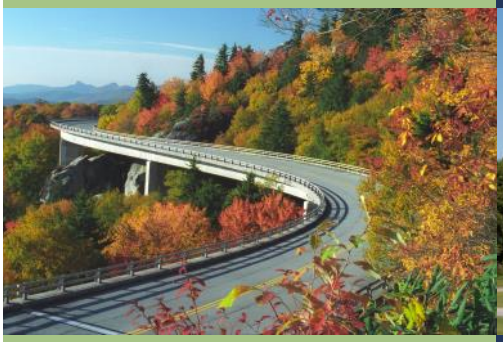
ICOET 2015

Roads to Resilience



Organized by
ITRE Center for Transportation and the Environment
North Carolina State University

Hosted by
North Carolina Department of Transportation

Supported by
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THE 2015 INTERNATIONAL CONFERENCE ON ECOLOGY & TRANSPORTATION

Strengthening Essential Transportation and Ecological Assets across Diverse Landscapes

September 20-24, 2015 | Raleigh, North Carolina, USA

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Take time during conference to visit all the Sponsor exhibits, learn about their products and services, and to express your appreciation for their support of ICOET. Morning and afternoon refreshment breaks will be served in the Sponsor exhibit area. **Welcome to the conference!**

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Infra Eco Network of Europe

Transportation Research Board ADC30 Committee on Ecology and Transportation

ITRE Center for Transportation and the Environment at North Carolina State University

Debra Nelson

Strategic Policy Advisor
New York State Department of Transportation

Welcome to the eighth biennial International Conference on Ecology and Transportation in Raleigh, North Carolina. We are pleased to have you join the conversation with experts from around the world, contributing to the energy and excitement as we share knowledge and best practices on the interrelationship of ecology and transportation.

Many people ask what makes ICOET special. I feel it's the multiple levels of sharing: of ideas, solutions, technologies, camaraderie, and new friendships. We have designed the program for just that. Take advantage of the networking opportunities at the sessions, the breaks, the lunches and reception, and the field trips. Whether you are a recognized expert in the field or newly discovering the nuances of the science, we want you to share your experiences as we continue to grow in our understanding. That's what ICOET is all about, and we are happy you are part of it.

You will learn much and contribute to the science as you take in the most cutting edge and progressive material on the topic of ecology and transportation. The range of topics and presentations outlined in the conference program allows you to customize your experience. More than 180 technical papers, posters, and panel discussions from over 20 countries and tribal nations will be presented at ICOET 2015. This global perspective is vital as we address ecological issues associated with transportation.

We are honored to welcome our keynote luncheon speakers Andrew Winston, best-selling author on adapting organizations to environmental changes, and Michael Leonard, chairman of The Conservation Fund, a national leader in combining environmental protection with economic vitality.

The North Carolina Department of Transportation is our outstanding host agency this year. Three field trips will showcase their diverse state as you tour across piedmont and coastal plains through urban, suburban and rural landscapes, into wetlands and forest ecosystems, and over the historic Bonner Bridge and dynamic Oregon Inlet on the state's renowned Outer Banks. You will learn about the exceptional work that NCDOT and its partner agencies do to mitigate for and protect natural resources "from the mountains to the sea" while managing 80,000 miles of state-maintained highways.

This year's conference theme, *Roads to Resilience*, emphasizes the challenges we face to keep our natural and built systems strong. By sharing our experiences and considering local, regional, national and international perspectives, we can face this challenge together. Thank you to the many people, organizations, and sponsors that helped to organize and bring us together at ICOET 2015. Their support and your participation ensure that ICOET continues to be the foremost conference on ecology, sustainability and transportation.

I hope you find the 2015 International Conference on Ecology and Transportation a rewarding and memorable experience. Enjoy the conference!

Debra A. Nelson

Debra Nelson
ICOET 2015 Conference Chair

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KEYNOTE LUNCHEON SPEAKERS

ICOET is honored to welcome these outstanding keynote speakers for our 2015 conference.

MONDAY September 21

Andrew Winston

Best-selling Author and Founder of Winston Eco-Strategies

Andrew Winston is a globally recognized expert on how companies can navigate and profit from the world's biggest environmental and social challenges. He is most recently the author of the book *The Big Pivot* and the Harvard Business Review Magazine cover story, "Resilience in a Hotter World." Andrew's latest book explores how companies can thrive in a hotter, scarcer, more open world, and it provides a new roadmap, helping executives create a more prosperous business, economy, and world. As founder of Winston Eco-Strategies, Andrew has advised some of the world's leading companies, including Bank of America, Bayer, Boeing, Bridgestone, Johnson & Johnson, and Pepsi. He serves on sustainability advisory boards for the Kimberly-Clark Corporation, Hewlett-Packard (HP), and Unilever, and acts as a sustainability advisor to PricewaterhouseCoopers (PwC). He has spoken all over the world – in Europe, Russia, Brazil, the Middle East, and China – bringing his ideas to leadership meetings of the top executives of Fortune 500 companies, large industry conferences, and high-profile business events like the World Innovation Forum. Andrew's work is based on significant business experience and education. His earlier career included advising companies on corporate strategy while at Boston Consulting Group and management positions in strategy and marketing at Time Warner and MTV. He received his BA in Economics from Princeton, an MBA from Columbia, and a Masters of Environmental Management from Yale.

TUESDAY September 22

R. Michael Leonard

Chairman, The Conservation Fund
Attorney and Partner, Womble Carlyle

Mike Leonard for decades has been a leader of land conservation both in North Carolina and throughout the country. Mike presently serves as Chairman of The Conservation Fund, a national non-profit organization that has preserved more than seven million acres in the U.S. His conservation work includes linking Alabama's Pinhoti National Recreation Trail to the Appalachian Trail, extending the Appalachian Trail an additional 400 miles. Mike helped lead a public-private effort to preserve nearly 1,600 acres and create three new walking trails near Charlotte, N.C. He secured private donations to help fund the 996-acre Chimney Rock State Park in North Carolina, and led negotiations for North Carolina to purchase Grandfather Mountain as a state park in 2009.
All of his conservation work has been done on a voluntary basis and, as an attorney, Mike is often retained by landowners to assist in negotiating land transactions which balance development and conservation. He has been nationally recognized by the Chevron Corporation, The Conservation Fund and The Nature Conservancy. In 2010, Mike received the North Carolina Award, the state's highest civilian honor, in honor of his conservation efforts.
He practices in Womble Carlyle's Winston-Salem, N.C. office and manages the firm's litigation support system. ICOET thanks The Conservation Fund for supporting Mike's participation at the conference.

THE CONSERVATION FUND

SUNDAY September 20	
1:00pm – 5:00pm	**Innovative Approaches to Wildlife and Highways Interactions: The Basics** **Pre-Conference Workshop** *(Room 201)*
1:00pm – 6:00pm	Registration Open | Exhibit Set-up for Sponsors | Presenter Set-up for Poster Session 1 Sponsor Organization Meetings *(to be announced)*
4:00pm – 5:00pm	**ICOET Steering Committee Meeting** *(Room 202)*
	Dinner on your own
7:00pm – 8:30pm	**Transportation Research Board ADC30 Committee Meeting** *(Room 202)*

MONDAY September 21					
7:00am – 3:00pm	Registration and Sponsor Exhibits Open	Presenter Set-up for Poster Session 1 *(Convention Center Lobby and Room 306 C)*			
7:00am – 8:00am		Continental Breakfast			
PLENARY **8:00am – 10:00am**		**OPENING SESSION** **Welcome Remarks and Invited Speakers** *(Ballroom B)*			
10:00am – 10:30am		Refreshment Break | Posters Preview | Sponsor Exhibits			
PARALLEL SESSIONS **10:30am – 12:00pm**		**SESSION 101** **Connectivity and Safety: Applications in Modeling and Circuit Theory** *(Room 305 A)*	**SESSION 102** **Sustainability and Resilience: The Changing Climate of Planning and Risk Assessment** *(Room 305 B)*	**SESSION 103** **Aquatics and Wetlands: Stream Assessment and Habitat Connectivity** *(Room 306 A)*	**SESSION 104** **Developing and Deploying Large-Scale Programmatic Approaches—Panel Discussion** *(Room 306 B)*
12:00pm –1:15pm		**Luncheon with Keynote Speaker Andrew Winston** *(Ballroom B)*			
PARALLEL SESSIONS **1:30pm – 3:00pm**		**SESSION 105** **Staying Connected in North. Appalachians: From Structural to Functional Connectivity—Panel Discussion** *(Room 305 A)*	**SESSION 106** **Planning: Connectivity and Conservation on the Drawing Board** *(Room 305 B)*	**SESSION 107** **Terrestrial Wildlife: Interactions Great and Small** *(Room 306 A)*	**SESSION 108** **Advancing the Eco-Logical Approach: New Implementation Activities and Resources—Panel Discussion** *(Room 306 B)*
3:00pm – 3:30pm		Refreshment Break | Posters Preview | Sponsor Exhibits			
PLENARY **3:30pm – 5:30pm**		**POSTER SESSION 1** *(Convention Center Lobby and Room 306 C)*			
6:00pm – 8:00pm		**Welcome Reception at Jimmy V's Restaurant** *(Sheraton Raleigh Hotel)*			
7:00pm – 10:00pm		Presenter Set-up for Poster Session 2 *(Convention Center Lobby and Room 306 C)*			

TUESDAY September 22

7:00am – 3:00pm	Registration and Sponsor Exhibits Open	Presenter Set-up for Poster Session 2 *(Convention Center Lobby and Room 306 C)*			
7:30am – 8:30am		Sponsor Organization Meetings *(to be announced)*			
7:30am – 8:30pm		Continental Breakfast			
PARALLEL SESSIONS 8:30am – 10:00am		**SESSION 201** **Connectivity and Safety: Assessment for Design and Implementation** *(Room 305 A)*	**SESSION 202** **Tools and Approaches to Integrate Climate Risk and Increase Resilience in the Transportation System —Panel Discussion** *(Room 305 B)*	**SESSION 203** **Best Management Practices for Construction, Operations, and Maintenance** *(Room 306 A)*	**SESSION 204** **Transportation Ecology Policy and Regulatory Developments** *(Room 306 B)*
10:00am – 10:30am		Refreshment Break | Posters Preview | Sponsor Exhibits			
PARALLEL SESSIONS 10:30am – 12:00pm		**SESSION 205** **Connectivity and Safety: Mitigation Monitoring and Analysis** *(Room 305 A)*	**SESSION 206** **Urban Transportation Ecology Issues** *(Room 305 B)*	**SESSION 207** **New Frontiers in Regional Advanced Species Mitigation for Transportation Projects— Panel Discussion** *(Room 306 A)*	**SESSION 208** **On the Verge: Vegetation Management within Transportation Corridors** *(Room 306 B)*
12:00pm –1:15pm		**Luncheon with Keynote Speaker Michael Leonard** *(Ballroom B)*			
PARALLEL SESSIONS 1:30pm – 3:00pm		**SESSION 209** **Connectivity and Safety: Evaluating Effectiveness of Structures** *(Room 305 A)*	**SESSION 210** **All Aboard: Multimodal Transportation Ecology Issues** *(Room 305 B)*	**SESSION 211** **Stormwater and Water Quality Management** *(Room 306 A)*	**SESSION 212** **Mitigation: Striking a Balance** *(Room 306 B)*
3:00pm – 3:30pm		Refreshment Break | Posters Preview | Sponsor Exhibits			
3:30pm – 5:30pm		**POSTER SESSION 2** *(Convention Center Lobby and Room 306 C)*			
	Dinner on your own				
5:30pm – 7:30pm	Sponsor Organization Meetings *(to be announced)*				
7:30pm – 9:00pm	**SESSION 213** **Wildlife Road Crossings for North Carolina: Research, Comprehensive Planning, and Implementation—Panel Discussion** *(Room 305 AB)*				

WEDNESDAY September 23			
6:00am – 8:30am	Continental Breakfast *(Convention Center Lobby)*		
6:00am – 8:00pm **Note Boarding and Departure times for each trip. Arrive promptly for check-in. Return times are estimated.**	**FIELD TRIPS hosted by North Carolina Department of Transportation** Refreshments provided for all trips. Lunch provided for Field Trips 2 and 3. **Check-in and Board buses from Convention Center Lobby**		
	FIELD TRIP 1 **Mingo Creek: Wetland and Stream Mitigation** *Boarding 8:30am* *Departure 9:00am* *Return 1:00pm* *Lunch on your own*	**FIELD TRIP 2** **Longleaf Pine Ecosystem: Endangered Species Mitigation** *Boarding 7:30am* *Departure 8:00am* *Return 6:00pm*	**FIELD TRIP 3** **The Outer Banks: Resiliency and Disaster Response** *Boarding 6:30am* *Departure 7:00am* *Return 8:00pm*
	Dinner on your own		
7:30pm – 9:00pm	Reserved for Evening Presentation or Special Event (*to be announced*)		

THURSDAY September 24					
	Breakfast on your own				
PARALLEL SESSIONS 8:30am – 10:00am	Registration and Sponsor Exhibits Open	**SESSION 401** **Connectivity and Safety: Valuation and Innovation** *(Room 305 A)*	**SESSION 402** **Sustainability and Resilience: Focal Points in the Big Picture** *(Room 305 B)*	**SESSION 403** **Aquatics and Wetlands: Conservation of Freshwater Fauna** *(Room 306A)*	**SESSION 404** **Programmatics and Partnerships** *(Room 306 B)*
10:00am – 10:30am		Refreshment Break | Sponsor Exhibits Open			
PARALLEL SESSIONS 10:30am – 12:00pm		**SESSION 405** **Partnerships for Achieving Effective and Sustainable Outcomes in Eastern North Carolina—Panel Discussion** *(Room 305 A)*	**SESSION 406** **Planning Tools and Strategies for Improved Outcomes** *(Room 305 B)*	**SESSION 407** **Terrestrial Wildlife: Understanding Infrastructure Effects on Landscape Connectivity** *(Room 306 A)*	**SESSION 408** **Emerging Issues and New Directions** *(Room 306 B)*
PLENARY 12:15pm – 1:00pm		**CLOSING SESSION** **Conference Wrap-Up** *(Room 305 AB)*			
	End of Conference – Lunch on your own				
1:00pm – 4:00pm	Sponsor Organization Meetings *(to be announced)*				

PRE-CONFERENCE WORKSHOP | 1:00pm–5:00pm | Room 201 | Pre-Registration Required for Attendance

Innovative Approaches to Wildlife and Highways Interactions: The Basics

Instructors: ***Sandra Jacobson****, U.S. Forest Service;* ***Darin Martens****, Wyoming Department of Transportation;* ***Clifton Meek****, U.S. Environmental Protection Agency; and* ***Brian Yanchik****, U.S. DOT Federal Highway Administration.*

Adapted from the U.S. Forest Service's multi-day training course, this workshop introduces participants to how highways affect terrestrial wildlife, and demonstrates tools for identifying and reducing highway-related impacts to wildlife. Topics covered include (a) an overview of wildlife issues relative to pre-existing highways and future highway planning; (b) terminology, jargon, and multi-disciplinary challenges in communication affecting the U.S. National Environmental Policy Act (NEPA) and project implementation; (c) structural and nonstructural mitigation solutions to wildlife mortality and habitat connectivity; (d) other natural resource issues and highways, including fish passage, visual objectives, and invasive species; (e) U.S. Surface Transportation legislation—current, new, and continuing resolutions—and how they affect planning wildlife-friendly highways; and (f) an overview of NEPA and 404 issues from EPA's perspective.

TRB ADC30 COMMITTEE MEETING | 7:00pm–8:30pm | Room 202 | Open to All ICOET Participants

Transportation Research Board Committee on Ecology and Transportation (ADC30)

Chair: ***Alex Levy****, ARCARDIS-US, Inc.*

The ADC30 standing committee of the TRB is conducting its mid-year meeting at ICOET 2015. The committee is tasked with stimulating research and communicating the results of recent and ongoing research to and throughout the transportation community. ADC30 members engage in research, planning, evaluation, education and outreach associated with sound ecological principals and designs, and strive to integrate ecologically sound principles into transportation planning, decision-making, maintenance and design. For more information visit the committee's website **www.itre.ncsu.edu/ADC30** and TRB's Information Resource Center website **www.trb.org/ADC30/ADC30.aspx**.

OPENING SESSION | 8:00am–10:00am | Ballroom B | Plenary Session

Welcome Remarks and Invited Speakers

***Debra Nelson**, ICOET Conference Chair, New York State DOT, Albany, NY, United States*

***Nick Tennyson**, Secretary, North Carolina DOT, Raleigh, NC, United States*

***Tom Reeder**, Assistant Secretary, North Carolina Dept. of Environment and Natural Resources, Raleigh, NC, United States*

***John Sullivan**, P.E., Division Administrator, U.S. DOT Federal Highway Administration—North Carolina, Raleigh, NC, United States*

***Larry Bright**, Branch Chief, Conservation Planning, U.S. Fish & Wildlife Service, Arlington, Virginia, United States*

***Anders Sjölund**, National Coordinator for Nature, Trafikverket / The Swedish Transport Administration, and Steering Committee Chair, IENE—Infra Eco Network Europe, Borlänge, Sweden*

***James Martin**, P.E., Associate Director, Center for Transportation and the Environment, Raleigh, NC, United States*

***Rodger Rochelle,** Director of Technical Services, North Carolina DOT, Raleigh, NC, United States*

SESSION 101 | Connectivity and Safety: Applications in Modeling and Circuit Theory

10:30am–12:00pm | Room 305 A | Moderator: Byron Moore, North Carolina DOT

Using Browning Bridge and Resource Selection Models to Evaluate Impact of Road and Environmental Factors on Road Crossing Locations by Elk and Moose in the Greater Yellowstone Ecosystem: Moving Forward from Research to Management

***Jon Beckmann**, Wildlife Conservation Society, Bozeman, Montana; and Timothy Cramer and Shane Roberts, Idaho Transportation Department, Idaho Falls and Rigby, Idaho, United States*

Roads, fencing, and other transportation infrastructure in the western U.S. can be detrimental to wildlife through direct effects on migration and dispersal. One highway impacting long-distance migration for ungulates and human safety through wildlife-vehicle collisions is U.S. Highway 20 (US 20). The Idaho Transportation Department, Wildlife Conservation Society, and Idaho Department of Fish and Game collaborated on a four-year project to examine the impacts of US 20 on seasonal and daily movements and habitat use of both elk and moose. This presentation discusses the results of our Brownian Bridge Movement and Resource Selection Function models, developed using GPS data, demonstrating that elk and moose selected for different habitat parameters and different locations to cross the road.

Wildlife-Vehicle Collisions: Predicting Where to Mitigate with a Conceptual Modelling Framework

***Casey Visintin**, Rodney van der Ree, and Michael A. McCarthy, University of Melbourne, Parkville, Victoria, Australia*

Wildlife-vehicle collisions are related to both anthropocentric and environmental variables throughout the literature, however, it is difficult to disentangle the independent effects of these variables. Our research compares risk for seven common native terrestrial mammal species involved in collisions in southeast Australia using a conceptually simple risk framework. Road authorities and environmental managers seek tools which are simple and robust to inform development projects. Our model framework may direct mitigation efforts (e.g. on road effects or species presence), simulate risk across differing scales and target species, infer patterns of threatening processes, and identify areas warranting additional data collection and analysis.

Single Large or Several Small Fauna Passages? The SLOSS Problem in Road Ecology Addressed using Circuit Theory

***Mårten Karlsson**, KTH, Stockholm; Jan Olof Helldin, Calluna AB, Stockholm; and Andreas Seiler, Swedish University of Agricultural Sciences, Riddarhyttan, Sweden*

This presentation addresses the trade-off between number and size of wildlife passages. Modeling of animal movements using the software Circuitscape suggests that a number of smaller passages perform better than a single large, at least in homogenous landscapes or when solid data on animal movements are lacking. A "several small approach" allows for more simplified planning of wildlife passages.

Applying Circuit Theory to Road Mitigation Planning for Wildlife

***Lisa Sjölund**, Sweco Position, Stockholm; Andreas Seiler, Swedish University of Agricultural Sciences, Riddarhyttan; Mattias Olsson, EnviroPlanning AB, Gothenburg; Mattias Bovin, Calluna AB, Stockholm, Sweden; and Kerry Nicholsen, Alaska Department of Fish and Game, Fairbanks, Alaska, United States*

This presentation describes new approaches to map connectivity for wildlife at large scale and evaluate effects of road mitigation measures with the use of the software Circuitscape. The approaches have been applied to three new infrastructure upgrading projects in Sweden.

