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LINKING STATEWIDE CONNECTIVITY PLANNING TO HIGHWAY MITIGATION: TAKING THE NEXT STEP IN LINKING COLORADO'S LANDSCAPES

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Abstract: Statewide connectivity planning represents an important first step for informing the transportation planning process at the statewide and regional levels. However, without finer scale assessment, such broad-scale planning does not provide sufficient information for integration into project-level designs. The *Linking Colorado's Landscapes* project – designated as a 2006 Exemplary Ecosystem Initiative by the Federal Highway Administration – was initiated in 2003 to identify, prioritize, and assess wildlife movement linkages throughout Colorado. The project developed as a collaborative effort between the Colorado Department of Transportation (CDOT), the Federal Highway Administration (FHWA) and the Southern Rockies Ecosystem Project (SREP). Under this unique partnership, a FHWA grant enabled CDOT to contract with SREP for the development of a connectivity assessment in Colorado. This arrangement has facilitated CDOT's consideration of landscape-scale permeability for wildlife while addressing the state's transportation needs and environmental stewardship objectives.

Linking Colorado's Landscapes consisted of two phases: a statewide assessment of broad-scale wildlife linkages, and an in-depth assessment of twelve of the highest priority linkages. Now complete, the challenge for the project partners lies in integrating both the vision for a connected landscape and the more detailed recommendations into all levels of transportation development – from long range transportation plans to on-the-ground transportation projects. This paper describes the methods and opportunities for implementing the vision as well as the site-specific recommendations provided in *Linking Colorado's Landscapes*.

Linking Colorado's Landscapes

The primary objective of Linking Colorado's Landscapes was to identify broad linkage zones that facilitate movement for Colorado's diverse array of wildlife species, to prioritize amongst them for further study, and provide in-depth evaluations for a subset of the highest priority linkages. A linkage is defined as the intervening area between larger blocks of suitable habitat that facilitates daily and seasonal movements or dispersal from natal sites by providing animals with the security, food and shelter they need to meet their life history requirements (Dobson et al. 1999; Servheen et al. 2003).

Phase I of this project consisted of a statewide assessment of wildlife linkages in Colorado (SREP 2005). The resulting connectivity map provides CDOT planners with a comprehensive strategy for maintaining and restoring habitat connectivity for wildlife. As CDOT embarks on its 2035 Statewide Transportation Plan, the data is accessible for direct incorporation, highlighting to planners where concerns about wildlife habitat connectivity intersect transportation routes. Integration at this level acts as an early warning flag to project-level transportation planning, prompting consideration for appropriate mitigation measures and funding for such measures.

The focus of Phase II was a set of wildlife linkage assessments prepared for each of twelve high priority linkages identified in Phase I (SREP 2006). These assessments provide a deeper accounting of both the challenges and the opportunities for improving highway permeability for wildlife along these twelve stretches of highway in Colorado. SREP visited and inventoried each of these linkage areas where they are intersected by highways, compiling information on existing structures, and determining how and where target species (primarily mid- and large-sized mammals) are traversing from one side of the roadway to the other, and identified locations where natural or man-made barriers might prevent such movements. These inventory data were combined with other layers of information, such as land ownership and management adjacent to the highway, traffic volumes, and zoning. Previous research on wildlife road-crossing locations in Colorado suggests that mid- and large-sized mammals focus their crossing activity along specific roadway segments (Barnum 2003). Such stretches of roadway were correlated to features in the surrounding habitat as well as the roadway itself. As the variables influencing crossing activity may vary from one location to the next, the Linkage Assessments capture a broad suite of factors including habitat type, vegetation cover, topographic features, roadway width, roadway barriers (e.g., jersey walls, guardrails), traffic volumes, and existing structures.

To complete the linkage assessments, SREP partnered with transportation engineers and biologists from CDOT, the Colorado Division of Wildlife and the U.S. Forest Service to develop guidelines and recommendations for improving safe passages for wildlife across these critical stretches of highway using the best available techniques. Recommended mitigation measures range from the simple and immediate to the large-scale and visionary. Recommendations are presented for specific mileposts or segments of roadway, focusing on the portions of each linkage with the greatest potential benefit to wildlife movement and the best opportunities for implementing those measures. These recommendations are tailored to the particular site and wildlife populations present. In many instances, several different mitigation measures are combined to create a comprehensive suite of mitigation measures that offer the most effective and feasible means for addressing wildlife movement and highway safety.

