	04	05	06	07	08
Map traffic volume												
Model wildlife-vehicle collision risk												
Assess corridor network centrality												
Assess risks to priority corridors												
Draft mitigation recommendations												
Create web map tools and data												
Produce written report												
Schedule practitioner meetings, workshop												

Literature cited

1 D. G. Brown, K. M. Johnson, T. R. Loveland, D. M. Theobald, *Ecol. Appl.* **15**, 1851 (2005).
2 P. H. Gude, A. J. Hansen, R. Rasker, B. Maxwell, *Landscape Urban Plann.* **77**, 131 (Jun, 2006).
3 R. F. Noss, *Nat. Areas J.* **13**, 276 (Oct, 1993).
4 R. T. T. Forman, *Conserv. Biol.* **14**, 31 (2000).
5 K. H. Riitters, J. D. Wickham, *Front. Ecol. Environ.* **1**, 125 (2003).
6 M. P. Huijser, J. W. Duffield, A. P. Clevenger, R. J. Ament, P. T. McGowen, *Ecol. Soc.* **14**, 15 (2009).
7 R. E. Allen, D. R. McCullough, *J. Wildl. Manage.* **40**, 317 (1976).
8 M. P. Huijser, P. J. M. Bergers, *Biol. Conserv.* **95**, 111 (2000).
9 M. F. Proctor *et al.*, *Wildlife Monographs* **180**, 1 (2012).
10 M. F. Proctor. Dissertation. The University of Calgary (2003).
11 M. P. Huijser *et al.*, “Wildlife-vehicle collision reduction study: Report to Congress” (2007).
12 K. E. Gunson, G. Mountrakis, L. J. Quackenbush, *J. Environ. Manage.* **92**, 1074 (2011).
13 Congress, U. S. 2012. MAP-21. H.R. 4348. 112th Congress. 03 Jul 2012.
14 D. M. Theobald, S. E. Reed, K. Fields, M. E. Soule, *Conservation Letters* **5**, 123 (2012).
15 B. McRae, S. A. Hall, P. Beier, D. M. Theobald, *PLoS ONE* **7**, e52604 (2012).
16 J. A. Litvaitis, J. P. Tash, *Environ. Manage.* **42**, 688 (2008).
17 A. G. Bunn, D. L. Urban, T. H. Keitt, *J. Environ. Manage.* **59**, 265 (Aug, 2000).
18 D. Urban, T. Keitt, *Ecology* **82**, 1205 (May, 2001).
19 S. P. Borgatti, *Social Networks* **27**, 55 (2005).
20 R. D. Mace, J. S. Waller, T. L. Manley, K. Ake, W. T. Wittinger, *Conserv. Biol.* **13**, 367 (2008).
21 R. M. Inman *et al.*, *J. Wildl. Manage.* **00**, 00 (in review).
22 N. Balkenhol. Dissertation. University of Idaho (2009).