SESSION 102 | Sustainability and Resilience: The Changing Climate of Planning and Risk Assessment

10:30am–12:00pm | Room 305 B

Moderator: Bill Barrett, North Carolina DOT

Scenario Planning for Sustainability and Resilience: Central New Mexico as a National Example

***Benjamin Rasmussen**, U.S. DOT Volpe Center, Cambridge, Massachusetts; Aaron Sussman and Chowdhury Siddiqui, Mid-Region Council of Governments, Albuquerque, New Mexico; and Tina Hodges, U.S. DOT Federal Highway Administration, Washington, D.C., United States*

A multi-agency project team recently completed a project in New Mexico that showcases how regions can incorporate climate change mitigation and resiliency strategies into their long-range transportation plans using scenario planning. Planning for a rapidly growing region in an arid climate means addressing challenges of congestion, sprawl, energy use, vehicle emissions, flash flooding, wildfire, water scarcity, and impacts on crucial habitats exacerbated by climate change. Scenario planning allowed stakeholders to consider the impacts of growth and development and evaluate the costs and benefits of various future land use and transportation development scenarios in terms of both sustainability and resiliency.

Arizona Department of Transportation Extreme Weather Vulnerability Assessment: A Landscape Ecology Approach

***Kristin Gade**, Arizona Department of Transportation, Phoenix, Arizona; Joshua DeFlorio, Cambridge Systematics, Inc., New York, New York; and Kristin Tremain, AECOM, San Francisco, California, United States*

ADOT conducted a pilot study to assess the vulnerability of its infrastructure to extreme weather, including extreme temperatures, intense precipitation, and wildfire, in the context of Arizona's diverse land cover types and biotic communities. This study, sponsored by the Federal Highway Administration, is one of the first to consider transportation vulnerability to extreme weather through the lens of landscape ecology, addressing the complex, often uncertain interactions between climate and extreme weather, land cover, and transportation facilities. The presentation will focus on the study results and collaborative efforts with multiple stakeholders to cost-effectively enhance the resilience of Arizona's transportation system.

Climate Vulnerability and Economic Assessment for At-Risk Transportation in the Lake Champlain Basin, New York

***Michelle Brown**, The Nature Conservancy, Keene Valley, New York; Debra Nelson, New York State Department of Transportation, Albany, New York, United States; and Jessica Levine, TNC Canada, an affiliate of The Nature Conservancy, Montreal, Quebec, Canada*

The Lake Champlain Basin of northern New York has experienced increased precipitation and extreme flooding over the past 50 years, resulting in damage to homes, businesses, and infrastructure. Undersized and poorly designed road-stream crossings are often at ground zero of flood damage and are particularly vulnerable to changing precipitation patterns and storm events. The current study, part of FHWAs Climate Resilience Pilot Program, addresses these problems through prioritizing road-stream crossings that are most vulnerable to expected climate changes, of community importance, and ecologically significant, and creating a flexible economic framework that considers the full benefits and costs of adaptation options.

A Case Study Approach for Engineering and Economic Analysis for Climate Change Adaptation: Denali National Park Road

***Amit Armstrong**, U.S. DOT Federal Highway Administration, Vancouver, Washington; Paul Schrooten, National Park Service, Anchorage, Alaska; Michael Flood, WSP| Parsons Brinckerhoff, Baltimore, Maryland; and Elias Scheker Da Silva, Vanderbilt Avenue Asset Management, New York, New York, United States*

The National Park Service and Federal Highway Administration have conducted a climate change vulnerability assessment of the transportation infrastructure for Alaska. The primary goals of this project are to identify transportation assets that are adversely affected by climate change and to identify engineering strategies to make infrastructure more resilient and adaptable. This presentation discusses the results of the case study for the Igloo Creek slide location on Denali National Park road. Primarily a gravel road stretching about 94 miles, the Denali National Park road provides the only road access into the park. The thawing permafrost layer is causing slides along this roadway, requiring constant maintenance to provide access. During this case study a detailed engineering and economic analysis was performed to select the optimal solution to build resiliency for this critical route.

SESSION 103 | Aquatics and Wetlands: Stream Assessment and Habitat Connectivity

10:30am–12:00pm | Room 306 A — Moderator: Gordon Cashin, North Carolina DOT

The North Atlantic Aquatic Connectivity Collaborative: Unifying Stream Crossing Assessment Protocols Across the Region

***Jessica Levine**, TNC Canada, an affiliate of The Nature Conservancy, Montreal, Quebec, Canada*

The North Atlantic Aquatic Connectivity Collaborative (NAACC) is a network of practitioners from conservation organizations, universities, and state and federal natural resource and transportation agencies focused on improving aquatic connectivity across a thirteen-state region, from Maine to West Virginia. The NAACC has developed unified protocols for road-stream crossing assessment, launched an online training program, created a regional database for field data, and developed a tool to identify priority watersheds and crossings for assessment. The NAACC supports planning and decision making by providing tools and information on where restoration projects are likely to have the greatest aquatic connectivity and resiliency benefits.

Stream Smart: Maine's Road-Stream Crossing Outreach and Education Program

***Barbara Charry**, Maine Audubon, Falmouth, Maine, United States*

In 2011, Maine Audubon and partners launched Stream Smart, a program that trains contractors, town officials, landowners and other professionals responsible for road-stream crossings, how to construct crossings that maintain fish and wildlife habitat while protecting roads and public safety. Stream Smart road crossings last longer and reduce maintenance costs, saving money in the long term, as well as, withstanding flooding and high storm intensity without damaging the road. The presenter will give an overview of this successful collaborative program which includes workshops, outreach capacity building, construction demonstration videos, the Stream Smart Online Website and Maine Stream Habitat Map Viewer.

Using Functions-based Approaches in Planning Transportation and Mitigation of Impacts

***Lydia Olander**, Dean Urban, and John Fay, Nicholas School of the Environment, Duke University, Durham, North Carolina; and Lawrence Band, Jonathan Duncan, and John Lovette, Institute for the Environment, University of North Carolina, Chapel Hill, North Carolina, United States*

Functions-based approaches to assessing the impacts and outcomes of transportation projects and mitigation may improve outcomes for aquatic and terrestrial ecosystems. Models of ecosystem functions developed using existing spatial data, models, and geospatial methods can be used in scenario analysis. This presentation will provide two examples. The planning example will show methods for predicting fragmentation of habitat by roads which results in the creation of "edge" habitat and the creation of barriers to dispersal. The mitigation planning example will prioritize catchments where mitigation can provide the most uplift for four key aquatic ecosystem functions; hydrology, water quality, geomorphology/hydraulics, and habitat.

Restoring Aquatic Habitat Connectivity Where Highways Cross Streams

***Paul Wagner**, Washington State Department of Transportation, Olympia, Washington, United States*

Aquatic organisms need habitat connectivity, too. Washington State Department of Transportation (WSDOT) has corrected hundreds of fish barrier culverts, improving access to over 1000 miles of stream habitat. The program emphasizes the stream simulation method of design which provides passage for multiple species as well as ecological stream processes. We will discuss key aspects of accelerating a major ecological restoration program including: development of specialized interdisciplinary design teams, regulatory permitting efficiencies and coordination with stakeholder groups, Native American tribes, and regulatory agencies.

SESSION 104 | Developing and Deploying Large-Scale Programmatic Approaches—Panel Discussion

10:30am–12:00pm | Room 306 B

Organizer and Moderator: ***Marlys Osterhues****, U.S. DOT Federal Highway Administration, Washington, D.C.; and Co-organizer and Panelist:* ***Julianne Schwarzer,*** *U.S. DOT Volpe Center, Cambridge, Massachusetts, United States Panelists:* ***Cindy Callahan****, U.S. DOT Federal Highway Administration—Oregon and Washington Divisions;* ***Phil DeGarmo****, US Fish & Wildlife Service—Kentucky Ecological Services Field Station;* ***Catherine Liller****, US Fish & Wildlife Service National Transportation Liaison, Lakewood, Colorado; and* ***Brian Yanchik****, U.S. DOT Federal Highway Administration Resource Center, Summerville, South Carolina, United States*

The Federal Highway Administration, National Marine Fisheries Service and Fish & Wildlife Service have been collaborating to develop large-scale programmatic approaches. These efforts hold the potential to streamline consultation processes across a wide geographic area, yielding time and cost savings, as well as benefits to species and habitat. The panelists will discuss what it was like to work across agencies on these efforts, and the importance of these partnerships in arriving at effective products. Panelists will share information about the recently released Indiana bat and Northern Long-Eared Bat programmatic informal consultation and some basic guidelines for application.

SESSION 105 | Staying Connected in the Northern Appalachians: From Structural to Functional Connectivity—Panel Discussion

1:30pm–3:00pm | Room 305 A

Organizer and Panelist: ***Jens Hilke****, Vermont Fish and Wildlife Department, Essex Junction, Vermont, United States Moderator:* ***Debra Nelson****, New York State Department of Transportation, Albany, New York, United States Panelists:* ***Phil Huffman****, The Nature Conservancy Vermont Chapter, Montpelier, Vermont;* ***Gina Campoli****, Vermont Agency of Transportation, Montpelier, Vermont; and* ***James Brady****, Vermont Agency of Transportation, 1 National Life Drive, Montpelier, Vermont, United States*

This session is focused on a landscape scale, public-private partnership called the Staying Connected Initiative that is implementing a multi-faceted, multi-scaled approach to habitat connectivity in the bi-national, Northern Appalachian / Acadian ecoregion. Participants will become familiar with the Staying Connected Initiative as a model framework for partnership and will understand the need for a multi-faceted approach to habitat connectivity. Presentations will demonstrate a sequence of investigation for identifying spatial priorities along road corridors, from structural connectivity modeling to functional connectivity monitoring, and will convey interpretive approaches for the use of these analyses by transportation agencies for project planning and review.

SESSION 106 | Planning: Connectivity and Conservation on the Drawing Board

1:30pm–3:00pm | Room 305 B

Moderator: Carla Dagnino, North Carolina DOT

Incorporating Wildlife and Ecosystem Values into Environmental Performance Measures for State Departments of Transportation

Daniel Nally, *David Zippin and Jeffrey Ang-Olson, ICF International, Englewood, Colorado, San Francisco, California, and Sacramento, California, United States*

Transportation systems have permeated and substantially altered ecosystems throughout the United States. Environmental performance measures used consistently across the country could help state transportation programs assess, improve, and communicate their performance in this critical area. To facilitate this goal, we developed a self-administered assessment that identifies actions state transportation organizations often use to reduce their impact on and benefit wildlife and ecosystems through policy, statewide planning, and project implementation. Proof-of-concept testing suggested that the tool can be effective in capturing a range of metrics to measure performance related to wildlife and ecosystems.

How Washington Developed Habitat Connectivity Investment Priorities Using a Geographic Information System

Kelly McAllister *and Stacey Plumley, Washington State Department of Transportation, Olympia, Washington, United States (Carl Ward, WSDOT, presenting)*

Using a Geographic Information System, Washington's 7,000 mile highway system was divided into 1 mile segments. Each segment was assigned two priority ranks, one for wildlife-related safety priority and the other for Ecological Stewardship. The safety rank was based on documented collision rates and large mammal ranges. The Ecological Stewardship rank used federal and state listed species ranges and a landscape integrity network to identify highway segments in high priority habitat. Multipliers were applied for proximity to public land blocks and traffic volume. Highly ranked segments will be examined to identify infrastructure projects likely to improve conditions for habitat connectivity.

Expediting Transportation Planning and Multi-Agency Environmental Review with Species Distribution Models in Virginia and Throughout the Eastern United States

Jason Bulluck, *Anne Chazal, and Joe Weber, Virginia Department of Conservation and Recreation—Division of Natural Heritage, Richmond, Virginia, United States*

The Virginia Department of Conservation and Recreation (VDCR) Division of Natural Heritage, in collaboration with the Virginia Department of Transportation, U.S. Fish & Wildlife Service, the South Atlantic Landscape Conservation Cooperative, the New York Natural Heritage Program, the Florida Natural Areas Inventory and other partners, is developing Species Distribution Models for use in state and federal environmental review and permitting decisions for transportation and other development projects. This presentation will describe project objectives, modeling approach, outputs and benefits of using mapped predictive suitable habitat for all threatened and endangered species in Virginia, and about 20 species throughout their eastern U.S. range.

A More Inclusive Transportation Framework: Integrating Wildlife into Transportation Decision-Making for Federal Lands

Steven Suder, *U.S. Fish & Wildlife Service, Falls Church, Virginia; Lauren Deaderick, U.S. Department of Transportation Volpe Transportation Systems Center, Cambridge, Massachusetts; Lia McLaughlin and David Perkins, U.S. Fish & Wildlife Service, Hadley, Massachusetts; and Jeffrey Mast, U.S. Forest Service, Hadley, Massachusetts, United States*

The U.S. Fish & Wildlife Service (FWS) manages the premier network of lands dedicated to fish, wildlife and plant conservation in the world. Transportation access to FWS lands serves recreational/educational opportunities, but is impactful to the very habitats entrusted to the agency. Federal transportation dollars have been used to improve the FWS transportation network, but only recently used to assess and complete transportation improvements for aquatic organism and wildlife benefits. This presentation will review a systematic planning approach in one FWS region and how that data and information will be used to enhance future transportation project selection for ecological benefit.

SESSION 107 | Terrestrial Wildlife: Interactions Great and Small

1:30pm–3:00pm | Room 306 A

Moderator: Jim Hauser, North Carolina DOT

Effectiveness of Bat Mitigation Measures on European Roads

***Morten Christensen**, Morten Elmeros, Hans Baagøe, Jasja Dekker, Inazio Garin, Joxerra Aihartza, Antton Alberdi, Esben Terp Fjederholt, and Julie Dahl Møller, Grontmij A/S, Soroe, Denmark*

The European road authorities have employed a wide range of measures to mitigate or compensate for the negative impacts of roads on bat populations. These measures include avoidance, mitigation and compensation measures ranging from early planning phase to the road construction phase. Only in a few cases, the effectiveness of these measures has been adequately tested. The presentation gives a short review of the measures used in different countries of Europe and examples of evaluation of the efficiency.

Best Management Practices for Bat Species Inhabiting Transportation Infrastructure

***Holly Smith** and Justin Stevenson, RD Wildlife Management and Consulting, Los Lunas, New Mexico, United States*

Forty-five bat species of 19 genera and four families populate the United States. Of those species, 60% and potentially 89% exploit manmade transportation structures (i.e., bridges, culverts). However, overarching guidelines to address incidental bat occupation including identification, mitigation and compensation measures are nonexistent. This presentation discusses applicable surveys and techniques, pervasive misconceptions, appropriate time schedules for operational activities and practicable mitigation measures. These best management practices promote and facilitate animal welfare, consistency of approach and provide transportation authorities with site-appropriate strategies to minimize impacts to endemic bat communities.

Anurans as a Model for Investigating Mechanisms by which Traffic Noise Could Reduce Abundance of Animal Populations

***Molly Grace** and Reed Noss, University of Central Florida, Orlando, Florida, United States*

The aim of this project is to experimentally assess the impact that traffic noise has on wildlife abundance, using anurans (frogs and toads) as a model. We broadcast traffic noise in four roadless sites and performed chorus surveys to assess its impact. Though preliminary data show strong effects of date and site, no effect of traffic noise was detected. We believe that this may be due to our limited ability to maximize sampling effort during periods of greatest frog calling activity (rain events), and we present future directions that will greatly increase data collection, including implementation of acoustic recording devices.

Using Wildlife Behavior to Better Design Mitigation on Highway Projects

***Sandra Jacobson**, USDA Forest Service, Davis, California, United States*

Wildlife species would be logically expected to react to the novel threat of vehicles and highways with the morphological and behavioral systems that were adapted to the risk factors, including predators, they faced prior to the advent of highways. Three example conceptual frameworks using a behavioral basis to identify how wildlife are likely to react to highway issues are presented: reactions to traffic volume as a mortality and barrier effect; perceptions of crossing structures based on animals' primary predator or threat avoidance adaptations; and the use of behavior and morphology to design appropriate barrier or diversion fencing.

SESSION 108 | Advancing the Eco-Logical Approach in 2015: New Implementation Activities and Resources—Panel Discussion

1:30pm–3:00pm | Room 306 B

*Organizer and Moderator: **Julianne Schwarzer**, U.S. DOT Volpe Center, Cambridge, Massachusetts, United States; and Co-organizer and Panelist: **Marlys Osterhues**, U.S. DOT Federal Highway Administration, Washington, D.C., United States Panelists: **Jeff Grabarkiewicz**, Michigan Department of Transportation, Lansing, Michigan; **Wood Hudson**, Charlottesville-Albemarle Metropolitan Planning Organization, Charlottesville, Virginia; **Fraser Shilling**, Road Ecology Center, University of California, Davis, California; and **James Kagan**, Institute for Natural Resources-Portland, Oregon State University, Portland, Oregon, United States*

Since the previous ICOET in 2013, partners across the country have worked to implement, develop resources for and perform research on the Eco-Logical approach. This dynamic session will include presentations on: the status of implementation of the approach; resources made available by the Second Strategic Highway Research Program; two on the ground applications of Eco-Logical; and new research on crediting systems and valuation methods including a step-wise approach to consider ecosystem attributes and services in transportation decision-making. This year's Eco-Logical session will discuss the progress made on the Eco-Logical approach and provide attendees with an opportunity to join the conversation.

POSTER SESSION 1 | 3:30pm–5:30pm | Convention Center Lobby and Room 306 C | Presentations and Discussion

Presentations and discussion in this poster session focus on topics addressing Aquatic Wildlife, Ecosystems, and Wetland Interactions; Stormwater and Water Quality Management; Best Management Practices for Construction, Operations and Maintenance; Crossing Structures, Reducing Collisions, Increasing Connectivity; Multimodal Transportation Ecology Issues; Planning; and Policy and Regulatory Developments.

[01] Impacts Assessment of Highway Construction on Hydrologic Connectivity—A Case Study in Jilin Province

***Xinjun Wang**, Jianye Chen, Hua Li, Yaping Kong, Jiding Chen, China Academy of Transportation Sciences, Beijing; and Hongqi Wang, Beijing Normal University, Beijing, China*

Since 1988, highway construction in China has undergone amazingly rapid development, reaching 4.1 million km in total length of roads by the end of 2012. The huge extent and fast rate of road network construction has exacerbated China's existing environmental problems caused by construction and operation. Highway run through wetland systems causes negative impacts such as ecosystem fragmentation, aquatic organisms disturbance, energy flow destruction and pollution, thus changing hydrologic connectivity of the wetland. This study focuses on structural connectivity and functional connectivity to assess the impact of highway construction on hydrologic connectivity of the wetland.

[02] Efficacy of Roadway Stormwater and Other Drainage Facilities as Suitable Wood Stork Forage Habitat in Central Florida

***Kristin Caruso** and Christine Sciarrino, Scheda Ecological Associates, Inc., Tampa, Florida; Brent Setchell, Florida Department of Transportation, Bartow, Florida; and Eric Stolen, Cocoa, Florida, United States (Sandy Scheda, Scheda Ecological Associates, Inc., presenting)*

The wood stork is a federally threatened species which forages predominately in wetlands with shallow, calm water with open canopies and high prey densities. We evaluated three forms of roadside drainage facilities, ditches, stormwater ponds, and floodplain compensation sites, to determine if their characteristics are similar to those found in natural wetlands and to determine if the designed facilities provide suitable foraging habitat for the species. We find that these facilities contribute positively to the availability of wood stork prey items. We recommend that the USFWS recognize foraging biomass credit (mitigation) for these systems.

[03] Restoring Stream Connectivity to Improve Habitat in the Range of the Yazoo Darter *(Etheostoma raneyi)*

***Amy Carson**, U.S. Fish & Wildlife Service, Jackson, Mississippi, United States*

Yazoo darters are small fish endemic to the Little Tallahatchie and Yocona Rivers in the Yazoo Basin in north-central Mississippi. Habitat fragmentation, which is widespread in the Yazoo basin, is a primary conservation threat to the species that has led to population isolation within their limited range. Perched culverts and box bridges, along with grade control structures and dams are barriers to aquatic organism passage. The U.S. Fish & Wildlife Service along with federal, state, and county partners are taking a strategic approach to remove aquatic organism barriers, focusing initial efforts on road crossings in the range of Yazoo darters.

[04] Use of a Keystone Species to Enhance Habitat Restoration for Transportation Projects

***David Bailey**, University of Washington, Woodinville, Washington, United States*

Our research focuses on gaining a better understanding of how beavers, a keystone species, can be used and managed to mitigate the effects of urban runoff, climate change, and habitat degradation from humans. Once prevalent in now urbanized areas, these animals can create conflict when they recolonize urban landscapes. Recently, designers and managers see the importance of creating urban landscapes that mimic natural systems to provide aesthetic and ecological function. This project has identified active beaver locations within Seattle, Washington and shown how beavers can be managed effectively to enhance urban natural designs.