The *Linking Colorado's Landscapes* project was designated a 2006 Exemplary Ecosystem Initiative by the Federal Highway Administration as a model for other state initiatives.

Implementing Linking Colorado's Landscapes at Multiple Scales

Linking Colorado's Landscapes was designed to guide CDOT and other local and regional transportation organizations in the creation of more wildlife-friendly landscapes and transportation networks. The key to realizing the vision for a

connected landscape as well as the more detailed recommendations lies in implementation - a multi-step process that involves flagging linkage areas early in the transportation planning process; coordinating with the appropriate regional transportation planning units to highlight the purpose and need for mitigation measures; and empowering project-level designers and engineers with both an understanding of the issue as well as the possible remedies. Partnerships through all levels of the transportation agency as well as with state and federal wildlife and land management agencies, and counties, land trusts and other local organizations are essential for on-the-ground success.

Several challenges that must be addressed to ensure the design of functional crossing structures and other mitigation measures for wildlife include:

- Integrating available ecological data into the planning process so that wildlife considerations arise early in the planning process;
- Reconciling timelines for planning for wildlife mitigation measures (including monitoring) with transportation project timelines;
- Budgeting for wildlife mitigation measures.

A comprehensive strategy that addresses all levels of the planning and design process is needed to adequately address these challenges. The following section describes several implementation activities being pursued in Colorado to meet these needs at the statewide, regional and local scales.

Statewide Scale

There are three primary areas where SREP is currently engaging to incorporate considerations for wildlife in the transportation planning and design process: (1) CDOT's 2035 Statewide Transportation Plan, (2) Developing an early warning system to alert transportation planners to potential wildlife conflicts, (3) Public education and awareness to build citizen support for wildlife-oriented mitigation measures.

Statewide Transportation Planning

While transportation projects occur at a local-scale, the seeds for each project are planted at the statewide scale in the Statewide Transportation Plan, which is renewed every five years. CDOT is currently undergoing a planning process for the 2035 Statewide Transportation Plan, including a ground-up effort to integrate the transportation concerns and visions from counties, residents and businesses in each region of the state. While the Statewide Plan does not allocate discretionary funds, it does present the dollars amount need to accomplish the vision, and it provides a preliminary prioritization of how funding will be distributed among each of the transportation corridors.

Integrating concerns regarding wildlife movement and animal-vehicle collisions in the statewide vision is the first step in ensuring that these concerns are adequately addressed at the project level. To assist this process, SREP overlaid the statewide linkage assessment data with the transportation corridors to determine where these concerns should be highlighted in the 2035 Statewide Transportation Plan. Based on this overlay, SREP submitted comments and attended meetings of the Transportation Planning Regions to ensure that the vision statements for each transportation corridor acknowledge wildlife concerns, where relevant. While inclusion of these concerns does not guarantee funding for mitigation measures, early consideration of habitat connectivity needs for wildlife can help to streamline wildlife crossings and highway improvement projects, before project designs are complete.

Developing Mechanisms for Avoiding Impacts and Placing Effective Mitigation

To further facilitate early considerations for habitat connectivity and wildlife movement in the transportation planning process, SREP and Defenders of Wildlife have teamed up under a grant from the Wildlife Conservation Society to integrate the State Wildlife Action Plans with CDOT's transportation planning processes. Although transportation priorities are set well in advance of construction, many biologists and conservationists only comment at the Environmental Impact Statement stage in the process. At this point, it is often too late to avoid environmental impacts since most decisions are already in place. Furthermore, because highway projects are designed and implemented on a project-by-project, basis often without a landscape-scale perspective, mitigation must occur within the project boundary as opposed to other locations that may be more effective.