[05] Effect of Tillage and Amendments on Vegetation Growth and Infiltration for Soils Disturbed Through Development

***Richard McLaughlin**, Fatemeh Mohammadshirazi, and Joshua Heitman, North Carolina State University, Raleigh, North Carolina; and Virginia Brown, TetraTech, Hillsboro, Texas, United States*

Constructing roads and buildings often involves removal of topsoil, grading, and traffic from heavy machinery. The result is exposed, compacted subsoil with low fertility and infiltration, which hinders post-construction vegetation establishment and generates significant runoff, similar to impervious surfaces. The authors found that tilling the soil to different depths greatly improved infiltration rates and that this was maintained for the 2-3 years of monitoring in this study. Infiltration rates of up to 30 cm h-1 were measured when tillage was implemented, suggesting that not only would this prevent runoff from treated areas during most storm events, but runoff from impervious areas might also be infiltrated.

[06] Urban Runoff Pollutants Spatial Distribution in the Southern California Association of Governments (SCAG) Region: An Application of GIS Using the U.S. Environmental Protection Agency's PLOAD Model and SCAG Land Use Scenario Dataset

***Tom Vo**, Frank Wen, Ping Wang, Frank Wen, Simon Choi, and Alison Linder, Southern California Association of Governments, Los Angeles, California, United States*

Non-point source (NPS) pollutants from urban run-off, which are hard to monitor and manage, exert significant impacts on watersheds in the Southern California Association of Governments (SCAG) region and have caused concerns from local jurisdictions about water quality and meeting regulatory requirements. Local jurisdictions do not have regulatory control over water, however, in California, they do have land use authority for local planning decisions. In this presentation, SCAG utilizes EPA's BASIN model to calculate and spatially visualize urban runoff pollutants in relation to different urban growth scenarios and land use changes. For NPS pollutants control, imperviousness as an indicator is widely used in local and regional environmental planning efforts.

[07] Influence of Highway Construction on Water Quality in the Qinghai-Tibetan Plateau of China

***Lin Hu** and Yongti Shan, CCCC First Highway Consultants Co., Ltd., Xi'an, Shaanxi, China*

In order to design the water Environment Protection technology of Qinghai-Tibet highway, we analyzed the influence of the road construction on the Water Quality. The adaptation of current water environmental protection technology and the water quality on the Qinghai-Tibet highway were investigate by sampling the river and runoff water with quality analysis. The results show that Suspended Solids content is highest in road surface runoff. The results also indicated that the biodegradable technology is not suitable for water Pollution control in this area. It is suggested that the physical precipitation technology can play an important role in water pollution control.

[08] Characterization of Stormwater Runoff from Bridges in North Carolina and the Effects of Bridge Runoff on Receiving Streams

***Chad Wagner** and Sharon Fitzgerald, U.S. Geological Survey, Raleigh, North Carolina; and Matt Lauffer, North Carolina Department of Transportation, Raleigh, North Carolina, United States*

The presentation will provide an overview of a collaborative study between USGS, NC Department of Transportation and URS Corporation to characterize stormwater runoff from bridges in North Carolina and the effects of bridge runoff on receiving streams. This investigation measured bridge deck runoff from 15 bridges for 12-15 storms, stream water-quality data for baseflow and storm conditions at four of the bridge deck sites and streambed sediment chemistry upstream and downstream of 30 bridges across North Carolina. Background on why the study was conducted, objectives and scope and a general summary of the major results and conclusions will be presented.

[09] Preserving a Legacy: The U.S. 17 ACE Basin Project

***James Trumbull**, HDR, North Charleston, South Carolina, United States*

The 22-mile US Route 17 project in the Ashepoo, Combahee and Edisto (ACE) Rivers Basin upgraded one of South Carolina's most dangerous highways while traversing one of the largest undeveloped estuaries on the East Coast. Being immediately adjacent to marsh and wetlands and within proximity to a US Fish & Wildlife Service Bald Eagle habitat, the Team faced many geotechnical and environmental challenges. Throughout design and construction, efforts were made to protect or enhance the natural landscape and wetlands that border US 17. This presentation describes this unique project, its challenges, and the key factors implemented to deliver a sustainable and environmentally sensitive project for the South Carolina Department of Transportation.

[10] Microbially Mediated Detection of Damaged Concrete

***Paul Moser**, Delaware Department of Transportation, Dover, Delaware; Kehui Zhang and Julia Maresca, University of Delaware, Newark, Delaware, United States*

As concrete weathers, the physical and chemical transitions occurring on a microscopic level may affect the local bacterial population dynamics. An experimental design using bacteria as a "bio-indicator" for early detection of Alkali-Silica Reaction, a common destructive weathering process in concrete, is proposed. The results of laboratory cultivation and investigation of microbial life in a concrete system is presented. A method of extracting bacterial genomic DNA directly from concrete and processing for genomic sequencing is presented.

[11] Why Did the Mammal Cross the Road? Evaluating the Effectiveness of Wildlife Passages for Smaller Mammals

***April Robin Martinig** and Jochen Jaeger, Concordia University, Montreal, Quebec; and André Desrochers, Université Laval, Quebec City, Quebec, Canada*

Few studies have looked at how smaller mammals respond to road mitigation measures using a multispecies approach. We investigated the effectiveness of wildlife passages in northern Quebec producing three different models that showed how environmental and structural characteristics explain differences in crossing success between passages and how use differs by species. This study highlights how agencies can engineer more effective wildlife passages by minimizing the barrier effect of the structures themselves.

POSTER SESSION 1 | 3:30pm–5:30pm | Convention Center Lobby and Room 306 C | Presentations and Discussion

[12] Cost-Effective Retrofit to Reduce Collisions with Elk along Interstate-17 in Northern Arizona

Jeffrey Gagnon, *Chad Loberger, Scott Sprague, Sue Boe, and Ray Schweinsburg, Arizona Game and Fish Department, Phoenix, Arizona, United States*

For many wildlife-collision hotspots, opportunities for implementing designated crossing structures are decades away. Retrofitting existing infrastructure could mitigate collisions while maintaining connectivity in the interim. We evaluated the effectiveness of upgrading right-of-way fence to exclude elk from a six mile stretch of Interstate-17. The fencing funnels wildlife to four existing structures within the highway segment. Analysis of elk structure use showed significant increases at two bridges, and elk movement data showed only a slight decrease (not significant) in the permeability of the fenced highway corridor. Most importantly, we documented a 97.5% reduction in elk-vehicle collisions.

[13] WWW.SRAZENAZVER.CZ: Experiences from the First Year of the Animal-Vehicle Collision Report Application

Michal Bíl, *Jan Kubeček, Peter Oříšek, Richard Andrášik, and Jiří Sedoník, CDV Transport Research Centre, Brno, Czech Republic*

The web-based application *www.srazenazver.cz* was launched in order to register data on animal-vehicle collisions (AVC) which took place in the Czech Republic. The AVC data comes from police, road administrators, hunters and volunteers. Data are continuously checked to prevent application misuse and determine duplicates. The data is visualized in the form of a map or table. The KDE+ approach (*www.kdeplus.cz*) is used to identify places with AVC concentration (clusters). The clusters are dynamically re-calculated when a new entry reaches the database. The clusters consequently always represent the best option for identifying risky places on roads based on the available data.

[14] Monitoring Deer and Black Bear Activity and Behavior along Unfenced Underpasses

Bridget Donaldson, *Young-Jun Kweon, and Lewis Lloyd, Virginia Center for Transportation Innovation and Research, Charlottesville, Virginia, United States (Andy Alden, VCTIR, presenting)*

This presentation describes an evaluation of deer and black bear activity and behavior at unfenced isolated underpasses and adjoining sections of interstate roadside. Cameras were installed beneath a large bridge underpass and a box culvert and along the adjoining 0.5-mile roadside on both sides of the underpasses. Despite frequent use of the underpasses by deer to cross the highway, deer activity was also high along the adjacent roadside. Deer roadside activity and certain behaviors along the roadside were correlated with deer-vehicle collisions. The findings support the installation of fencing along the roadside adjacent to existing large underpasses and culverts used by wildlife.

[15] Securing Trail Cameras to Reduce the Likelihood of Theft

Kelly McAllister, *Washington State Department of Transportation, Olympia, Washington, United States; and Patricia Cramer, Utah State University, Logan, Utah, United States (Carl Ward, WSDOT, presenting)*

Researchers using trail cameras to monitor wildlife use of bridges and culverts often lose cameras to thieves. Methods to deter theft include disguise (cameras enclosed in utility boxes or bird boxes), heavy armoring (heavy duty steel enclosures, welding, concrete, shrouded padlocks made of the hardest of metals), secrecy (not talking about camera locations), inaccessibility (tree mounts accessible only by ladder), and messaging (stickers or placards with messages to prospective thieves). All of the approaches have advantages and disadvantages related to camera functionality and theft deterrence. The methods presented are likely to be best applied with knowledge of local conditions and the specific camera performance needed to accomplish project goals.

[16] The Passage Bench: A Review of Their Construction as a Standard Bridge Design on River Crossings in Minnesota

Peter Leete, *Minnesota Department of Natural Resources, Saint Paul, Minnesota, United States*

The Passage Bench is a gravel bench incorporated into bridge riprap. Its primary function is to allow wildlife to pass beneath bridges uninterrupted as they travel along the streambank. In 2005 the Passage Bench was considered an experimental design. In 2011 the feature became part of the MnDOT Standard Plan Set for use on all bridges over water in Minnesota. This feature is now being installed as a standard practice throughout Minnesota. We have learned a few things along the way, a summary of these observations is provided in this poster.

[17] Crossing Structure Design for Arboreal Mammals' Passage and its Efficiency in Connecting Two Atlantic Forest Remnants

***Camila Paula de Castilho**, Universidade Estadual de Campinas, São Paulo; Nayara Vieira Peres, Associação Sítio Anhanguera, São Paulo; and Wilson Miguel de Oliveira, Grupo Eco & Eco, Campinas, São Paulo, Brazil*

In this is study we present a technical proposal for a crossing structure design for arboreal mammals to connect two Atlantic forest fragments in Brazil. The crossing structure was designed with two levels, giving two-way access for the animals: its bottom base consists on a wooden bridge made of treated Eucalyptus timber, while its upper level is made of steel cables and treated Eucalyptus timber similarly to a "horizontal" ladder. Camera trapping survey indicated that the crossing structure design was appropriate to permit the passage of arboreal mammals, especially the Common marmoset and Ingram's squirrel.

[18] Enhancing Wildlife Connectivity along California's Highways: The Case of State Route 241 Wildlife Protection Fence in Orange County, California

***Valarie McFall** and Doug Feremenga, Transportation Corridor Agencies, Irvine, California; Winston Vickers and Patrick Huber, University of California, Davis, California, United States*

Estimates suggest that less than 30 adult pumas remain within southern California's Santa Ana Mountain Range. Threats to this population include habitat loss and fragmentation, vehicle-wildlife collisions, depredation permits, and genetic restriction. The SR 241 fence project aims to: enhance wildlife safety by funneling animals to existing undercrossings; reduce habitat loss and fragmentation by locating the fence close to the roadway; and develop wildlife protection fence design guidelines that can be replicated where similar target species (pumas, bobcats, coyotes, and deer) exist. Since installing the fence, there have been no reported wildlife-vehicle collisions within the project area.

[19] Turtle Mortality and Hotspot Identification along a Rural Southern Ontario Highway

***Sarah Merriam**, Ministry of Transportation, Ontario; and Kari Gunson, Ecokare International, Ontario, Canada*

In the spring of 2014 the Ministry of Transportation received a number of complaints from the public about turtle mortality along Highway 48 between Ravenshoe Road and Cydermans Road in Georgina, Ontario, Canada. We suspected that the turtles were using the gravel shoulders to nest along and attempting to cross the road to reach nesting habitat and wetland habitat on either side of Highway 48. A monitoring program was developed and a turtle occurrence model was used to predict where turtle hotspots occurred along Highway 48 so appropriate mitigation strategies could be applied.

[20] Addressing and Minimizing Vehicle and Wildlife Interactions in Maine, USA

***Richard Bostwick**, Maine Department of Transportation, Augusta, Maine, United States*

Since 2004 the Maine Department of Transportation (MaineDOT) has employed various strategies to reduce animal vehicle interaction and crashes (AVC) in rural areas. MaineDOT has tried to modify animal behavior, increase driver awareness, and provide separate passage structures. These strategies are used on highways that have higher rates of AVC and are within habitat blocks in areas where animal move freely across the landscape. These strategies have been used for both safety reasons and habitat connectivity.

[21] Combining Genetic and Non-Genetic Techniques to Evaluate the Ability of Wildlife Crossing Structures to Restore Population Connectivity for Arboreal Mammals

***Kylie Soanes** and Rodney van der Ree, Australian Research Center for Urban Ecology, Melbourne; Andrea Taylor and Paul Sunnucks, Monash University; and Peter Vesk, Unversity of Melbourne, Melbourne, Australia*

We used genetic and non-genetic techniques in a before-after-control-impact comparison to evaluate the effectiveness of crossing structures at restoring connectivity for an arboreal marsupial across a major freeway. Canopy bridges and glider poles were retrofitted to the 30-year-old freeway to restore movement, dispersal and gene flow for the squirrel glider (*Petaurus norfolcensis*), a threatened arboreal marsupial in southeast Australia. By analysing spatial genetic structure and parentage relationships, as well using radiotelemetry and motion-triggered cameras to observe movement, we detected a positive effect of crossing structures on the connectivity of squirrel glider populations within just five years of their installation.

[22] Moose Collisions in the Fairbanks North Star Borough, Alaska

***Job Noordeloos**, University of Alaska Fairbanks, Fairbanks, Alaska, United States*

Moose Vehicle Collisions (MVCs) occur frequently in the Fairbanks North Star Borough. An average of 101 collisions took place during the study period 2000-2012. Despite their frequent occurrence, there is little knowledge about places and times of MVCs. Primary results show that the general trend of the annual collisions is decreasing. The analysis shows that the large majority of collisions take place in the urban areas. Interestingly, the peak months show a large increase in collisions in the remote areas while the urban areas have a relative constant number of collisions.

POSTER SESSION 1 | 3:30pm–5:30pm | Convention Center Lobby and Room 306 C | Presentations and Discussion

[23] ARC Solutions—The Next Phase: Facilitating New Thinking, New Methods, New Materials and New Solutions for Wildlife Crossing Structures

***Renee Callahan**, Center for Large Landscape Conservation, Bozeman, Montana; Rob Ament, Montana State University, Bozeman, Montana; and Sandra Jacobson, USDA Forest Service, Davis, California, United States*

ARC Solutions (*arc-solutions.org)* is an international network seeking to identify and promote leading-edge solutions to improve human safety, wildlife mobility and long-term landscape connectivity. Originating in 2010 with the ARC International Wildlife Crossing Design Competition, ARC today fosters innovation to improve the placement, design and construction of wildlife crossings, and to build support for safe passage of motorists and wildlife across our highways. Since the competition, ARC Solutions has evolved into an interdisciplinary partnership working broadly to innovate, educate and advocate for wildlife crossing systems. This poster provides an overview of ARC's significant accomplishments since its inception in 2010.

[24] Where People and Wildlife Intersect: Prioritizing Mitigation of Road Impacts on Wildlife Connectivity

***Meredith McClure**, Center for Large Landscape Conservation, Bozeman, Montana; and Rob Ament, Montana State University, Bozeman, Montana, United States*

Roads pose a growing threat to Northern Rocky Mountains wildlife. We used wildlife carcass data to index road risk to wildlife, then compared risk to connectivity value as identified by the Western Governors' Association Wildlife Corridors Initiative. Risk was inversely related to connectivity value, suggesting that focusing mitigation on high-risk sites does not necessarily promote wildlife connectivity, especially for species of concern. We identified four complementary sets of priority sites that explicitly consider wildlife connectivity needs alongside human safety, and highlight ways for stakeholders with diverse perspectives to get involved in the process of mitigating highway impacts on wildlife.

[25] Assessing Habitat Permeability at Wildlife Corridor-Road Intersections

***Martin Lafrenz**, Catherine de Rivera, and Leslie Bliss-Ketchum, Portland State University, Portland, Oregon; Lori Hennings, Metro Regional Government, Portland, Oregon; and Sandra Jacobson, USDA Forest Service, Davis, California, United States*

Efforts to prevent and mitigate habitat fragmentation, including from roads, are essential for decreasing animal-vehicle collisions and ensuring the habitat connectivity requisite for healthy animal populations. We developed an approach for selecting surrogate species that addresses connectivity needs for a diversity of species. We also developed field assessment tools that verify GIS data, assess barriers, and record habitat attributes important to wildlife in a way that is comparable across areas and species. This iterative approach uses GIS analysis, field verification and expert local opinion to inform habitat connectivity efforts on an actionable scale and should be widely applicable.

[26] Evaluation of Mule Deer Barriers at Access Roads in Utah, USA

***Joseph Flower** and Patricia Cramer, Utah State University, Logan, Utah, United States*

To ensure the success of wildlife crossings, wildlife must be prevented from entering highways at access roads that bisect wildlife fencing. We evaluated the effectiveness of four wildlife barrier designs currently used to exclude wildlife from highways in Utah, USA. We also evaluated cattle guards retrofitted with electrified pavement. Double cattle guards and wildlife guards were 80% effective for mule deer, while electric mats and standard cattle guards were 50% effective. Although cattle guards retrofitted with electrified pavement effectively excluded mule deer and elk from baited feeding stations, results were mixed on an access road to Interstate 15.

[27] Improving Connectivity for Mountain Lions on California Highway 17 Corridor through Collaboration with Multiple Partners

***Nancy Siepel** and Morgan Robertson, California Department of Transportation, San Luis Obispo, California; Tanya Diamond and Ahiga Snyder, Pathways for Wildlife, Los Gatos, California; Vivian Lindsay and Christopher Pincetich, California Department of Transportation, Oakland, California, United States*

The Santa Cruz Mountains along the central coast of California are becoming increasingly isolated by habitat fragmentation, making it more difficult for mountain lions to traverse and occupy the mountain range. Highway 17 bisects the range, creating an insurmountable obstacle to wildlife connectivity. In 2013/2014 the Land Trust of Santa Cruz County, Midpeninsula Regional Open Space District, Peninsula Open Space Trust, and Pathways for Wildlife teamed up with the California Department of Transportation to identify locations for wildlife crossing structures along the highway. The partnership provides a forum for developing solutions to implement landscape-scale connectivity along the entire highway corridor.

[28] More than 10,000 Reptiles Road-Killed Per Year on a Recent Paved Road in Southern Brazil

Júlia Diniz Beduschi Travassos Alves, *Larissa Oliveira Gonçalves, Fernanda Zimmermann Teixeira, Igor Pfeifer Coelho, and Andreas Kindel, Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, Brazil*

Higher road-kills of reptiles occur when animals were attracted to the road for feeding, breeding and to elevate their body temperature. We aimed to estimate the magnitude of reptile road mortality and identify road-kill hotspots and hot moments on a 276.8 km road (BR-101) in Southern Brazil. The road mortality rate was 28.2 road-kills/day, and the mortality magnitude was 10,263 reptile road-kills per year. Hotspots identified for each species were not spatially coincident. Summer season is a critic period for all species of reptiles, and temporary mitigation measures could be implemented in this period.

[29] Predicting the Effects of Road Paving on Vehicle-Animal Collisions: A Case Study in a Brazilian Protected Area Considering Carcass Removal and Detection

Larissa Gonçalves, *Júlia Diniz Beduschi Travassos Alves, Fernanda Zimmermann Teixeira, Igor Pfeifer Coelho, and Andreas Kindel, Federal University of Rio Grande do Sul (UFRGS), Porto Alegre; and Magnus Machado Severo, Instituo Chico Mendes de Conservação da Biodiversidade, Porto Alegre, Brazil*

Mortality by vehicle-animal collisions can affect substantially population persistence of wildlife, especially within protected areas. We estimated the magnitude of road mortality in four roads (14.4km paved and 51.6km unpaved) surrounding two national parks in southern Brazil, in order to predict the impact of road paving and traffic increase. Road mortality rate considering carcass detectability and removal was 0.18 road-kills/km/day on paved segments and 0.06 on unpaved. We estimated 65.7 road-kills/km/year of paved road and 21.9 road-kills/km/year of unpaved. These results pointed out that the corrected road-kill mortality rate on paved segments is three times higher than on unpaved segments.

[30] Do Resource Agency Reviews of Transportation Projects Translate to Better Fish and Wildlife Crossings?

Marla Chambers, *North Carolina Wildlife Resources Commission, Oakboro, North Carolina, United States*

The North Carolina Wildlife Resources Commission and other state and federal resource agencies work with the North Carolina Department of Transportation to promote environmentally sound projects that safely pass fish and wildlife through them, as well as the traveling public along them. Examination of stream and wildlife crossings in recently constructed projects help planning teams to determine the successful aspects of their efforts and areas where improvements can be made. Views of various crossing structures and post-construction analysis are presented, focusing on resource agency recommendations.

[31] Using Multiple Research Methods to Understand Movement Patterns and Choices in Road Crossing Locations by Black Bears for Mitigation Planning

Heather Chasez, *E Sciences Inc., Orlando, Florida; and Daniel Smith, University of Central Florida, Orlando, Florida, United States*

The effectiveness of wildlife crossing structures is dependent upon location, adjacent suitable habitat, structure design, and the use of fencing adjacent to the crossings. We will present results from a recent study and previous work that used road-kill and track surveys, telemetry, genetics and landscape analysis to identify and evaluate black bear habitat use, preferred movement pathways and highway crossing locations. This project emphasized the importance of collecting and analysing coarse and fine scale data for more precise mitigation planning including pinpointing locations for mitigation.

[32] Broad Utility of Volunteer-Collected Wildlife-Vehicle Collision Observations at Large Scales

Kate Tiedeman *and Fraser Shilling, University of California, Davis, California; Rosemary Garcia, California State University, Los Angeles, California; and Alan Muchlinski, California State University, Los Angeles, California, United States*

We show that volunteer-collection of Wildlife Vehicle Collision (WVC) observations at state-scales could be useful in prioritizing mitigation action by state transportation agencies to protect biodiversity and improve driver safety. Because of the extent and taxonomic accuracy at which volunteer observations can be collected, they may be an important source of data for transportation agencies to protect both drivers and wildlife. We further demonstrate that WVC observations can be used to inform investigations of ecological processes requiring spatiotemporal data about wildlife species, such as invasions, by analysis of Western Gray squirrel and Eastern Fox squirrel in California.

POSTER SESSION 1 | 3:30pm–5:30pm | Convention Center Lobby and Room 306 C | Presentations and Discussion

[33] Effectiveness of Wildlife Fences in Reducing Wildlife-Vehicle Collisions and the Wildlife Use of Underpasses along the SP-225 Motorway, São Paulo, Brazil

Fernanda Delborgo Abra, *Vânia Regina Pivello, and Katia Maria Paschoaletto Micchi de Barros Ferraz, Universidade de São Paulo, Brazil; and Marcel Huijser, Montana State University, Bozeman, Montana, United States*

We conducted a Before-After-Control-Impact (BACI) study to investigate the effectiveness of the wildlife fencing in reducing wildlife-vehicle collisions in SP-225, a highway located in center west of São Paulo State Brazil, and we also recorded wildlife use of the underpasses (after duplication only).

[34] Modeling Black Bear-Vehicle Collision Zones in Yosemite National Park

Katie Elaine Rodriguez, *San Jose State University, San Jose, California, United States*

The purpose of this study was to identify road and habitat characteristics associated with black bear-vehicle collisions in Yosemite National Park and to suggest proper mitigations to reduce their occurrence. Black bear-vehicle collision data collected by Yosemite National Park staff between 1995 and 2011 were used to identify variables associated with collisions. Analyses showed that segments with collisions were associated with crossing sites, understory vegetation, curves, close proximity to meadows, and a flat outbound shoulder slope. Those same road segments, grouped by collision frequency, also showed that segments with high frequencies of collisions were associated with a lack of visibility, fewer crossing sites, high understory cover, steep shoulder slopes, and close proximity to human development and meadows. Findings of this study were used to suggest effective and appropriate mitigation strategies for reducing collisions between bears and vehicles.

[35] Innovative and Sustainable Transportation Evaluation Process (INSTEP), National Park Service, US Department of the Interior

Jan Burton *and Treff Alexander, National Park Service, Denver, Colorado, United States*

INSTEP is a sustainable transportation evaluation system being developed by the National Park Service (NPS), to address the organization's unique mission, goals and regulatory framework. The NPS researched and tested multiple green infrastructure rating systems before beginning the process of developing INSTEP, which will function to guide project planning, design, and implementation while also measuring a project's progress with its identified sustainability goals. INSTEP will provide documentation, education and sharing of sustainable practices through a searchable online database, in support of the triple bottom line of sustainable development: environment, economy, and social equity.

[36] Planning for Wildlife and Safety: Departments of Transportation Can Plan for Wildlife-Vehicle Collision Mitigation with Limited Resources

Coleman Burnett, *SWCA Environmental Consultants, Warrenville, Illinois; Chris Cudia and James Hirsch, New Mexico Department of Transportation, Santa Fe, New Mexico; and Mark Watson, New Mexico Department of Game and Fish, Santa Fe, New Mexico, United States*

In 2013, the New Mexico Departments of Transportation (NMDOT) and Game and Fish (NMDGF) convened a wildlife-vehicle collision mitigation workshop to 1) integrate wildlife-vehicle collision mitigation into transportation projects and 2) engage NMDOT maintenance personnel in the wildlife-vehicle collision mitigation discussion. Fifty participants from NMDOT district offices, NMDGF staff, and volunteers identified 32 priority segments along New Mexico highways. Two priority mitigation projects have been funded by the Highway Safety Improvement Program. We propose this planning process as a low cost and internally-sponsored example for other DOTs to consider when planning for wildlife and transportation safety.

[37] GreenLinks: A Tool to Better Integrate Transportation and Landscape-Level Conservation Planning

Mary Mittiga, *U.S. Fish & Wildlife Service, Panama City, Florida; and Joy Swanson, Florida Department of Transportation, Chipley, Florida, United States*

GreenLinks is a landscape-level approach to identify shared regional conservation priorities among multiple partners involved in transportation and other project planning. The resulting models are science-based GIS tools that can be added to ArcGIS projects to assist users in strategically avoiding and minimizing impacts to our most valuable natural resources during the earliest phases of planning. Areas identified as high conservation priorities are also potential targets for land acquisition/restoration and other mitigation efforts. GreenLinks provides upfront a common vision of the "green infrastructure" needed to protect the region's essential ecosystem functions, resulting in sustainable fish, wildlife, and plant populations.

[38] Roads and Ecological Infrastructure: Concepts and Applications for Small Animals

***Kimberly Andrews**, University of Georgia, Aiken, South Carolina; Priya Nanjappa, Association of Fish and Wildlife Agencies, Denver, Colorado; and Seth Riley, National Park Service, Thousands Oaks, California, United States*

Public infrastructure enables us to go where we need for food, work, and pleasure. For animals, ecological infrastructure is the basic habitat components and their connections necessary for species survival, and for natural populations, communities, and ecosystems to function properly. *Roads and Ecological Infrastructure: Concepts and Applications for Small Animals*, recommends considerations for ecological effects, planning and mitigation, and minimizing costs, how transportation agencies operate, road projects are funded, and conservation practitioners can engage. The ecosystem perspective targets groupings based on ecological and habitat specializations. The book is part of The Wildlife Society book series by Johns Hopkins University Press.

[39] Large Scale Defragmentation Plan for Ungulates along E20 in Southwestern Sweden

***Mattias Olsson**, EnviroPlanning AB, Gothenburg; Andreas Seiler and Kerry Nicholson, Grimsö Research Station, Riddarhyttan; and Mats Lindqvist, The Swedish Transport Administration, Göteborg, Sweden*

This presentation provides a method to describe the ecological flow at the landscape scale and the effect of fauna passages to increase the connectivity for ungulates. ArcGIS and Circuitscape was used in the analysis and the method can be adapted for many species groups, and in relation to present and future land use. In this study, we were able to identify important landscape patterns for ungulates that are in conflict with existing infrastructure. We used the tool to visualize the change of ecological flow when mitigations such as fauna passages or ecoducts opened the barrier at strategic locations along the highway.

[40] Effective Sustainable Transportation Design: Using the Envision™ Manual in the Decision Making Process

***John Lazzara** and Janet Gonzalez, HDR Engineering, Inc., Chicago, Illinois, United States*

As a sustainability tool, Envision™ serves as a holistic framework to help project teams conduct a thorough review of their current sustainability efforts, and suggests strategies to improve project performance and lessen project impacts. Achieving a third-party Envision™ verification award contributes to increased public support and industry recognition for the project. This poster will define ways Envision™ can guide transportation project owners and teams to choose solutions to address community improvement, ecological resources, energy, water, siting, and climate risk and resiliency preparedness. Envision™ not only asks "Will we do the right project?" but also, "Will we do the project right"?

[41] When the Project Changes During Construction: Managing Environmental Commitments through Redesign

***Gray Rand**, David Evans and Associates, Inc., Bellevue, Washington; and Mark Norman, Washington State Department of Transportation, Union Gap, Washington, United States*

David Evans and Associates, Inc. and the Washington State Department of Transportation collaborated to secure environmental approvals within 18 months (12 months for NEPA from NOI to ROD) for a major redesign of an ongoing $177 million construction project in a very sensitive environmental setting prone to avalanches along I-90. Instrumental in this success were: Regular updates to an interdisciplinary agency team; Limited scope Supplemental EIS; Design simulations showing varying lake levels at proposed avalanche bridges versus a designed 1,100-foot (335-meter) snowshed over six traffic lanes; Researching important information needed by USFWS to reinitiate ESA Section 7 consultations; and Accelerated project delivery NEPA provisions of MAP-21.

[42] Making a Change in the Life of Riverine Species: Removal of 300 Barriers in Northern Sweden

***Sofia Perä,** County Administrative Board of Norrbotten, Luleå; Niklas Kemi and Torbjörn Nilsson, Swedish Transport Administration, Luleå, Sweden*

Many animals and plants that live in streams are dependent on migration during certain stages of their lives. For fish, migration is vital in order to move between spawning grounds, nursery grounds and feeding grounds. The aim of the project Remibar is to remove migratory barriers in five larger water systems in the northern part of Sweden. The work is conducted within the network of Natura 2000, and the goal is to improve the conditions for the target species salmon, freshwater pearl mussel, bullhead and otter. A total of 300 migratory barriers, both culverts and dams, will be addressed.

SESSION 201 | Connectivity and Safety: Assessment for Design and Implementation

8:30am–10:00am | Room 305 A

Moderator: Chris Rivenbark, North Carolina DOT

The Wildlife Crossing Guilds Decision Framework: A Behavior-based Approach to Designing Effective Wildlife Crossing Structures

***Julia Kintsch**, ECO-resolutions, Golden, Colorado; Sandra Jacobson, USDA Forest Service, Davis, California; and Patricia Cramer, Utah State University, Logan, Utah, United States*

We classified non-aquatic wildlife into eight Wildlife Crossing Guilds for identifying crossing structure dimensions and characteristics that influence wildlife passage. Our synthesis is based on five primary behavioral and physiological factors underlying a species' willingness to use crossing structures, ultimately determined by an animal's ability to minimize mortality risk. This presentation will describe each of the Wildlife Crossing Guilds and the decision-making framework for maximizing cost-effectiveness in the design of ecologically effective wildlife crossing structures. This framework is particularly useful where there is a lack of species-specific data or an understanding of species crossing structure preferences.

Small Animal Funneling Extractor (S.A.F.E.) for Gopher Tortoise and Other Small Animals in Florida

***David Bogardus**, Florida Department of Transportation, Fort Lauderdale, Florida; and Michael Melendez, Genesis Enterprises & Engineering Services, LLC, Pompano Beach, Florida, United States*

The Gopher Tortoise is threatened in Florida and is currently being evaluated for federal listing. In an effort to protect it, the Florida Department of Transportation (FDOT) began designing a rail crossing retro-fit that facilitates migration and self-extraction if trapped within the rails. Engineering challenges included insuring track stability; maximizing channel height and width; avoiding custom materials; and circumventing any special maintenance methods which would reduce the likelihood of rail authority approval. The ecological challenges included providing acceptable light, strata, and elevations. Participants benefit from lessons learned in the establishment of precedent for the modification of railroad track systems.

Landscape Linkage Models Fail to Predict Wildlife Movement Based on Wildlife-Vehicle Collision Carcass Data

***Fraser Shilling**, Road Ecology Center, University of California, Davis, California, United States*

Most state wildlife agencies and Departments of Transportation (DOTs) use wildlife-vehicle collision (WVC) information and other evidence of wildlife movement to locate mitigation. State agencies and conservation scientists have treated "linkage" models in GIS as a source of prioritization information. I tested whether least-cost linkage models developed within California could predict wildlife movement and conflict with traffic, using carcass data. For both regional and statewide linkage models, there was no relationship between the occurrence of a putative linkage and rate of WVC. I propose that state agencies should treat these model outputs as hypothetical until proven otherwise using wildlife-occupancy or movement observations.

Road Connectivity for Amphibians and Reptiles: A Survey of Systems in California

***Tom Langton**, Transport Ecology Services (HCI Ltd.), Halesworth, Great Britain; Anthony Clevenger and Tiffany D.H. Allen, Montana State University, Harvie Heights, Alberta, Canada and Bozeman, Montana, United States; Robert Fischer and Cheryl Brehme, U.S. Geological Survey, San Diego, California, United States*

Development of road impact mitigation measures for reptiles and amphibians in North America and around the world is summarised. The need to identify system categories, to determine success criterion and standard designs are current foci for attention, as is construction materials strength and durability. We provide provisional information from the early planning stages of CALTRANS funded investigations in California. This includes consideration of the relationship between species sensitivity and the state road network, with wider implications for all roads. The aim is to address the needs for herpetofauna protection from roads and road traffic in California in the coming decades.

SESSION 202 | Tools and Approaches to Integrate Climate Risk and Increase Resilience in the Transportation System—Panel Discussion

8:30am–10:00am | Room 305 B

Organizer: ***Heather Holsinger****, U.S. DOT Federal Highway Administration, Washington, D.C., United States*

Climate change and extreme weather present a significant risk to transportation infrastructure and natural systems. Participants in this session will learn about the unique threats to the transportation system and the innovative tools and approaches that transportation agencies are using to assess and address these risks. Panelists will discuss real world examples of solutions sets of adaptation options, including ecosystem based adaptation approaches, as well as lessons learned and next steps following recent climate change adaptation and resilience pilot projects from around the country.

SESSION 203 | Best Management Practices for Construction, Operations, and Maintenance

8:30am–10:00am | Room 306 A

Moderator: Kathy Herring, North Carolina DOT

Developing a New Pile to Reduce Impacts to Endangered Species Act Listed Species

Marion Carey *and Jim Laughlin, Washington State Department of Transportation, Olympia and Seattle, Washington; Tim Dardis, Per Reinhall, and Peter Dahl, University of Washington, Seattle, Washington, United States*

The install steel piles in the aquatic environment is facing increasing restrictions from regulatory agencies that protect fish and wildlife. This presentation discusses how the Washington State Department of Transportation utilized their research program to develop and implement series of research projects which have culminated in a new steel pile design which minimizes sound transmission in the water column and substrate. The new pile design will reduce project costs and minimizes effects to Endangered Species Act listed species.

Enhancing Wildlife Conservation in Road Corridors by Applying Best Maintenance Practices

Carme Rosell*, MINUARTIA, Barcelona, Spain; Andreas Seiler, Swedish University of Agricultural Sciences, Riddarhyttan, Sweden; Jan Olof Helldin, Calluna AB, Lindesberg, Sweden; Heinrich Reck, Institute for Natural Resource Conservation, Kiel, Germany; and Edgar A. van der Grift, Alterra–Wageningen UR, Wageningen, The Netherlands*

Road maintenance provides us excellent opportunities to reduce road's impacts on wildlife as well as road-wildlife hazards. Mitigation measures maintenance also play a key role for ensuring their long-term effectiveness. Current practices in Europe were analyzed conducting interviews to road managers and performing a literature review within the framework of SAFEROAD project, financed by Conference of European Director of Roads. Based on this information Guidelines for Best Maintenance Practices are being drafted to provide guidance on road maintenance policies, procedures and practices with regard to wildlife conservation while guaranteeing maintenance and road safety standards.

Airport Grasslands Produce a Diverse Insect Fauna of Threatened Species

Magnus Stenmark*, Ecocom AB, Gävle; and Magnus Persson, Swedavia AB, Stockholm-Arlanda, Sweden*

Airport grasslands deliver ecosystem services if the vegetation is managed properly. Around the globe, more than 9,000 airports cover large areas of intensively managed grasslands. We present data from 10 of the largest airports in Sweden. Our findings indicate a high rate of flower-visiting insects and a set of vascular plants and ferns normally found only in traditional hay-meadows. This very specific 'airport biocenose' calls for a new attitude to airport and infrastructure wildlife. By encouraging new and innovative vegetation management methods we can both build a strong educational tool and a crucial support for a set of threatened species.

Effect of Tillage and Amendments on Vegetation Growth and Infiltration for Soils Disturbed Through Development

Richard McLaughlin*, Fatemeh Mohammadshirazi, and Joshua Heitman, North Carolina State University, Raleigh, North Carolina; and Virginia Brown, TetraTech, Hillsboro, Texas, United States*

Constructing roads and buildings often involves removal of topsoil, grading, and traffic from heavy machinery. The result is exposed, compacted subsoil with low fertility and infiltration, which hinders post-construction vegetation establishment and generates significant runoff, similar to impervious surfaces. The authors found that tilling the soil to different depths greatly improved infiltration rates and that this was maintained for the 2-3 years of monitoring in this study. Infiltration rates of up to 30 cm h-1 were measured when tillage was implemented, suggesting that not only would this prevent runoff from treated areas during most storm events, but runoff from impervious areas might also be infiltrated.

SESSION 204 | Transportation Ecology Policy and Regulatory Developments

8:30am–10:00am | Room 306 B

Moderator: Neil Medlin, North Carolina DOT

Synchronization of Reviews for Transportation and Infrastructure: The Effort to Update the 1988 "Red Book"

***Lauren Diaz**, U.S. Army Corps of Engineers, Washington, D.C.; and Michael Ruth, U.S. DOT Federal Highway Administration, Washington, D.C., United States*

The 2015 Red Book, entitled "Synchronizing Environmental Reviews for Transportation and Other Infrastructure Projects," is an update to the 1988 version and serves as a how-to handbook. The handbook is meant for transportation practitioners, including transportation, resource, and regulatory agency staff at the Federal, State, and local level. It captures lessons learned, while disproving the misconceptions of synchronization, and includes information on the use of programmatic approaches, dedicated transportation and infrastructure liaisons, and compensatory mitigation. It contains many examples and demonstrates how these have helped many transportation agencies achieve an efficient review process, without sacrificing protection of the environment.

It is a Long Way from Bangkok to the Andaman Sea: An IENE Mission for Greening Development Plans and Promoting Environmentally Friendly Solutions in a Biodiversity Hotspot of Southeast Asia

***Lazaros Georgiadis**, IENE, Ammochori, Florina, Greece; Miklos Puky (†), MTA Centre for Ecological Research, Danube Research Institute, Budapest, Hungary; Elke Hahn, Bundesministerium fur Verkehr und Innovation, Vienna, Wien, Austria; and Anders Sjölund, Swedish Transport Administration, Borlänge, Sweden*

The extensive infrastructure development in Southeast Asia creates a need for transportation improvement to overcome current difficulties, but emerging serious wildlife threats. Tenasserim Region in Myanmar and Thailand, where the planned Dawei road and railway will cross, is an important conflict area as one of the most intact forest in Asia. In February 2015, an IENE working team visited the area after a WWF invitation assisting on green transport infrastructure solutions. After meetings with relevant authorities and conducting intense fieldwork practical suggestions and mitigation solutions proposed, while general recommendations were made for the countries in the Greater Mekong Region.

The History of Restoring Wildlife Habitat Connectivity in New South Wales, Australia

***Josie Stokes**, New South Wales Roads and Maritime Services, Sydney, Australia*

Roads and Maritime is responsible for over 18, 000 kilometres of road network in New South Wales (NSW), Australia. To minimise impacts on biodiversity, the agency aims to restore wildlife habitat connectivity. However, wildlife mitigation is a recent discipline and has been driven by changes to threatened species legislation. This paper provides a history of fauna mitigation in NSW and illustrates how the culture of a road agency has changed from an ad-hoc and experimental approach, to one that is evidence-based and now includes the restoration of wildlife habitat connectivity as a key factor when planning and implementing road projects.

"Pay or Prevent": Case Studies Involving the Legal Responsibility for Damages and Losses from Large Mammal-Vehicle Collisions on Highways in São Paulo, Brazil

***Fernanda Delborgo Abra**, Prime Engenharia, São Paulo; Beatriz Granziera, Environmental Department, São Paulo; Katia Maria Paschoaletto Micchi de Barros Ferraz, ESALQ–University of São Paulo; Camila Mansur Haddad de Oliveira Santos, Lazzarini Moretti e Moraes Advogados, São Paulo, Brazil; and Marcel Huijser, Western Transportation Institute, Montana State University, Bozeman, Montana, United States*

Between 2005 and 2013, the Military Highway Police of São Paulo recorded 23,858 animal-vehicle collisions of which 194 included human fatalities. We investigated the percentage of large mammal-vehicle collisions that included human fatalities resulted in a law suit in which monetary compensation for damages and losses was sought. We also investigated who was determined to be legally liable for the damages and losses, the laws these rulings were based on, and how high the monetary compensation was based on the jurisprudence of the Brazilian Superior Court of Justice, as well as the São Paulo Court of Justice.