A four-step process developed by SREP and Defenders of Wildlife addresses these needs. The first step requires additional analysis of the wildlife linkages identified in Colorado's statewide connectivity assessment to further define the spatial extent of each linkage, producing clear habitat boundaries within the landscape and identifying optimal travel routes for select focal species to move between protected core habitat areas. In the next step these data are overlaid with the Statewide Transportation Improvement Program (STIP) to determine where upcoming highway projects intersect with important wildlife travel routes. The STIP is renewed every 1-3 years and covers the funded projects expected to happen over a 5-year period. By creating a clear spatial and temporal depiction of where planned future highway projects will overlap with priority wildlife habitat movement corridors we will align both the avoidance and mitigation requirements of CDOT with the goals of the State Wildlife Action Plan.

The third step in the process applies Section 6001 of the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU) that requires each state department of transportation to consult with federal and state land management, natural resource, and wildlife management agencies while developing their transportation plans. Under this act, each consultation will include a comparison of the transportation plan with conservation maps and must also include potential mitigation activities. The GIS overlay of the STIP with spatially-defined wildlife linkages is being used to develop an early-warning flagging system to identify conservation conflicts – areas where high priority wildlife connections intersect with upcoming transportation projects. This warning system will ensure these areas are avoided and impacts are minimized as transportation projects proceed from the planning stage, to design, then construction. An automated GIS spatial query is being developed to flag these conservation conflicts, ensuring that both CDOT and relevant engineering and environmental consulting firms are made aware of these conflicts.

Once the early-warning system is in place, we will apply the framework outlined in the recently released FHWA publication *Eco-logical – An Ecosystem Approach to Developing Infrastructure Projects* (Brown 2006) to ensure sensitive areas are avoided and the right mitigation happens in the right place. Applying this concept of ecosystem-based mitigation, we are developing a ‘matchmaking’ system that defines the most effective mitigation measure at the ecosystem level. This powerful approach will allow us to look outside of project bounds when assessing a location for mitigation. The following criteria are being applied to ensure that mitigation is placed effectively: (1) species ranking and associated habitat type, (2) degree of conservation threat, (3) land ownership and protection status, (4) roadway engineering assessment to determine mitigation feasibility, (5) conservation opportunity and potential partners to leverage resource, and (6) cost effectiveness. Upon completion of these activities we will have established a clear and replicable framework for adoption by other DOTs and Divisions of Wildlife across the nation.

Public Education

The third effort in which SREP is engaging at the statewide level is a public education and awareness campaign. These efforts are an essential component in building public support for mitigation measures that improve habitat connectivity for wildlife. Activities in this category include outreach to counties, land trusts and other local partners working in wildlife linkage areas to ensure due consideration of wildlife concerns in their planning, zoning, and land protection efforts; distributing tens of thousands of driver safety tips sheets across Colorado to educate drivers about animal-vehicle collisions; and semi-annual press releases that reach millions of people via print, TV and digital media.

Local Scale

While efforts at the statewide scale are essential for setting the framework for wildlife-oriented transportation development, project development occurs at the site, or local scale. Coordination with project managers, regional environmental personnel, field-based wildlife and land managers, counties and other local partners is essential to facilitate implementation of on-the-ground projects that include protective measure for wildlife. SREP is currently engaged in two site-specific implementation projects. The first is a major effort to construct a large wildlife crossing within a critical wildlife linkage at Vail Pass. The second is a smaller project to make improvements to wildlife fencing along a stretch of Highway 500 in western Colorado. Each project provides an excellent example of project-based partnership, and both are important actions helping to improve habitat connectivity for wildlife across the landscape.

Vail Pass Wildlife Bridge

The stretch of Interstate 70 (I-70) over Vail Pass travels between the Gore Range to the northeast, and the Sawatch Range to the southwest. This location was identified in *Linking Colorado's Landscapes* as an ecologically significant site for north-south connectivity (SREP 2005). The main goal for this linkage is to restore landscape-scale connectivity across the interstate, which is the primary east-west route through Colorado and generally recognized as a significant barrier to wildlife movement.