SESSION 205 | Connectivity and Safety: Mitigation Monitoring and Analysis

10:30am–12:00pm | Room 305 A

Moderator: Jim Mason, North Carolina DOT

Impacts of Highway 40 on the Greater Ocala National Forest Ecosystem, Florida, USA

***Daniel Smith**, University of Central Florida, Orlando, Florida, United States*

Ocala National Forest, an important conservation area in central Florida is bisected by Highway 40, a two-lane road proposed for widening to four lanes. Data was collected from 2011-2014 to assess current and potential impacts on wildlife. Locations of road-kills and tracks were recorded for hotspot analysis. Hair snares identified likely crossing locations by large mammals. Mark-recapture and telemetry work demonstrated that the current road is a significant barrier to small animal movement. Wildlife crossing structures and fencing that address the needs of small and large animals were planned and designed to improve habitat connectivity and reduce road mortality.

Distribution and Abundance of Roadkill on an Irish Motorway in Relation to Mammal Underpasses

***Eugene J. Finnerty**, Fidelma Butler, and Pádraig M. Whelan, University College Cork; David Schuller, Eurolink Motorway Operations M3 Ltd, Co. Meath; and Vincent O'Malley, National Roads Authority, Dublin, Ireland*

In Ireland, mammal mitigation measures are primarily designed to facilitate the movement of the Eurasian badger (*Meles meles*) and other wildlife species through the landscape. In this study we report on 4.5 years of daily roadkill monitoring along a motorway scheme. We assessed the frequency, distribution and seasonal occurrence of badger road mortalities. Kernel density analysis was then used to determine 'hotspots' and measure spatial clustering for badger mortalities. The implications for mammal mitigation measures that rely on fencing and 600 mm diameter crossing structures are presented.

Estimating Crossing Rates at Wildlife Crossing Structures: Methods Matter!

***Edgar A. van der Grift**, Alterra–Wageningen UR, Wageningen, The Netherlands; Marcel Huijser and Jeremiah Purdum, Montana State University, Bozeman, Montana; and Whisper Camel-Means, Confederated Salish & Kootenai Tribes, Pablo, Montana, United States*

The purpose of wildlife fencing and wildlife crossing structures is to reduce wildlife-vehicle collisions and restore connectivity for wildlife across roads. In some cases monitoring is carried out immediately after their construction to assess whether they are used by the target species or not. Used survey techniques and sampling schemes, however, do not always allow for proper evaluations. We will provide practical guidelines for selecting appropriate survey techniques and sampling schemes to evaluate wildlife use of crossing structures.

Evaluation of a Roadside Buried Cable Animal Detection System

***Cristian Druta** and Andrew Alden, Virginia Tech Transportation Institute, Blacksburg, Virginia; and Bridget Donaldson, Virginia Department of Transportation, Charlottesville, Virginia, United States*

In order to reduce the animal-vehicle collisions in the state, Virginia Department of Transportation in collaboration with the Virginia Tech Transportation Institute evaluated an innovative roadside animal detection system in naturalistic and controlled conditions. The animal detection system (ADS), a buried dual-cable sensor, detects the crossing of large animals based on their conductivity and provides data on their location along the length of the cable. Data collection and analysis indicated that the ADS, if properly installed and calibrated, is capable of detecting wild animals, with over 95% reliability.

SESSION 206 | Urban Transportation Ecology Issues

10:30am–12:00pm | Room 305 B

Moderator: Deanna Riffey, North Carolina DOT

Estimating the Future Impacts of Exurban Growth and Traffic Demand on Wildlife Connectivity

***Patrick McGowen**, Western Transportation Institute, Montana State University, Bozeman, Montana; Rob Ament and Meredith McClure, Center for Large Landscape Conservation, Bozeman, Montana; and Cameron Ellis, Sonoran Institute, Bozeman, Montana, United States*

Current methods for prioritizing wildlife mitigations on highways has typically utilized historic data such as crash histories, carcass counts, traffic counts, and current land use. Considering typical 20 year transportation planning horizons and 75 year life-spans for wildlife crossing structures, there is a need to forecast future barriers. This project involves an innovative effort to forecast 20 years into the future using a housing and business growth model and a travel demand model for a two county area in northwest Montana. The projected growth used with wildlife connectivity models and field review with local experts provided a more proactive approach.

Getting it Done: Two Large-Scale Wildlife Crossing Projects Speed to Completion on the Edge of the Highly Urbanized Tucson, Arizona Region and a Path Forward for More

***Kathleen Kennedy** and Carolyn Campbell, Coalition for Sonoran Desert Protection, Tucson, Arizona, United States*

In Pima County, Arizona, local jurisdictions are building a broad portfolio of wildlife linkage protection projects using an innovative local funding source totaling $45 million. This presentation will present a detailed case study of the two largest wildlife crossing projects to date, two large wildlife underpasses on State Route 86 on the Tohono O'odham Nation and a large wildlife underpass and wildlife bridge on State Route 77 on the edge of the highly urbanized Tucson region. A range of challenges, solutions, and ongoing issues will be discussed, focusing on the unique location of these wildlife crossings near a large metropolitan area.

The Effect of Artificial Light on Wildlife Use of Passage Structures

***Leslie Bliss-Ketchum**, Catherine de Rivera, Brian Turner, and Dolores Weisbaum, Portland State University, Portland, Oregon, United States*

Barriers to animal movement, including artificial light, can isolate populations but few studies have investigated the effect of light on movement of terrestrial vertebrate communities. We studied the effect of light level on usage of an under-road bridge. Nocturnal taxa avoided the passages significantly more in High than Zero light while crepuscular animals, mostly black-tailed deer, used the passages most during the Reference period. These findings suggest artificial light may be reducing habitat connectivity due to strong avoidance by nocturnal and especially the crepuscular species. This information is needed to mitigate habitat fragmentation in the face of expanding urbanization.

Sustainable Bridge Solutions for Resilience that Enhance the Environment Today while Planning for the Future

***Linda Figg**, FIGG Bridge Group, Tallahassee, Florida, United States*

This presentation of recent bridge case studies illustrates how bridge design and construction are evolving to integrate resilient, sustainable technologies to create model transportation assets. The bridge case studies will include: examples of how they saved energy and reduced environmental impacts through precasting; restored a superfund site; used native landscaping and context-sensitive solutions to transform an industrial area; reduced footprint solutions to save space in the landscape; created community by connecting pedestrian bridge pathways to parks; and used unifying design elements that make bridges more than a transportation facility.

SESSION 207 | New Frontiers in Regional Advanced Species Mitigation for Transportation Projects—Panel Discussion

10:30am–12:00pm | Room 306 A

Organizer: ***David Zippin****, ICF International, San Francisco, California, United States*
Presenters: ***Liz O'Donoghue****, The Nature Conservancy California Chapter, San Francisco, California;* ***Chris Maguire****, Oregon Department of Transportation, Salem, Oregon;* ***Matthew Perlik****, Ohio Department of Transportation, Columbus, Ohio; and* ***Patrick Atchison****, ICF International, San Diego, California, United States*

The number of federally listed species is expanding rapidly. A panel of four speakers will highlight innovative and cost-effective approaches to address this growing challenge for transportation projects with tools used in California, Oregon, and Ohio. Approaches described include habitat conservation plans (HCPs) for capital projects, HCPs for routine maintenance activities, large-scale programmatic consultations under Section 7 of the Endangered Species Act, and other strategies. The benefits and challenges of each approach will be discussed, along with lessons learned from real-world application of these techniques.

SESSION 208 | On the Verge: Vegetation Management within Transportation Corridors

10:30am–12:00pm | Room 306 B — Moderator: Erin Cheely, North Carolina DOT

The Role of Roadside Habitats for the Conservation of Biodiversity

Jan Olof Helldin*, Calluna AB, Stockholm, Sweden; and Andrew Bennett, La Trobe University, Melbourne, Australia*

This presentation describes the role and value of roadside habitats; their ecological function, landscape context, and potential importance for biodiversity conservation. While the scope is global, examples are given primarily from Australia and northern Europe.

The Role of Roadsides in Pollinator Health: Best Management Practices for Pollinator Habitat Health in Highway Rights of Way

Jennifer Hopwood *and Scott Hoffman Black, Xerces Society for Invertebrate Conservation, Portland, Oregon; Scott Fleury, ICF International, San Diego, California; and Deirdre Remley, U.S. DOT Federal Highway Administration, Washington, D.C., United States*

Pollinators are critical to our food supply as well as the health of ecosystems, yet wild pollinators such as the monarch butterfly and a number of bumble bee species are in decline, and beekeepers have reported significant losses of managed honey bee colonies. Roadsides can benefit pollinators by providing foraging and breeding habitat, and by linking patches of fragmented habitat. Two key approaches that state DOTs can take to improve the quality of roadside habitat for pollinators include 1) adjusting roadside vegetation management techniques to accommodate pollinator resource needs, and 2) enhancing and restoring native vegetation to roadside habitat.

North Carolina's Colorful Transportation Ecosystem

Derek Smith*, North Carolina Department of Transportation, Raleigh, North Carolina, United States*

The North Carolina Department of Transportation manages the nation's second largest state-maintained highway infrastructure encompassing 80,000 miles of highways and 300,000 acres of vegetation. 2015 marks the 30th anniversary of the NC Wildflower Program. What began in 1985 with 12 experimental acres has grown to include 1,500 acres of 22 different annual, perennial and NC native wildflowers. Included in this program, NCDOT protects 145 populations of 12 different federally endangered plant/wildflower species in 39 different counties. All of these plantings function as pollinator species habitat and sources of nectar and pollen.

Integrating an Unmanned Air System in Mitigation Implementation

Mark Mickley*, Mulkey Engineers & Consultants, Cary, North Carolina; LeiLani Paugh, North Carolina Department of Transportation, Raleigh, North Carolina; and Kyle Snyder, Institute for Transportation Research and Education, North Carolina State University, Raleigh, North Carolina, United States*

The North Carolina Department of Transportation (NCDOT) with Mulkey Engineers and Consultants, Inc. (Mulkey) developed an Unmanned Aircraft System (UAS) for implementation of the Bodie Island Lighthouse Pond Wetland Mitigation Plan. In coordination with NCDOT, Mulkey conducted extensive research, design, and testing of spray mechanisms attached to a UAS custom-built by Cary, NC-based Hangar 18 Hobbies for the purpose of aerial application of herbicide to control invasive *Phragmites australis* (phragmites) at the mitigation site. This work was done in collaboration with NextGen Air Transportation Group (NGAT), whose mission is development, implementation, and operation of an UAS program for North Carolina.

SESSION 209 | Connectivity and Safety: Evaluating Effectiveness of Structures

1:30pm–3:00pm | Room 305 A

Moderator: Colin Mellor, North Carolina DOT

The Effectiveness of Wildlife Underpasses in Combination with Short Sections of Wildlife Fencing in Providing Safe Crossing Opportunities for Wildlife and Reducing Wildlife-Vehicle Collisions for Large Mammals

Marcel Huijser *and Elizabeth Fairbank, Western Transportation Institute, Montana State University, Bozeman, Montana; Whisper Camel-Means and Dale Becker, Confederated Salish & Kootenai Tribes, Pablo, Montana; Jonathan Graham and Vicki Watson, University of Montana, Missoula, Montana; and Pat Basting, Arvada, Colorado, United States*

Wildlife fencing in combination with wildlife crossing structures is regarded as the most effective and robust strategy to reduce collisions with large mammals while also maintaining wildlife connectivity across highways. However, tall fences may affect landscape aesthetics and some landowners object to their presence and associated measures at access roads. Therefore fence length is sometimes minimized. We investigated whether the length of a mitigated road section affects the effectiveness of the measures in reducing large mammal-vehicle collisions and whether it influences the proportion of animals that choose to cross the highway through an underpass versus at a fence end.

The Effectiveness of Wildlife Crossings and Fencing on Preventing Wildlife Mortalities: A Ten-Year Study along US-1 Highway in South Florida

Barbara Culhane *and Joy Castro, Florida Department of Transportation, Miami, Florida; Greg Juszli, Scheda Ecological Associates, Inc., Delray Beach, Florida; and Jeffry Marcus, Stantec, Coral Gables, Florida, United States*

The Florida Department of Transportation conducted a wildlife monitoring study along the US-1 South roadway corridor between Florida City and Key Largo, Florida to determine the effectiveness of wildlife crossings and fencing. The crossings were designed to minimize impacts to endangered Florida panthers (*Puma concolor coryi*) and American crocodiles (*Crocodylus acutus*). Design features were also added that helped restore historic hydrologic connectivity among surrounding wetland and marine habitats. The combination of fencing and wildlife crossings is reducing wildlife mortalities and allowing wildlife to access natural areas east and west of the roadway, while also making the roadway safer for drivers.

Monitoring Effectiveness of Road Wildlife Mitigation for Large Animals in Ontario, Canada

Kari E. Gunson*, Eco-Kare International, Peterborough, Ontario; and Andrew Healy, Ministry of Transportation, Ontario, Canada*

This presentation documents methods, results, and conclusions from four years of monitoring (September 2011 to September 2015) mitigation measures on Highway 69 in Ontario, Canada. Mitigation measures included one wildlife overpass, four wildlife underpass, one creek bridge pathway, 10 km fencing, 27 one-way gates, and 2 ungulate guards. This presentation will summarize the results obtained from using both snow tracking and motion activated cameras data to evaluate both mitigation measures as well as highway permeability for the large animal community comprised of deer, elk, moose, black bear, lynx, bobcat, coyote, and wolves.

Long-Term Response of Grizzly Bears to Wildlife Crossing Structures: Will They Get Used to Small Structures?

Mirjam Barrueto *and Anthony Clevenger, Western Transportation Institute, Montana State University, Bozeman, Montana; Michael Sawaya, Sinopah Wildlife Research Associates, Missoula, Montana, United States; and Adam Ford, University of Guelph, Ontario, Canada*

Grizzly bears prefer overpasses to underpasses along the Trans-Canada Highway in Banff National Park, but have occasionally used all crossing structure types to cross the highway. This raises the question if they would use small structures in absence of the preferred (but costlier) large structures. We assess 18 years of monitoring data and show that females with cubs (family groups), as opposed to males and non-family groups, near exclusively use the largest crossing structures only for their cross-highway movements. We discuss the implications of these findings for future mitigation planning in critical grizzly bear cross-highway corridors.

SESSION 210 | All Aboard: Multimodal Transportation Ecology Issues

1:30pm–3:00pm | Room 305 B

Moderator: John Merritt, North Carolina DOT

Permitting and Conservation Issues with a Passenger Rail Project: Perspectives from a Public/Private Sector Partnership

***Mark Bakeman**, Chris Regan, and Marion Carey, Washington State Department of Transportation, Olympia, Washington; and William Vogel, U.S. Fish & Wildlife Service, Lacey, Washington, United States*

Intercity passenger rail projects in the United States received a major boost in 2009 with billions of dollars in federal grants to improve rail infrastructure through the American Reinvestment and Recovery Act. These projects may be implemented by state Departments of Transportation, federal agencies, and private rail companies, which may own the rail lines. We review the environmental issues from a passenger rail project in Washington State, and how those issues developed and were resolved among the project partners. We explain why rail projects may present unusual challenges for team members and suggest ways to improve these working relationships.

Evaluating Permeability of Existing Roads and Railroads for Ungulates

***Andreas Seiler**, Swedish University of Agricultural Sciences, Riddarhyttan; Mattias Olsson, EnviroPlanning AB, Gothenburg; and Mats Lindqvist, Swedish Transport Administration, Gothenburg, Sweden*

We present an approach to evaluate the overall permeability of major infrastructure barriers to wildlife, considering the suitability and spacing of existing road bridges that may provide safe passages for animals. This approach has been used already in strategic mitigation planning in Sweden.

A Simple, Low-Cost Train Detection and Warning System to Prevent Wildlife–Train Collisions

***Jonathan A. J. Backs**, John A. Nychka and Colleen Cassady St. Clair, University of Alberta, Edmonton, Alberta, Canada*

Train collisions can be a significant source of mortality for threatened populations of wildlife, such as the grizzly bear population in Banff National Park (Alberta, Canada). A reliable, unambiguous signal of train approach could increase the ability of wildlife to avoid train encounters. We explore two methods by which an approaching train can be detected, triggering small-scale auditory and visual cues for wildlife. By using inexpensive, widely-available components, we hope to provide technology that is accessible to individuals wishing to reduce train collisions in both developed and developing nations.

Assessing the Relationships between Emissions and Vehicle Activity for a Compressed Natural Gas (CNG) Transit Bus Fleet

***Phil Lewis**, Chuanhai Zhu, and Yongwei Shan, Oklahoma State University, Stillwater, Oklahoma, United States*

This paper assesses the relationships between fuel use, emissions, and vehicle activity for a fleet of CNG buses using real-world data. The data were collected by a portable emissions measurement system (PEMS). Pollutant data included NOx, HC, CO, and CO2. Engine activity variables included manifold absolute pressure, revolutions per minute, intake air temperature, engine load, and vehicle speed. Pearson's correlation coefficients (r) were used as a means of assessment and were summarized in a correlation matrix for each tested bus. The results showed that there were moderate-to-strong relationships between pollutant emissions rates and vehicle activity variables.

SESSION 211 | Stormwater and Water Quality Management

1:30pm–3:00pm | Room 306 A

Moderator: Marissa Cox, North Carolina DOT

Estimating the Risks for Adverse Effects of Total Phosphorus in Receiving Streams with the FHWA Stochastic Empirical Loading and Dilution Model (SELDM)

***Gregory Granato**, U.S. Geological Survey, Northborough, Massachusetts; and Susan Jones, U.S. DOT Federal Highway Administration, Washington, D.C., United States*

This paper and presentation provide an example case study that shows how the Stochastic Empirical Loading and Dilution Model (SELDM) can be used to assess the risks for water-quality excursions and the potential effectiveness of mitigation measures to reduce such risks. SELDM was used to simulate the quality of runoff, BMP discharge, and receiving waters to evaluate risks for water-quality exceedances with different criteria concentrations, allowable exceedance frequencies, and selected water-quality statistics. These simulations demonstrate how SELDM can be used to assess long-term ramifications of water-resource policy decisions.

Environmentally Sustainable Approach to Groundwater Remediation

***Chris Niver**, North Carolina Department of Transportation, Raleigh, North Carolina; and Jason Prosser, CLP Services, P.C., Raleigh, North Carolina, United States*

The North Carolina Department of Transportation (NCDOT) by the 1960's implemented an asphalt quality assurance program. On-site solvent disposal from asphalt testing labs (ATL) contaminated groundwater at many facilities. Bio-remediation with energy substrates (e.g., sugars) is the best alternative for cleaning groundwater, but the scale of the ATL remediation program makes the use of commercial products cost prohibitive. Beverage manufacturer Pepsi Bottling Ventures (PBV) in Raleigh, NC uses High Fructose Corn Syrup in their formulations. In a public service collaboration with NCDOT, PBV provided infrastructure and labor to recover and repackage expired sugared beverages. Environmentally, PBV's objective is to minimize their footprint, conserve natural resources, and preserve natural habitat through the implementation of waste minimization and pollution reduction practices. NCDOT transported 65,000 gallons of sugared beverages from the Raleigh PBV facility to an ATL project in Richmond County, NC. The injections reduced or eliminated contamination in treated areas and also reduced NCDOT material and labor costs.

Coupling Green Infrastructure Construction with Scheduled City Street Renovation: Research Findings, Lessons Learned, and Future Opportunities

***Andrew Anderson** and William Hunt III, North Carolina State University, Raleigh, North Carolina, United States*

The City of Fayetteville, North Carolina has completed a design of perhaps the first fully-inclusive "green street" in the state. The City had previously planned a traditional re-paving and lane-narrowing effort for two blocks of a major thoroughfare leading to the historic district of downtown. Taking advantage of this opportunity, City engineers and NC State University's Stormwater Engineering Group worked together to design innovative stormwater BMPs into the retrofit footprint to improve water quality to and reduce stormwater runoff volumes reaching Blounts Creek, a stream leading to impaired Cross Creek. The project hopes to reap many benefits, including public investment that spurs business growth in the area, aesthetic and quality of life improvement, traffic safety, and model-able results that can be applied to other streets in need of improvement to assess their feasibility for a similar green street approach.

Total Maximum Daily Load (TMDL) Alternative—Category 4b Watershed Restoration Plans

***Andrew McDaniel**, North Carolina Department of Transportation, Raleigh, North Carolina, United States*

Section 303(d) of the federal Clean Water Act requires states to develop total maximum daily loads (TMDLs) for a pollutant identified as causing impairment to the designated uses of a waterbody. Many transportation agencies have requirements in their environmental permits which mandate compliance with TMDLs and often struggle to achieve the required load reductions. Alternatives to TMDLs, such as watershed restoration plans, can help transportation agencies and other permittees achieve Clean Water Act goals while avoiding compliance jeopardy with difficult to implement TMDLs.