A wildlife bridge has been proposed as an early action, ecosystem-based mitigation measure for the unavoidable infrastructure impacts the I-70 mountain corridor expansion will have on wildlife, including the planned addition of climbing lanes to West Vail Pass. Travel demand has been increasing steadily on the I-70 mountain corridor between Glenwood Springs and Denver. In response to that demand, CDOT released a Programmatic Environmental Impact Statement (PEIS) in November 2004 - a major study that evaluates transportation improvements to I-70, detailing a variety of transportation alternatives and their associated environmental impacts.

According to the draft PEIS, “the primary issue affecting wildlife in the Corridor is the interference of I-70 with wildlife movement and animal-vehicle collisions. Barriers to wildlife movement include structural, operational, and behavioral impediments to wildlife trying to cross I-70” (CDOT 2004). In 2001, CDOT and FHWA convened an interagency group of wildlife specialists called *A Landscape Level Inventory of Valued Ecosystem Components* (ALIVE) to guide the development of wildlife mitigation strategies as a part of the I-70 PEIS. Other agencies engaged in the ALIVE committee included agencies responsible for the protection and management of wildlife habitats and threatened and endangered species - the Colorado Division of Wildlife (CDOW), the Bureau of Land Management (BLM), the US Forest Service (USFS), and the US Fish and Wildlife Service (USFWS).

The ALIVE committee compiled and evaluated a wide range of ecological components. The subsequent GIS analyses highlighted barriers to ecosystem flows and wildlife movement, and impaired landscape components, enabling the committee to assess the direct, indirect and cumulative impacts of transportation improvements proposed in the I-70 PEIS, and target effective landscape-level mitigation strategies. The ALIVE group made comprehensive recommendations on wildlife crossing mitigations in thirteen key wildlife “Linkage Interference Zones”, or wildlife movement areas. The committee gave each zone a priority rank and identified specific mitigation measures for locations within each Linkage Interference Zone. Two zones were mapped on Vail Pass, one along the west side of the pass and another along the east side. The identification of Vail Pass as one of these high priority linkage areas crossing I-70 was further substantiated in the statewide assessment of wildlife linkages (Phase I).

While the Final Programmatic Environmental Impact Statement (PEIS) will not be complete until late 2007 and the precise nature of the increased infrastructure uncertain until then, the identification of the Linkage Interference Zones provides guidance for moving forward with appropriate mitigation measures as opportunities arise. Vail Pass presents just this opportunity - Forest Service lands on either side of this stretch of interstate ensure habitat protection in the linkage approaches, a new crossing structure near the summit of the pass will greatly increase north-south permeability across the interstate by complementing the existing span bridges located lower down on the pass by providing an additional crossing option that would be accessible to a greater variety of species. Political factors also play a role in advancing this proposal – due to bi-partisan support from Colorado’s congressional delegation, in 2005, the Colorado Department of Transportation received \$420,000 from public lands highway discretionary funds for a feasibility assessment and preliminary engineering designs. This initial investment is a crucial step in planning for a crossing structure and additional congressional support will be necessary to raise the full amount of funding needed for construction of the wildlife bridge.

To complement these efforts and begin collecting baseline data on wildlife activity around Vail Pass, SREP, in collaboration with the Denver Zoo and the Gore Range Natural Science School launched the *Citizen Science Wildlife Monitoring* program to engage local citizens in the collection of these data. The program is designed to (1) engage a broad range of community members in an educational wildlife monitoring project, (2) collect critical information about wildlife movement, and (3) develop an informed and active community that engages with scientists, policy-makers and other citizens about the importance of landscape connectivity for wildlife movement.

Thirty-one trained citizen scientists are now maintaining and collecting images from forty-nine motion-sensitive cameras placed along the interstate and in the forested approaches to the roadway. Over the long-term, these data will be compared with post-construction data after the bridge is complete, allowing evaluations of on the effectiveness and impact of this structure.

The Citizen Science Program has been instrumental in catalyzing support among a larger group of agency and university partners to expand the monitoring effort and begin developing protocols for pre- and post-construction monitoring of wildlife crossings. A multi-species monitoring approach that tests several different monitoring techniques could greatly enhance support for monitoring projects at other locations where these data are needed to locate, design and evaluate mitigation projects. The next step for this interagency collaboration is to develop a fundraising plan and submit proposals to accomplish the monitoring goals defined by the group.