SESSION 212 | Mitigation: Striking a Balance

1:30pm–3:00pm | Room 306 B

Moderator: Linda Fitzpatrick, North Carolina DOT

Mitigating for Rare Species in Croatan National Forest, North Carolina

***Mary Frazer**, Three Oaks Engineering, Hillsborough, North Carolina, and Rachelle Beauregard, North Carolina Department of Transportation, Raleigh, North Carolina, United States*

To improve traffic operations for regional and statewide traffic along the US 70 corridor and to enhance the ability of US 70 to function according to the NCDOT Strategic Highway Corridor plan, the North Carolina Department of Transportation has proposed the construction of a ten mile long bypass around the city of Havelock, NC. Due to existing development adjacent to US 70 and the presence of the Cherry Point Marine Corps Air Station, the bypass will run through Croatan National Forest, which is home to endangered red-cockaded woodpeckers (*Picoides borealis*) and other rare, protected species. Impacts to rare plant populations, the potential spread of invasive species, habitat fragmentation and a potential reduction in habitat quality due to safety issues with prescribed burns near the bypass have been some of the challenges associated with the development of the bypass. Developing a variety of methods to avoid, minimize and mitigate impacts to rare species in conjunction with US Forest Service staff has been essential to ensure species viability at Croatan post-construction, and will result in a context-sensitive project.

Decision Support for Regional Advance Mitigation Planning

***Patrick Crist**, NatureServe, Boulder, Colorado; Michelle Fink, Lee Grunau, and Karin Decker, Colorado Natural Heritage Program, Fort Collins, Colorado; Richard Muzzy and Craig Casper, Pikes Peak Area Council of Governments, Colorado Springs, Colorado, United States*

Regional advanced mitigation planning (RAMP) is a process to evaluate the cumulative effects of all proposed transportation projects in a long range plan and then develop a suite of locations capable of providing mitigation for those projects. Use of RAMP can direct mitigation to larger, more contiguous, and more sustainable and efficient locations while streamlining the transportation capacity process. This project used RAMP to develop an Integrated Regional Mitigation Plan for the Pikes Peak Area COG in support of its new long range plan. This session will present the approach and outcomes of this work.

Permeability of a Four-lane Mitigated Highway and a Two-lane Unmitigated Highway for American Martens in the Boreal Forest

***Jorge Gaitan**, Robby Marrotte and Jochen Jaeger, Concordia University, Montreal, Quebec; Marianne Cheveau and Sarah Sherman Quirion, Ministère des Forêts, de la Faune et des Parcs, Quebec City, Quebec, Canada*

We are assessing the effect of the increased width of a highway in combination with mitigation measures on the movement of American martens *(Martes americana)*. We used radio-telemetry and capture-mark-recapture methods to observe if the four-lane mitigated highway posed a significant barrier compared to a control road with two lanes and no mitigation measures. Our results suggest that the widened and mitigated highway still represents a more significant barrier for martens than a two-lane unmitigated highway and that it could limit the gene flow between the populations on the two sides of the highway.

Through the Eco Lens: A Landscape Ecology Approach to Resilience in Transportation Planning

***Kristin Tremain**, AECOM, San Francisco, California; Kristin Gade, Arizona Department of Transportation, Phoenix, Arizona; and Joshua DeFlorio, Cambridge Systematics, Inc., New York, New York, United States*

In an effort to address transportation resiliency to extreme weather events in the changing climate, we introduce a framework for assessing climate change impacts to transportation assets through the fundamentals of landscape ecology: the 'eco-lens' approach. Multiple scales of land cover were assessed. To test this methodology, we conducted a preliminary application to a Federal Highway Administration (FHWA) vulnerability pilot project with the Arizona Department of Transportation (ADOT). Here we present our methods, lessons learned, and identify both the strengths and weaknesses of this approach. This study proved successful and can be adapted globally to facilitate transportation system vulnerability assessments.

POSTER SESSION 2 | 3:30pm–5:30pm | Convention Center Lobby and Room 306 C Presentations and Discussion

Presentations and discussion in this poster session focus on topics addressing Emerging Issues and New Directions; Mitigation for Transportation Projects; Policy and Regulatory Developments; Programmatics and Partnerships; Sustainability and Resilience in Transportation Systems; Terrestrial Wildlife and Ecosystem Interactions; Urban Transportation Ecology Issues; and Vegetation Management within Transportation Corridors.

[43] An Automated GIS Approach to Estimating Lateral Drainage Effect of Ditches for Regional Environmental Screenings

***David Johnson**, North Carolina Department of Transportation, Raleigh, North Carolina, United States*

The North Carolina Department of Transportation (NCDOT) has been leveraging GIS technology to help streamline project delivery and reduce costs. By using GIS to automate a labor-intensive manual process NCDOT was able to remotely map over 3000 linear miles of ditches and their lateral drainage effect. The lateral effect ditch data will be used to refine NCDOT's GIS-based Wetland Predictive model as part of a larger pilot project to assist NCDOT with the project planning process.

[44] Impacts of Roads on Migratory Ungulates in Gobi-Steppe Ecosystem of Mongolia: Challenges and Achievements

***Dashzeveg Tserendeleg** and Buuveibaatar Bayarbaatar, Wildlife Conservation Society, Ulaanbaatar, Mongolia; Badamjav Lkhagvasuren, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia; and Takehiko Ito, Tottori University, Tottori, Japan*

Substantial populations of migratory ungulates are found in Mongolia's Gobi–Steppe Ecosystem (GSE), which is characterized by constant fluctuations in precipitation and availability of forage. Ungulates travel extremely long distances to cope with this unpredictability. The largest infrastructure project underway is a railroad to link major coal deposits and will span undisturbed GSE, dividing the largest tracts of habitat used by ungulates. Practical steps for ungulate conservation include regional-scale planning, mitigating existing and future infrastructure. WCS Mongolia, government, and other stakeholders have been monitoring ungulate movements, and plan to partially remove railroad fences to assess impacts and mitigation efforts.

[45] Jake Brakes and Rare Snakes

***James Brady**, Vermont Agency of Transportation, Montpelier, Vermont, United States*

During the 2014 construction season, modifications were performed at low additional cost to an adjacent weigh station construction project to benefit documented North American racer habitat. During construction, artificial hibernacula were created using waste material; trees were chipped to create basking piles; and rebar ladders were installed in drop inlets, allowing the racers to climb out to avoid entrapment. All work was done under the guidance of the Vermont Fish & Wildlife Department, helping to build upon an already strong working relationship.

[46] Watershed Resources Registry: Working Together to Improve Environmental Outcomes in Maryland

***Heather Lowe** and Donna Buscemi, Maryland State Highway Administration, Baltimore, Maryland, United States*

The Watershed Resources Registry (WRR) is a GIS based targeting tool developed by a partnership of agencies to analyze watersheds and identify the best opportunities for the protection of high quality resources, restoration of impaired resources, resource conservation and environmental resource planning, and improvement of stormwater management. The WRR identifies ecological opportunities, assigning each a score from one to five stars, with five stars indicating the greatest potential ecological value. These scores are based upon suitability analyses including wetland restoration and preservation, upland restoration and preservation, riparian restoration and preservation, stormwater natural infrastructure preservation and stormwater compromised infrastructure restoration.

[47] Funding Advanced Mitigation for Environmental Impacts of Transportation Projects

***Jaimee Lederman**, University of California, Los Angeles, Los Angeles, California, United States*

This presentation reviews the role of transportation agencies in efforts to fund Habitat Conservation Plans (HCPs) under the Federal Endangered Species Act. High costs and difficulty accessing funding are major challenges to successful HCP implementation, even though they can protect the environment while allowing development and infrastructure expansion. Large-scale HCPs must secure multiple funding streams to succeed. We must remove policy and legal roadblocks to securing larger-scale funding sources to achieve a shift to regional environmental initiatives. Transportation agencies can play increasingly important roles providing funding to area-wide HCPs, promoting funding stability while allowing transportation agencies to benefit from economies of scale in mitigation.

[48] Environmental Impact Assessment in Europe in Relation to Road Building and Species Conservation

***Dennis Wansink**, Bureau Waardenburg (BUWA), Culemborg, The Netherlands; Miklos Puky (†), MTA Centre for Ecological Research, Danube Research Institute, Budapest, Hungary; Eugene O'Brien, University College, Dublin, Ireland; and Lennart Folkeson, VTI–Swedish National Road and Transport Research Institute, Linköping, Sweden*

Harmony, a consortium of Irish, Dutch, Swedish and Hungarian partners, performed a study on the implementation of the duties required by EU Environmental Legislation in Environmental Impact Analyses (EIAs). Relevant EIA guidelines and Environmental Impact Statements (EISs) in eight reference countries were analysed and comparisons were made between countries. It was noted that standardised guidelines about the assessment of effects on specific habitats and species are needed, as well as for the assessment of cumulative effects. A great variety of mitigation measures to lower the effect of road construction and traffic on wildlife are proposed in EISs, but monitoring their efficacy is rare.

[49] Mingo Creek: Paying It Forward from Mitigation to Education

***Deanna Riffey**, North Carolina Department of Transportation, Raleigh, North Carolina, United States*

The NC Department of Transportation constructed the US 64 Knightdale Bypass that connects the I-440 Beltline in Raleigh to US 64. As part of the project, 205 acres of relatively undisturbed natural area was acquired near the confluence of Mingo Creek and the Neuse River, to provide compensatory mitigation for unavoidable wetland impacts. The Mingo Creek Mitigation Site provides an excellent example of a compensatory mitigation site under long-term stewardship that also minimizes future indirect environmental impacts, improves water quality, and promotes the natural flora and fauna to the local community through educational outreach.

[50] Bear Creek Case Study: Reconciling Salmon Habitat Restoration with Cultural Resource Preservation

***Jon Gage** and Gray Rand, David Evans and Associates, Inc., Issaquah, Washington, United States*

Sites needing salmon habitat restoration frequently contain archaeological resources. David Evans and Associates, Inc. encountered this situation at the Bear Creek Restoration Project. For this project, restoring salmon habitat and mitigating impacts for transportation improvements included accommodating archaeological investigations, preservation, and mitigation at one of the oldest known archaeological sites (>12,000 years) in Western Washington. The discovery meant that the optimal restoration design had to be revisited to protect the Section 106 cultural resource. Stakeholders used an alternatives analysis analogous to Section 404 wetland requirements to reach consensus on a revised design that balanced salmon habitat and cultural resource preservation.

[51] A Comparison of Three Methods to Determine the Location of Highway-Crossing Sites for Red Wolves and Black Bears: Implications for Successful Placement of Mitigating Structures

***Christine Proctor**, Marcella Kelly, Michael Vaughan, and Andrew Trent, Virginia Tech, Blacksburg, Virginia, United States*

Mitigating structures are incorporated into U.S. highway design in order to reduce wildlife-vehicle collisions. However, high variability in use of wildlife crossing structures indicates that placement, construction specifications, distance between crossings, and animal social interactions are essential factors influencing the success of the structures. Past research also has shown that habitat connectivity plays a large role in successful use of crossing structures for carnivores. We compared three methods for identifying highway-crossing locations of red wolves and black bears along a 44 km stretch of highway in Dare and Washington Counties, North Carolina. Our results stress the importance of using the correct methodology in determining the location of wildlife crossing sites.

[52] The Environmental Mitigation for Construction of the North Section of the Ring Road, São Paulo, Brazil

***Marcelo Arreguy Barboza** and Guilherme Augusto Domenichelli, Dersa - Desenvolvimento Rodoviário S.A, São Paulo; Plinio Bruno Aiub, Vet-Sistem, São Paulo; and Fernanda Delborgo Abra, Prime Engenharia, São Paulo, Brazil*

Rodoanel Norte is an innovative and outstanding project of road construction in São Paulo State – Brazil, for several reasons: 1) it directly addresses the impacts of habitat loss during the construction phase by rescuing and relocating plants and animals before the land is cleared for construction; 2) it includes unique and highly functioning partnerships between planners, veterinarians and field staff; 3) it aims to reduce habitat fragmentation through the implementation of fencing and a combination of wildlife underpasses and the first-ever wildlife overpass in Brazil. Brazil is more biodiverse than any other country in the world. The Rodoanel Norte project has the potential to act as a model not just for other road construction projects in Brazil, but for other projects in areas of high biodiversity elsewhere in South America or the world.

POSTER SESSION 2 | 3:30pm–5:30pm | Convention Center Lobby and Room 306 C | Presentations and Discussion

[53] Road Mitigation is Associated with Increased Mortality from Train Collisions for Large Mammals in Banff National Park

Patrick Gilhooly *and Colleen Cassady St. Clair, University of Alberta, Edmonton, Alberta, Canada*

Road mitigation for wildlife using fencing and crossing structures has proliferated worldwide, but without knowledge of collateral effects on adjacent infrastructure. We compared annual rates of train collisions for large mammals before and after mitigation of the highway in Banff National Park, Canada. After mitigation, collisions were higher for both carnivores and ungulates. At least 93% of the strikes were fatal and 67% were elk, which, corrected for population size, also increased. Rail use by wildlife may have increased following road mitigation to compensate for losses in foraging, scavenging, and travel opportunities, and encourages more holistic mitigation.

[54] Successful Design and Implementation of Federally Threatened Species Transplant and Habitat Restoration

Tim Buntrock *and Patrick Hickey, Colorado Department of Transportation, Denver, Colorado; Samantha Clark, Jacobs Engineering Group, Denver, Colorado; and Alison Deans Michael, U.S. Fish & Wildlife Service, Denver, Colorado, United States*

A collaborative approach has been taken between multiple federal, regional, and local agencies to design and apply innovative measures to mitigate impacts to two federally threatened species – Preble's meadow jumping mouse (*Zapus hudsonius preblei*) (PMJM) and Ute ladies'-tresses orchid (*Spiranthes diluvialis*)(ULTO). The size of off-site mitigation, project timing, and scarcity of similar studies for transplanting ULTO were primary challenges, as past attempts were unsuccessful in the long term. Off-site mitigation for these species is on a trajectory towards successful establishment. Monitoring and maintenance will continue, and funding is being sought to track PMJM populations.

[55] Igor I. Sikorsky Airport Runway Safety Area Improvements: Integrated Tidal Wetland and Listed Species Mitigation Planning and Design

Daniel Hageman*, Fitzgerald and Halliday, Inc., Hartford, Connecticut, United States*

The project consisted of design and permitting for the installation of an Engineered Material Arresting System (EMAS) to improve the runway safety area (RSA) at Igor I. Sikorsky Airport, in Stratford, Connecticut. A "perfect storm" of environmental resources existed in the proposed work areas consisting of high value tidal wetlands, state-endangered plants, state-endangered birds, a Superfund Site, and non-superfund contamination. The mitigation measures were designed to provide substantial compensatory tidal wetland and listed species mitigation, provide an improved RSA, improve airport safety and operations, provide an education component, and ultimately strike a sustainable balance between ecological resources and transportation needs.

[56] Mitigation for Transportation Projects: Kirk Ave Bus Depot

Glenn Robinson*, Morgan State University, Baltimore, Maryland; and George Hill, Maryland Transit Administration, Baltimore, Maryland, United States*

This presentation shares the development of a unique mitigation model to address environmental and visual impacts posed by transportation facilities to urban blocks in close proximity to transportation maintenance facilities. Focus is on steps taken by residents, researchers, planners and advocacy groups to develop a $450,000 community green space mitigating some of the negative health impacts from a bus facility on the surrounding residential community in Baltimore, Maryland. Environmental justice and sustainability are inherent in the arguments set forth by the authors; these contend with metropolitan social, economic and environmental equity issues.

[57] Ohio River Bridges—Downtown Crossing: Environmental Compliance and Conformance

Nancy Allen*, Stantec Consulting Services, Inc., Louisville, Kentucky, United States (Kenneth Carper, Stantec, presenting)*

The Ohio River Bridges (ORB) project, connecting Louisville, Kentucky and southern Indiana, is currently one of the nation's largest transportation improvement projects. The Environmental Compliance and Mitigation Plan (ECMP) and the Environmental Management System (EMS) for Downtown Crossing portion of this project were essential for implementation. The ECMP includes regulatory approvals, commitments and stipulations, lines of communication, and reporting requirements. The ECMP, EMS and close collaboration of the DBT have greatly contributed to the success of this project.

[58] South Carolina Department of Transportation's Environmental Compliance Program

Jason McMaster*, HDR, North Charleston, South Carolina, United States*

The South Carolina Department of Transportation Environmental On-Call program is now entering its second three year term after its successful initial launch. HDR was the only firm to be re-selected and now is tasked with managing two regional districts. This presentation highlights the successes and growing pains of a new approach to environmental compliance within its continually changing landscape.

[59] Commitment Tracking for Environmental Compliance

***Susie Ridenour**, Ben Morrow, and Russ Freistat, McCormick Taylor, Phoenix, Arizona, Baltimore, Maryland and Columbus, Ohio, United States*

The authors will be presenting their development of an effective Environmental Commitments Tracking program from project development through project construction Discussions will be held on how to successfully develop and implement a commitment tracking program through all phases of the project development process using web-based multi-user applications that allow for the tracking and reporting of project compliance. Specific examples from work with a variety of DOTs will be shared. Experiences learned at the presentation are beneficial, whether it is for large mega-projects or for smaller-scale rehabilitation programs.

[60] Oklahoma DOT Programmatic Biological Assessment for the American Burying Beetle

***Julianne Whitaker**, Oklahoma Department of Transportation, Oklahoma City, Oklahoma; and Rhonda Spinks, U.S. Fish & Wildlife Service, Tulsa, Oklahoma, United States*

The Federal Highways Administration (FHWA), Oklahoma Department of Transportation (ODOT) and US Fish & Wildlife Service (USFWS) entered into a programmatic consultation for the American burying beetle (*Nicrophorus americanus*) (ABB) that allows ODOT to address compliance under the Endangered Species Act (ESA). The programmatic approach provides conservation measures for avoiding, minimizing and offsetting any unavoidable impacts to the ABB from ODOT transportation projects over the next 10 years, while allowing transportation projects to move forward in a predictable and timely fashion.

[61] Evolution of a Newly Formed Inlet in a Transportation Corridor on the Outer Banks of North Carolina: A Photographic Tale of Inlet Migration

***Kathy Herring**, North Carolina Department of Transportation, Raleigh, North Carolina, United States*

Pea Island National Wildlife Refuge lies on a narrow piece of barrier island on the Outer Banks of North Carolina between Oregon Inlet and the village of Rodanthe on Hatteras Island in Dare County. The NC Department of Transportation was granted a 100-foot wide easement within the Refuge for the purposes of maintaining NC 12, the only transportation corridor on Hatteras Island. Situated as it is, separated from the mainland of the state and jutting out into the Atlantic Ocean, this 13 mile sandbar is very vulnerable to storms with high winds and tides. This poster presentation documents the evolution of a newly formed inlet on the Outer Banks of North Carolina in Dare County.

[62] Conceptual Nature-Based and Gray Infrastructure for Flood Resiliency at Oakwood Beach, Staten Island, New York

***Brian Sayre**, Dewberry, Parsippany, New Jersey, United States*

Following the damaging effects of Hurricane Sandy, Dewberry designed a conceptual $173-million flood protection system to restore the quaint Oakwood Beach community on the southeastern shore of Staten Island, NY. This included a Feasibility Study and Conceptual Design Plan for a combination of natural and gray infrastructure to provide storage for a 100-year rainfall event and reduce damages to infrastructure from the 500-year coastal storm event. The solution includes constructing a revetment, flood walls, tide gates, berms, stormwater conveyance, and freshwater and tidal wetlands to offer benefits in both increased flood protection and natural habitats.

[63] Overview of the Center for Environmental Excellence by AASHTO Website: A Comprehensive Resource on Environmental Issues in Transportation

***Kate Kurgan**, AASHTO, Washington, D.C.; and Amy Phillips, Bloomberg BNA, Arlington, Virginia, United States*

This poster provides a tour of the Center for Environmental Excellence by AASHTO Website (*http://environment.transportation.org*), a key information resource from the American Association of State Highway and Transportation Officials. The website is updated weekly with news, research, new AASHTO products, best practice case studies from DOTs, document links, and other pertinent information. The presenters will provide an introduction to the site and explain how to access key resources. Content updates are ongoing to meet the needs of practitioners.