State Highway 550, Wildlife Fencing Improvements

This stretch of Highway 550 between Montrose and Ridgway was identified in *Linking Colorado’s Landscapes* as a high priority wildlife linkage for elk, mule deer and mountain lion. The linkage encompasses important winter and summer habitat for mule deer and elk, and provides dispersal and forage habitat for carnivores such as mountain lion, bobcat, black bear and potentially gray wolf. The main goal for this linkage is to restore the connectivity function of the linkage for these species and to reduce animal-vehicle collisions, which are among the highest in the state along this stretch of roadway.

The Phase II Linkage Assessment identified the existing wildlife fencing that borders eight miles of this highway as problematic for both wildlife movement and driver safety. This long stretch of fencing combined with a lack of adequate structures has created a substantial barrier to successful wildlife crossings over this section of roadway. Yet holes in the fencing and gaps at roadway access points have the undesired effect of allowing animals to enter the highway right-of-way where they can become trapped by the fencing. With the implementation of additional mitigation measures there lies excellent potential to transform the existing infrastructure along this stretch of roadway from a problematic barrier into a comprehensive and effective wildlife crossing system.

To begin addressing these needs and opportunities, SREP, in collaboration with the San Juan Corridors Coalition (a local conservation organization), Ridgway State Park, the City of Ouray, the Town of Ridgway, the Division of Wildlife, and CDOT are submitting a proposal to the Transportation Planning Region for an enhancement grant to reduce animal-vehicle collisions along this stretch of roadway. The proposal calls for removing the existing one-way deer gates, which are too small for elk use and malfunctioning due to disrepair, and replacing them with escape ramps, as well as tying in the fence ends to landscape features to discouraging animals from entering the right-of-way at these locations.

This request is for just \$109,000 with a \$30,000 local match, which is not sufficient funding for a complete solution for restoring landscape permeability for wildlife across the highway. Regardless, this proposal does represent an important step towards minimizing opportunities for wildlife to get trapped in the right-of-way and providing opportunities for exiting the right-of-way when they do get trapped. By engaging local partners we are setting the groundwork for future collaborations and other improvements including, land protection at key locations, the construction of new wildlife crossing structures, and additional improvements to the wildlife fencing. This proposal has garnered local support, demonstrating the role of even seemingly small improvements in the bigger picture, and can be used to help the partners leverage additional funds for future remediation.

Conclusion

Both the statewide assessment (Phase I) and the more detailed linkage assessments for twelve high priority linkage areas (Phase II) are proving invaluable resources as SREP moves forward with our partners towards realizing a landscape with restored connections for wildlife. While the statewide connectivity assessment provides a broad view of the landscape, allowing wildlife-highway conflict areas to be identified early on in the transportation planning process, the recommendations developed in the linkage assessments provide a guide to reducing transportation-related impacts to wildlife along specific stretches of highway.

By integrating considerations for wildlife habitat connectivity and specific recommendations for mitigation measures into transportation projects, Colorado now has the occasion to transform problematic highway segments from danger zones for wildlife and drivers into effective wildlife crossing systems. CDOT, SREP and a number of other partners will play critical roles in public education and citizen engagement, habitat protection, and the planning, design, and construction of appropriate mitigation measures to implement all the components of a vision for a connected landscape.

Biographical Sketch: Julia Kintsch is the Program Director at the Southern Rockies Ecosystem Project where she led the *Linking Colorado's Landscapes* project. She received a master's degree in landscape ecology from Duke University where her research focused on conservation design strategies. Her work continues to focus on developing guidelines for designing appropriate mitigation measures for wildlife and assisting project planners and engineers in the implementation of such measures. She oversees a variety of research and implementation projects and advises conservation groups, consultants, and agencies on conservation design and habitat connectivity for wildlife.

The Southern Rockies Ecosystem Project is a nonprofit conservation science organization working to protect, restore and connect ecosystems in the Southern Rockies of Colorado, Wyoming and New Mexico.

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