[64] Indirect Effects of Roads on Native Island Herpetofauna

***Kristina Chyn**, Texas A&M University, College Station, Texas, United States*

This study tests if the Species-Area Relationship and Island Biogeography theories hold in an anthropogenically modified and fragmented landscape. In developed regions, it is often difficult to isolate and study indirect effects of single "road-effect zones," so it is more applicable and necessary to study the indirect effects of overlapping and possibly interacting road-effect zones. Taiwan, an island with twice the road density of the US, is an area where single road-effect zone research is nearly impossible. This project studies how indirect effects of road-zone landscapes with varying road densities affect native and endemic reptiles and amphibians in Taiwan.

POSTER SESSION 2 | 3:30pm–5:30pm | Convention Center Lobby and Room 306 C | Presentations and Discussion

[65] The Small, The Forgotten and The Dead: Lessons from a Roadkill Survey

Alberto González Gallina, *Griselda Benítez-Badillo, and Octavio R. Rojas-Soto, INECOL - Instituto de Ecología, A.C., Veracruz; and Mircea G. Hidalgo-Mihart, Universidad Juárez Autónoma de Tabasco, México*

In Mexico few studies have addressed the issue of highway impact on small vertebrates. We look at the richness and abundance of vertebrate roadkills along a 14 km stretch of the Amozoc-Cantona-Perote highway, at the border of the states of Veracruz and Puebla across two environments: shrubland on lava spill and grassland. We found that roadkill surveys are easy in terms of methodology, cheap compared to other survey methods such as trapping on vast areas, and it is quite informative and an underestimated tool when it comes to gathering biodiversity data. Small species are generally underestimated.

[66] Wildlife Friendly Roads Toolbox for Central America

Daniela Araya-Gamboa, *Panthera, San José; Esther Pomareda-García, Centro de Rescate las Pumas, Guanacaste; Yocelin Ríos Montero, Ministerio de Ambiente y Energía, San José; Esmeralda Arévalo-Huezo, Universidad Nacional, San José; Maria Cristina Aguilar-Ruiz, Universidad Técnica Nacional, San José; and Rose Marie Menacho Odio, Universidad Estatal a Distancia, San José, Costa Rica*

In Central America it is essential to harmonize the relationship between infrastructure development and biodiversity conservation. To address this need The Environmental Guide: Wildlife Friendly Roads was developed in Costa Rica. These are the Technical Guidelines for road development, core of this toolbox: 1.Identification of Environmentally Fragile Areas and Wildlife Vulnerable to Road Impact. 2. Identification of Wildlife Crossing Sites. 3. Recommendation of Environmental Measures to reduce road impact. 4. Establishment of Wildlife Monitoring, Rescue and Environmental Education. This toolbox with proper adjustments can be implemented in other Central American countries and thus decrease road impacts on this biodiverse region.

[67] How Do Bats Cross the Road? Crossing Structure Use Varies based on Ecological Functional Groups of Insectivorous Bats in Southeast Australia

Manisha Bhardwaj, *Kylie Soanes, Tanja Straka, and Rodney van der Ree, Australian Research Center for Urban Ecology, Melbourne; Jose Lahoz-Monfort, Quantitative and Applied Ecology Group, Melbourne; and Lindy Lumsden, Arthur Rylah Institute, Heidelberg, Victoria, Australia*

In this study we evaluated the use of wildlife underpasses (bridge and culverts) by insectivorous bats in Southeast Australia. Insectivorous bat species can be grouped into ecological functional groups based on their flight, navigation and hunting behaviour. We predicted that these groups would influence the use of the two different crossing structure styles. We determined that bats of all groups are more active under bridges than culverts, and that, when a bridge is present, the activity of bats above the road is lower than if a culvert is present. These findings suggest that bridges may be more effective at providing "safe crossing areas" than culverts.

[68] Long Point World Biosphere Reserve Causeway Improvement Plan, Port Rowan, Ontario: Update On Reducing Wildlife Road Mortality And Restoring Hydraulic Connectivity

Rick Levick, *Long Point World Biosphere Reserve Foundation, Port Rowan, Ontario; and Stephen Burnett, S. Burnett and Associates, Ontario, Canada*

This presentation provides an update on the progress made and the benefits achieved since the initial Improvement Plan was presented at the ICOET conference in 2009. This community-driven project is intended to mitigate the negative environmental impacts of the causeway on wildlife, especially Species At Risk reptiles, and the adjacent federally-protected wetland. The project's monitoring program has recorded an average reduction in reptile road mortality of more than 50 per cent since 2008 and a 60 per cent reduction in road kill of SAR turtles. As well, the project is helping to restore an important Great Lakes coastal wetland.

[69] Modeling Occupancy of Barn Owls in Relation to Road Mortality in Southern Idaho, USA

Tempe Regan, *Erin Pikcilingis and James Belthoff, Boise State University, Boise, Idaho; Christopher McClure, The Peregrine Fund, Boise, Idaho; Angela Kociolek, Western Transportation Institute, Montana State University, Bozeman, Montana; and Melinda Lowe, Idaho Transportation Department, Boise, Idaho, United States*

Barn owls (*Tyto alba*) are frequent victims of roadway mortality. They are killed in greater numbers along roads than any other North American raptor. Interstate-84 (I-84) in southern Idaho has among the world's highest rates of Barn owl-vehicle collisions. Nothing is known about patterns of Barn owl occupancy in this region. We were interested in determining which landscape-level and local features of habitat were related to occupancy, and using model-based results to compare with actual mortality locations. Our poster discusses results of mortality vs. occupancy analyses, multi-season occupancy models and radio-tracking studies to help understand Barn owl roadway mortality.

[70] How Spatial, Geometric, and Biotic Features of Roads Affect Vehicular Collisions with Barn Owls *(Tyto alba)* Along Interstate 84 in Southern Idaho

***Erin Pikcilingis**, Tempe Regan and James Belthoff, Boise State University, Boise, Idaho; Steven Hanser, U.S. Geological Survey, Boise, Idaho; Jeremy Thompson, Borah High School, Boise, Idaho; Eric Yensen, Michigan State University, East Lansing, Michigan; Angela Kociolek, Western Transportation Institute, Montana State University, Bozeman, Montana; and Melinda Lowe, Idaho Transportation Department, Boise, Idaho, United States*

Barn owls (*Tyto alba*) are particularly susceptible to vehicular collisions along major roads. Rates of barn owl roadway mortality are among the world's highest along Interstate 84 in southern Idaho. Our objective was to examine how roadway and environmental features influence barn owl mortality. We found plant cover type in the median and right of way, percentage of cultivated crops and development, length of secondary roads, distance to Snake River Canyon, distance to nearest dairy, and width of median were associated with rates of owl mortality. Our results will help guide future mitigation efforts to reduce barn owl roadway mortality.

[71] Road Kills of Owls *(Asio otus, Tyto alba)*

***Janos Farkas**, Flóra Pokorni, Tamás Cserkész, and Ákos Klein, Eotvos Lorand University, Budapest, Hungary*

From 2006 till 2014 more than 1000 road casualties of *Asio otus* and *Tyto alba* were recorded along the motorways of Hungary. As the number of observations increased, the more and more positional irregularity was suspected. To visualise these patterns we edited a table which recognises the recorded milestones and gives coordinates to every records. To visualise density of records we applied Heatmap Plugin (Radius: 3000 m, Decay ratio: 0,1, Pseudo Color). The result layer displays the distribution of points and the hot spots of mortality. Discovering these places allows further investigations on prevention strategies and calculations on home ranges with the opportunity to extend investigation to other motorways.

[72] Creating Nesting Habitat for Barn Swallows *(Hirundo rustica)*

***Larry Sarris**, Ministry of Transportation, Ontario, Canada*

The Barn Swallow is a medium-sized songbird that is about 15-18 cm long. In the province of Ontario, Canada, this species was listed as 'threatened' under Ontario's Endangered Species Act in January 2012, resulting in both species and habitat protection. As a result, individuals who are maintaining, repairing, modifying, replacing or demolishing a building or structure that provides Barn Swallow habitat must develop a mitigation/compensation plan. The Ministry of Transportation of Ontario (MTO) is currently exploring and implementing techniques for Barn Swallow mitigation/compensation measures on existing provincially owned infrastructure, including, but not limited to bridges, culverts, and salt domes.

[73] Variation in Wildlife-Vehicle Collisions based on Landscape Context and Road Classification: A Case Study in the Raleigh, North Carolina Metropolitan Area

***Brenda D Lemus**, Prescott College, Franklinton, North Carolina, United States*

Millions of animals die worldwide every day as a result of collisions with vehicles. In the United States, wildlife mortality on roads is more than one million per day, yet little has been documented about the variation in the rate of wildlife vehicle collisions (WVCs) based on landscape character/context and road classification. This study compared the difference in number of WVCs by road size, traffic volume and posted speed limit in certain land cover types. The study examines the extent of WVCs along certain segments of three different class roads in Raleigh, NC metropolitan area. The main purpose was to evaluate how wildlife mortality differs by landscape character/context and road classification. Results of this study were used to evaluate need for mitigation.

[74] Developing a Science-Based Conservation Strategy for the Honduran Emerald in Response to an Agricultural Corridor Project

***Fabiola Rodriguez**, Dorian Escoto and Jeff Larkin, Indiana University of Pennsylvania, Indiana, Pennsylvania, United States; Daniel Lebbin and John Tschriky, American Bird Conservancy, The Plains, Virginia, United States; José Luis Ramos and Ivan Ochoa, ASIDE, Tegucigalpa, Honduras; Thelma Mejía, Lilian Ferrufino, Saby Cruz, Rosa Ramírez, and Denis Padilla, Universidad Nacional Autónoma de Honduras, Tegucigalpa, Honduras*

The Honduran Emerald is the only endemic bird to Honduras. This hummingbird species is included on the International Union for Conservation of Nature and Natural Resource's Red List as endangered and its population is considered to be in decline. Honduran Emeralds inhabit thorn forest found in arid intermontane valleys. The government initiatives in Honduras include promoting infrastructure projects such as roads that cross multiple departments. The Olancho department, home to one of the Honduran Emerald populations, is a potential area for development. Science-based conservation strategies need to be created to protect the species and its fragile habitat.

POSTER SESSION 2 | 3:30pm–5:30pm | Convention Center Lobby and Room 306 C | Presentations and Discussion

[75] Improving Marginal Lands to Enhance Insect Pollinator Habitat

Jennifer O'Brien, *Danesha Seth Carley, Margarita Lopez-Uribe, Rich McLaughlin, David Tarpy, and Tom Rufty, North Carolina State University, Raleigh, North Carolina, United States*

Insects are valuable animal pollinators that perform important ecosystem services; most notably pollination of agricultural and ornamental crops and plants. Over the past few decades, insect pollinator populations have declined. One major driving force is change in landscape due to urbanization and include habitat fragmentation, alteration and loss. In efforts to beautify North Carolina roadsides and increase pollinator habitat, N.C.D.O.T. plants thousands of acres of wildflowers across North Carolina. In this study, N.C.D.O.T. wildflower sites and "lightly managed" sites in the piedmont region of NC were used to determine pollinator abundance and richness. Pollinators assessed were bees, flies and butterflies.

[76] A Feasibility Growth Study of Native Mosses and Associated Self-Sustaining Flora on Vertical Infrastructure

Mary Kaufman, *Achievable Landscapes in Planning, Glen Ellyn, Illinois, United States*

This exploratory study objective is to determine if mosses and associated floras are a feasible landscape-ecology solution on transportation sound and retaining walls. The poster presentation includes supporting studies, vertical infrastructure vegetation characteristics, the results of a landscaping policy, practice and decision-making survey given to Departments of Transportation in 2010 and exploratory studies in moss husbandry. The work will show the beneficial characteristics of the genus that make it a very desirable candidate to include in landscaping in transportation corridors.

[77] Tracking and Managing Federally Protected Plant Species on NCDOT Roadsides

Cheryl Gregory, *North Carolina Department of Transportation, Raleigh, North Carolina, United States*

This poster presentation will convey the best practices developed for managing and tracking rare plant species on North Carolina's roadsides. NCDOT has developed mowing regimes, has committed to avoiding the use of herbicides at these sensitive locations as well as other management commitments aimed at protecting rare roadside populations. Using field tested guidelines and regimes benefits transportation departments by eliminating staff time devoted to informal and potential formal Section 7 consultations while enhancing the habitat and protection of these rare species.

[78] Research on Slope Erosion of Highway in the Qinghai-Tibetan Plateau

Tianwei Wang, *Lin Hu, Yongti Shan, Bo Zhang and Wen Guo, CCCC First Highway Consultants Co., Ltd., Xi'an, Shaanxi, China; and ZongWei Chen, China Academy of Transportation Sciences, Beijing, China*

The highway slope in the Qinghai-Tibetan Plateau is being severely eroded due to low temperature in the Permafrost zone and frequent thawing and freezing. In this project we built up run-off plots on the representative slope of the China National Highway 214, and used relevant technology to discriminate factors such as temperature, topography and precipitation, then observed sediment in the runoff barrel over time. Soil bulk density, soil impermeability and hydraulic conductivity, and the physical properties of sediment in the runoff barrel were measured at different times to get the quantitative relation between the factors and slope erosion. Simulation experiments of water erosion, freeze-thaw erosion and wind erosion were conducted in the lab. Soil erosion levels in different conditions of roadbed, slope angle and slope height were obtained, providing a choice for the building program of the Qinghai-Tibetan highway.

[79] Experimental Study on Highway Slope Greening with Wild Flowers on Hainan Island

Ti Wang, *Jian-ye Chen, and Yan-feng Zhang, China Academy of Transportation Sciences, Beijing, China*

In order to solve the problem of deficiency in wild flowers species for highway slope greening on Hainan Island, we conducted a survey of local species from 2011 to 2014 within the scope of the road region in many multi-grade highways that have been built for many years on Hainan Island. Eleven kinds of native wild flowers were found, and two species were selected to conduct a series of experiments. The results show that these two species can adapt to the conditions of the road environment. Similar trials will be carried out on the other species of wild flowers.

[80] Challenge and Countermeasures to the Revegetation of the High Altitude and Cold Regions of Qinghai-Tibetan Highway

Xueping Chen, *Yangang Yang, Jiding Chen, and Yaping Kong, China Academy of Transportation Sciences, Beijing, China*

Vegetation degradation, water and soil loss, and damaged landscape have accompanied highway construction in the high altitude and cold regions of the Qinghai-Tibetan plateau. Most of the Qinghai-Tibetan highway is located in the perennial frozen soil region, lacking soil resources adaptable to plant growth. The thin layer soil in this region is prone to be destroyed during road construction. In recent years, several studies of the surface soil and vegetation protection, revegetation engineering techniques, and engineering of the Qinghai -Tibet highway, railway and electricity facilities construction have been conducted, and significant progress has been made.

[81] Tidal Wetland Creation along the Connecticut Coastline: Real World Challenges and Lessons Learned

Kevin Carifa *and Christopher Samorajczyk, Connecticut Department of Transportation, Newington, Connecticut; Jeffrey Simmons and Simon Hildt, Stantec Consulting Services, Inc., Topsham, and Northampton, Massachusetts, United States*

The Connecticut Department of Transportation (CTDOT) recently completed a tidal wetland mitigation project at the Groton-New London Airport in Groton, CT. The site included 2.5 acres of creation, with areas of open water, high and low marsh, and mudflat. The project encountered many challenges during construction which required design changes in the field. Among the more significant changes were modifications in grading and topsoil placement, revised tidal channel design, invasive species control, and innovative plant handling strategies. The site has responded well, and provided many lessons learned to be applied on future transportation related projects.

[82] Adaptive Management for Balancing Safety and a Rare Plant at a Regional Airport

Matt Arsenault*, Jeffrey Simmons and Simon Hildt, Stantec Consulting Services, Inc., Topsham, Maine, and Northampton, Massachusetts; Kevin Carifa and Christopher Samorajczyk, Connecticut Department of Transportation, Newington, Connecticut, United States.*

The Groton – New London (GON) airport in Groton, Connecticut provides important habitat for yellow thistle *(Cirsium horridulum)*, a state-endangered species. Recently completed safety upgrades of Runway Safety Areas (RSA) were required in order to meet federal aviation safety standards resulted in direct impacts to yellow thistle. Compensatory mitigation measures implemented a restricted mowing schedule in order to maintain yellow thistle populations. Thus far, two years of post-construction monitoring data collected to-date indicate yellow thistle populations are apparently stable on the airport grounds with comparable richness and spatial distribution.

[83] The Function of Infrastructures' Habitats as Landscape Features on Biodiversity

Jörgen Wissman *and Tommy Lennartsson, Swedish Biodiversity Centre, Swedish University of Agricultural Science and Uppsala University, Uppsala, Sweden*

Efforts to conserve habitats in transport infrastructure corridors, alongside road and railroad verges, have primarily focused on identifying management practices that preserve vascular plant species and species-rich vegetation. When pressure and willingness, in recent years, have increased to include more species groups and for the practice of landscape perspectives in management decisions, needs for new knowledge and new perspectives on infrastructures' habitats have emerged. We identify four main functions of habitats within infrastructure. This conceptual model can function as a tool for prioritizing and designing conservation measures both in infrastructure corridors and in the surrounding landscape.

[84] Creating Accountability in Community Visioning through Performance Measures

Leigh Blackmon Lane*, Institute for Transportation Research and Education, North Carolina State University, Raleigh, North Carolina; Teresa Townsend and Ann Steedly, Planning Communities, Inc., Raleigh, North Carolina, United States*

This poster will demonstrate how the U.S. DOT Federal Highway Administration's Community Vision Metrics tool can be used to identify performance measures to guide the planning process and create community visions that are implementable and accountable. Case study examples of transportation and comprehensive planning from Oregon, North Carolina, Mississippi, and Alabama will be highlighted. How practitioners worked with the tool to select livability measures responsive to each community context will be discussed. Key goals and measures will be noted to illustrate how the tool helped planners define visions and the mechanisms for gauging planning outcomes.

SESSION 213 | Wildlife Road Crossings for North Carolina: Research, Comprehensive Planning, and Implementation—Panel Discussion

7:30pm–9:00pm | Room 305 AB

Organizers: ***Ron Sutherland*** *and* ***Maggie Ernest****, Wildlands Network, Seattle, Washington, United States*
Presenters: ***Scott Sprague****, Arizona Game and Fish Department, Phoenix, Arizona;* ***Renee Callahan****, Center for Large Landscapes Conservation & Partnership Coordinator, ARC Solutions, Bozeman, Montana;* ***Christine Proctor****, Department of Fisheries and Wildlife Conservation, Virginia Tech, Blacksburg, Virginia; and* ***Amy Keister****, South Atlantic Landscape Conservation Cooperative, Raleigh, North Carolina, United States*

This panel discussion will center on how North Carolina can lead the way in developing a statewide wildlife road crossings plan. The topic will be explored by learning from what other states have done to tackle this ambitious goal, reviewing the effectiveness of crossings already in use in NC, and brainstorming ways in which connectivity modeling and planning can provide the foundation for a comprehensive wildlife crossing strategy. We expect the discussion will be highly relevant not just for ICOET's host state of North Carolina, but for many other states and countries as well, where similar strategies could be pursued.

Three concurrent field trips are hosted by staff of the **North Carolina Department of Transportation** and its state and federal resource agency partners. Refreshments are provided on each tour, and lunch is provided on Field Trips 2 and 3. Note the Boarding and Departure times for each trip, and please arrive promptly for check-in. Return times are estimated. **Check-in and board tour buses at the Convention Center front lobby.**

Field Trip 1: Mingo Creek—Wetland and Stream Mitigation

Boarding 8:30am | Departure 9:00am | Return 1:00pm | Lunch on your own

This half-day tour will visit the distinctive Mingo Creek mitigation site, a large piedmont North Carolina wetland complex, surrounding buffer, and uplands that have been preserved despite suburban development pressure. Located just east of Raleigh and the Neuse River, the mitigation site is bordered by major transportation corridors for U.S. Highway 64 and the Norfolk Southern Railway. Within this unique site participants will observe vegetation typical not only of piedmont North Carolina, but also representative species from the mountains and the coastal plain. Discussions will address the site's history from its inception to its future long-term stewardship. While viewing this wetland complex and several piedmont streams, participants will also learn about North Carolina's own wetland (NCWAM) and stream (NCSAM) assessment methods developed by an interagency team of state and federal staff from NCDOT, N.C. Department of Environment and Natural Resources, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and U.S. Fish & Wildlife Service. Sturdy walking shoes or boots are recommended for this tour. Participants will return to downtown Raleigh in time for lunch on your own.

Field Trip 2: Longleaf Pine Ecosystem—Endangered Species Mitigation

Boarding 7:30am | Departure 8:00am | Return 6:00pm | Lunch included

This full-day tour will highlight mitigation sites in the North Carolina's Sandhills region and coastal plain, home to the longleaf pine. Covering 92 million acres of the southeastern U.S., the longleaf pine ecosystem was, in its prime, one of the most extensive and biologically diverse ecosystems in North America. The decline of these once dominant forests now threatens such wildlife species as the red-cockaded woodpecker, rough-leaf loosestrife, and the Venus flytrap. The first tour stop will be at the Plantation Road site in New Hanover County, purchased by NCDOT for wetland and endangered species mitigation for the I-40 interstate highway connector. Discussions will address mitigation site management highlighting interagency cooperation. Participants may view rare carnivorous endemics such as Venus flytrap and pitcher plants. Next stops will include sites along the future widening of U.S. Highway 17 in Pender County, where NCDOT is creating habitat for a red-cockaded woodpecker population in the adjacent Holly Shelter Game Land. Participants will visit the game land to observe a red-cockaded woodpecker cavity tree—and hopefully a bird—as it is the only woodpecker known to excavate cavities in living trees. The tour will also look at a swing-span bridge, due for replacement, over the state's Intracoastal Waterway and discuss the challenges of replacing this infrastructure in a developed coastal environment.

Field Trip 3: The Outer Banks—Resiliency and Disaster Response

Boarding 6:30am | Departure 7:00am | Return 8:00pm | Lunch included

This extended-day tour will take participants to the dynamic and fragile ecosystems of the Outer Banks of North Carolina—a chain of narrow barrier islands along the state's coast. Linked together by N.C. Highway 12 and the NCDOT Ferry System, the Outer Banks is a major economic region of the state and home to many endangered species. The tour will visit infrastructure sites that continually face significant impacts from routine storms, hurricanes, and other natural processes. Discussions will address the efforts of recovery and the challenge of implementing ecologically sensitive solutions to the transportation needs of Outer Banks residents and visitors. The tour will cross over the ever-changing Oregon Inlet on the 2.5 mile-long Bonner Bridge—opened in 1963 and due for replacement—and travel through Pea Island National Wildlife Refuge to the New Inlet that breached Highway 12 during Hurricane Irene in 2011. Tour stops will include the historic U.S. Coast Guard lifesaving station on Pea Island for a view of Bonner Bridge and the Oregon Inlet, a visit to the temporary bridge over New Inlet, and lunch at the Bodie Island lighthouse.

SESSION 401 | Connectivity and Safety: Valuation and Innovation

8:30am–10:00am | Room 305 A

Moderator: Randy Griffin, North Carolina DOT

Design and Effectiveness of Fence Ends and Animal Jump-outs in Kootenay National Park

***Trevor Kinley**, Parks Canada, Radium Hot Springs, British Columbia, Canada*

A wildlife crossing project in Kootenay National Park included (a) fence ends designed to shift cross-highway movements away from openings, and (b) at-grade jump-outs to facilitate egress of animals penetrating the fenced area. About 19% of approaches to jump-outs from the highway side resulted in animals successfully exiting, but ultimate success was higher as multiple approaches appeared to be of the same animals. Almost 99.7% of animals passing by jump-outs on the "safe" side of the fence remained there, with breaches by two coyotes, one white-tailed deer and possibly wolves. Fence-end monitoring was technologically limited but showed partial success.

Maine Road Infrastructure Survey for Terrestrial Wildlife Passage Retrofit Potential

***Barbara Charry**, Maine Audubon, Falmouth, Maine; and Julia Kintsch, ECO-resolutions, Golden, Colorado, United States*

Wildlife road crossings are a proven solution to help wildlife safely cross roads and prevent vehicle collisions. Identifying priority sites for building wildlife crossings is important to meet the needs of wildlife and use limited funding effectively. Retrofitting culverts and bridges already in place is a cost effective approach for improving wildlife passage. During the summer and fall of 2014, Maine Audubon and partners conducted a pilot project to survey and evaluate existing road crossings for retrofit potential using the Permeability of Existing Structures for Terrestrial Wildlife: A Passage Assessment System (PAS). The presenters will share the process and results.

Efficacy and Cost-Effectiveness of Mitigation Measures to Reduce Wildlife-Vehicle Collisions in the Bow River Valley, Alberta, Canada

***Anthony Clevenger**, Western Transportation Institute, Montana State University, Harvie Heights, Alberta; Tracy Lee, Miistakis Institute, Mount Royal University, Calgary, Alberta; Ben Dorsey, Parks Canada, Revelstoke, British Columbia; Adam Ford, University of British Columbia, Vancouver, British Columbia; Mirjam Barrueto, Banff, Alberta, Canada; Rob Ament, Western Transportation Institute, Montana State University, Bozeman, Montana; and Meredith McClure, Center for Large Landscape Conservation, Bozeman, Montana, United States*

We evaluated the effectiveness of two mitigated sections of the Trans-Canada Highway in the province of Alberta. We compared wildlife-vehicle collision (WVC) counts before and after mitigation for both mitigated and control segments of equal length. This study design allowed us to determine whether WVCs were reduced following mitigation and whether any observed reduction may be attributed to other causes that would affect both mitigated and control segments. We found a substantial decline in the number of WVCs after each mitigation phase was completed despite annual increases in traffic volumes.

Cost Reduction Opportunities Associated with the Design and Construction of Wildlife Overpass Structures

***Terry McGuire**, McGuire Consulting, Calgary, Alberta, Canada; Rob Ament, Western Transportation Institute, Montana State University, Bozeman, Montana; and Renee Callahan, ARC Solutions, Bozeman, Montana, United States*

The widespread implementation of wildlife overpasses has been hindered by their perceived and actual expense. For that reason, a facilitated workshop was convened gathering prominent wildlife crossing practitioners from North America to determine whether there are strategies that could be utilized to reduce or avoid costs, while not compromising the overall efficacy of wildlife overpasses. The resulting paper captures a number of strategies viewed by participants as having the greatest likelihood of reducing or avoiding costs or, in some cases, adding value, as a result of employing one or more of the strategies identified.

SESSION 402 | Sustainability and Resilience: Focal Points in the Big Picture

8:30am–10:00am | Room 305 B

Moderator: Mike Sanderson, North Carolina DOT

Addressing Biodiversity Conservation on Roads in South Africa

***Wendy Collinson**, Harriet Davies-Mostert, and Shelley Lizzio, The Endangered Wildlife Trust, Johannesbeurg, South Africa*

Since 2012, the EWT has been actively addressing the conservation impacts of southern Africa's rapidly growing, but potentially impactful transport industry through establishing relevant forums and networks of stakeholders within the transport industry and the launch of a smartphone app (Road Watch) for recording roadkill sightings nationally. Initially our attention was focused on road impacts on wildlife outside of protected areas, since traffic volume is higher and collisions are often more visible and more threatening to human life. However, reports from various social media platforms have indicated huge public concern for wildlife-vehicle collisions inside protected areas. Consequently, in 2014 we initiated an assessment of roadkill rates within selected protected areas, with an emphasis on using park visitors to provide citizen science data.

Ecosystem Services and the U.S. Forest Service: Implications for Regional Transportation Planning

***Jonas Epstein**, USDA Forest Service, Washington, D.C., United States*

The U.S. Forest Service is increasingly applying an ecosystem services-based approach to planning and decision-making—or, the translation of ecological impacts as economic costs and benefits to social well-being. A better articulation of the ecosystem services provided by optimizing transportation planning can proactively leverage federal funding for important work by realizing shared benefits across landscapes. As a specific case study, Aquatic Organism Passage (AOP) culvert upgrades provide numerous socioeconomic benefits, from flood resilience to avoided costs of water filtration, lost recreational activity due to impacted fish and wildlife habitat, and disruption of commercial and emergency services due to road collapse.

Effective Sustainable Transportation Design: Using the Envision™ Manual in the Decision Making Process

***John Lazzara** and Janet Gonzalez, HDR Engineering, Inc., Chicago, Illinois, United States*

As a sustainability tool, Envision™ serves as a holistic framework to help project teams conduct a thorough review of their current sustainability efforts, and suggests strategies to improve project performance and lessen project impacts. Achieving a third-party Envision™ verification award contributes to increased public support and industry recognition for the project. This presentation will define ways Envision™ can guide transportation project owners and teams to choose solutions to address community improvement, ecological resources, energy, water, siting, and climate risk and resiliency preparedness. Envision™ not only asks "Will we do the right project?" but also, "Will we do the project right"?

Road Salt Recycling and Water Quality Improvement through Phytoremediatiion and Bio-Fuel Production

***Andrew Alden** and Cristian Druta, Virginia Tech Transportation Institute, Blacksburg, Virginia, United States*

Research was conducted to establish proof-of-concept for recovery and recycling of applied road deicing salt through its uptake in halophytic plants established near roadways; harvesting as biomass; extraction as bio-char in biomass-to-fuel biochemical conversion; and reapplication on winter-affected roads. Laboratory tests were conducted to establish the key unproven element within the reuse cycle, the efficacy of saline biochar for roadway deicing and traction improvement. Laboratory tests conducted on a temperature gradient table and outdoor albedo heating tests revealed 350% increased friction and 720% higher material temperatures, respectively. Saline biochar chemical deicing potential was also demonstrated in laboratory testing.

SESSION 403 | Aquatics and Wetlands: Conservation of Freshwater Fauna

8:30am–10:00am | Room 306 A

Moderator: Bruce Ellis, North Carolina DOT

Oregon Spotted Frog Habitat Model: An Application of Science to Facilitate Endangered Species Act Project Review

Jeff Dreier, *Kelly McAllister, and Marion Carey, Washington State Department of Transportation, Olympia, Washington; and Steve Germaine, U.S. Geological Service, Fort Collins, Colorado, United States*

Biologists conducting environmental review of transportation projects may face challenges recognizing habitat suitability for species. The Washington State Department of Transportation addressed this issue with a recently listed species – the Oregon spotted frog. The agency recognized the need for a habitat assessment model to facilitate project environmental review. Using the model, biologists can make efficient use of their time and deliver the information needed to complete consultations. The process of developing a habitat model based on scientific literature, experienced biologists, and federal agency input can be applied to newly-listed species to facilitate Section 7 consultations for transportation projects.

Fish, Waterways and Roads: The Challenges of Combining Hydrology and Dynamic Systems with Stationery and Static Infrastructure

Fabrice Ottburg, *Alterra–Wageningen UR, Wageningen, The Netherlands; Matt Blank, Western Transportation Institute, Montana State University, Bozeman, Montana; and Paul Wagner, Washington State Department of Transportation, Olympia, Washington, United States*

This presentation focuses on fish that use fresh-water systems and provides solutions to minimise the effects of roads and road–stream crossings on fish and fish habitat. Streams are often in close proximity to or crossed by roads and railways, which can lead to habitat degradation and barriers fish movement. Steps typically taken to create and protect roads near streams generally result in loss of habitat and impacts to fish. The dynamic character of streams and their changing nature needs to be accommodated in planning, expanding or operating transportation infrastructure where roads cross water or occur in a floodplain.

Arroyo Toad (*Anaxyrus californicus)* Management: Down the Path of Invasive/Exotic Species Removal

Michael Robson, *Bergmann Associates, Horseheads, New York, United States*

California's State Route 74 Ortega Highway Safety Improvement Project included critical habitat for the endangered arroyo toad (*Anaxyrus californicus*). An adaptive management plan was developed spanning 5 years involving coordination of regulatory and permitting with the USFWS, USFS, USACE, CDFG and Regional Water Quality Control Board. Subsequently, a 3-mile exclusion fence was designed and constructed, with USFWS protocol surveys conducted while simultaneously designing and implementing an invasive/exotic species eradication plan and habitat restoration plan. The results are discussed as they relate to inter-agency coordination, endangered species management in critical habitat, and best management practices in extremely demanding transportation construction corridors.

Minimizing Transportation Related Impacts to Native Freshwater Mussels: A Look at the Toxicity of Polyacrylamide and Turbidity

Sean Buczek, *Gregory Cope, and Richard McLaughlin, North Carolina State University, Raleigh, North Carolina, United States*

Polyacrylamide (PAM) is widely used as a chemical flocculent and has become an effective tool for reducing suspended sediment and turbidity. However, little is known about the effects of PAM on many freshwater organisms, and no information exists on the toxicity of PAM formulations to native freshwater mussels (*Family Unionidae*). Following ASTM standard guidelines, we exposed three different mussel species to six formulations of anionic PAM. We found that PAM concentrations typically recommended for turbidity control (1–5 mg/L), regardless of molecular weight or charge density, were not acutely toxic to the mussel species and life stages tested, indicating minimal risk of short-term exposure effects.

SESSION 404 | Programmatics and Partnerships

8:30am–10:00am | Room 306 B

Moderator: Brett Feulner, North Carolina DOT

Herpetofauna and Roads: How Can We Get Along?

Kevin Williams *and Denise Cologna, Atlantic Industries Ltd., Ayr, Ontario, Canada*

Current road design, construction and operation practices in Ontario are having significant negative impacts on many herpetofauna species. Ontario's herpetofauna population is in a critical state and there needs to be a coordinated strategic push from all directions to tackle the threat of herpetofauna road mortality. Results are presented from a systematic analysis intended to identify means to changes the conversation from 'why care about road impacts on herpetofauna?' to 'how can we mitigate road impacts?' This presentation is recommended for attendees interested in herpetofauna road ecology and/or ideas on how to more effectively implement positive road ecology change.

In Pursuit of Statewide Migratory Bird Treaty Act Take Coverage – An Oregon Journey

Chris Maguire*, Oregon Department of Transportation, Salem, Oregon; and Diane Winterboer, USDA/APHIS/Wildlife Services, Portland, Oregon, United States*

The Migratory Bird Treaty Act (MBTA) prohibits the take of nearly every species of bird in the United States; it is a challenging law for transportation agencies. The Oregon Department of Transportation (ODOT) undertook an eight-year journey to obtain incidental take coverage under the MBTA. In 2013, ODOT was issued a three-year programmatic MBTA special purpose permit for all Agency activities. This presentation takes the audience on a recap of that journey.

Public/Private Partnerships, a Roadway to the Future: Alabama Department of Transportation and Westervelt Ecological Services

John Wigginton*, Westervelt Ecological Services, Auburn, Alabama; and Keith Walker, Alabama Department of Transportation, Montgomery, Alabama, United States*

The Alabama Department of Transportation (ALDOT) entitled its first mitigation bank in 1991 and now operates 13 banks. The development of a successful statewide banking program is discussed. ALDOT's strong banking program inhibited the development of private mitigation banks. However, in recent years, ALDOT, which operates no stream mitigation banks, has purchased significant amounts of stream credits from private bankers. Additionally, in 2013, ALDOT published a notice requesting stream and wetland mitigation banking services. Westervelt was awarded a portion of this work, and aspects of the ALDOT/Westervelt partnership are discussed. The effects on private mitigation banking are also discussed.

Bridging the Knowledge Gap between Engineers and Biologists

Scott Aston*, Contech Engineering Solutions, West Chester, Ohio; and Sandra Jacobson, USDA Forest Service, Davis, California, United States*

Engineers and biologists have widely divergent background training and jargon, and the specialization needed for each of these complex disciplines nearly guarantees that knowledge and understanding of the other's field is limited. Yet engineers and biologists need to work closely together to design and build effective wildlife and aquatic passage structures. We discuss some of the questions that each discipline would like to ask the other, as well as which key elements that each discipline wishes the other would keep in mind when designing structures.

SESSION 405 | Partnerships for Achieving Effective and Sustainable Outcomes in Eastern North Carolina—Panel Discussion

10:30am–12:00pm | Room 305 A

Organizers: ***Anne Burroughs****, Dewberry, Raleigh, North Carolina; and* ***Gary Jordan****, U.S. Fish & Wildlife Service, Raleigh, North Carolina, United States*

A highway widening project in a setting containing a diverse array of natural and community resources required team communication, coordination, education, compromise, and innovation to minimize impacts across the full range of regulated and non-regulated resources. The partnership produced a sustainable habitat connectivity plan. The project's wildlife crossings include 10 bridges, 1 large arch-pipe, 14 medium and 45 small arch-pipes with 10.5 miles (16.9 km) of wildlife fencing dispersed along the project's 25 terrestrial miles (40.23 km). Additional innovative features to be designed include jump-outs for trapped wildlife, day-lighting of pipes to equalize temperature and humidity, wildlife canal bridges, and specialized gates.

SESSION 406 | Planning Tools and Strategies for Improved Outcomes

10:30am–12:00pm | Room 305 B

Moderator: Tyler Stanton, North Carolina DOT

European Strategies for Adaptation of Infrastructure to the Surrounding Landscape

Lars Nilsson *and Anders Sjölund, Swedish Transport Administration, Borlänge, Sweden*

Twelve years ago, a pan-European cooperation resulted in a handbook on how to handle the conflict between wildlife and road traffic. The handbook has been widely distributed and used. However, the European organization for road administrations, CEDR, identified that several important aspects are missing and recommended six actions including a research program for cost-effective measures. In 2014 a CEDR financed research program started. It contains three major research projects—*Saferoad, Harmony,* and *SafeBatPaths*—with scientists from Ireland, Spain, Netherlands, Germany, Hungary, Denmark, Sweden and Norway and it involves cooperation with scientists from the USA, Canada and Australia.

Prisoners' Dilemma: Using Game Theory to Create Collaboration and Resilience in Transportation Ecology

Patricia Cramer*, Utah State University, Logan, Utah, United States*

The principles of Game Theory can be used to help understand how transportation and natural resource agencies can work together to help mitigate roads for wildlife. The theory of prisoners' dilemma is used to demonstrate how cooperation can develop between two parties. If a transportation agency's needs for safety on roads can be paired with a wildlife agency's needs to keep wildlife populations moving and stable, a "game" situation can occur where each side has a more vested interest in cooperating than the payoff of defecting. Using the experiences of several states, the talk will demonstrate the continuum of cooperation and how it has resulted in safer roads and promoted wildlife connectivity.

Development of a Provincial Wildlife Mitigation Strategy for Large and Small Animals on Highways in Ontario

Brenda Carruthers*, Ministry of Transportation, Ontario, Canada*

What do you get when you have limited mitigation dollars and 19,000 km of highway over a large area that's home to more than 50 small animal species considered to be 'at risk' and several large animal species with which there are at least 14,000 vehicle collisions annually? You get strategic! Hear about how the Ministry of Transportation in Ontario, Canada is working collaboratively, using the best available data and science, to develop solutions to promote safe and ecologically sustainable highways.

Tools and Training Programs for Integrating Wildlife and Natural Resources Conservation in Land Use and Transportation Planning in North Carolina

Kacy Cook *and Brooke Massa, North Carolina Wildlife Resources Commission, Star and Raleigh, North Carolina; and Allison Schwarz Weakley, North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina, United States*

We will present a synopsis of and preliminary results from the NC Wildlife Resources Commission's Green Growth Toolbox and the NC Natural Heritage Program's Conservation Planning Tool and Data Explorer. These tools and training programs can be used by local governments, other decision-makers, planners and communities to reduce wildlife habitat impacts through planning, incentives, ordinances and development design. The focus of these resources is to help to buffer and connect protected habitats. We will provide an evaluation of the effectiveness of training and case studies regarding the use and implementation of conservation-based planning information by land use decision-makers.

SESSION 407 | Terrestrial Wildlife: Understanding Infrastructure Effects on Landscape Connectivity

10:30am–12:00pm | Room 306 A

Moderator: Tim Bassette, North Carolina DOT

Cumulative Effects Evaluation Study for a Proposed Interchange at Interstate 75 Highway and Everglades Boulevard, Collier County, Florida

Mark Easley *and Robert Whitman, Kisinger Campo & Associates, Corp., Tampa, Florida, United States*

A Cumulative Effects Evaluation study was conducted for a proposed interchange at Interstate 75 and Everglades Boulevard. This study identified past, present, and reasonably foreseeable future actions and their effects on eight focal species. Reasonably foreseeable future actions were assessed using the LUCIS model. Habitat suitability for each species was compared for pre-development, present, and study horizon year conditions using ArcGIS Spatial Analyst. Measures available to lessen the effects of future actions were also identified. The eight focal species included: Florida panther, Florida black bear, mangrove fox squirrel, wood stork, red-cockaded woodpecker, Florida sandhill crane, gopher tortoise, and Eastern indigo snake.

Utilizing Wildlife Crossings in Nevada: A Multiagency Approach to Reduce Wildlife-Vehicle Collisions and Improve Habitat Connectivity at the Landscape Scale

Nova Simpson, *Nevada Department of Transportation, Carson City, Nevada, United States*

Over the last decade, Nevada began to critically assess wildlife-vehicle collisions and started integrating wildlife crossings into their highway infrastructure. Realizing the topic was important to numerous stakeholders, a multiagency approach was adopted to embrace overlapping goals. Multiple partnerships between state and federal agencies, neighboring states, and special interest groups have been essential in their successes. Come learn how this approach has been pivotal in decreasing fragmentation while maintaining a sustainable solution at the landscape level, all while being mindful of the unique challenges present at each site and the varying interests and resources of the participating stakeholders.

The Differential Use of Large Underpasses by Small Animals and Effects of Adding Structure

Jeff Tracey*, Cheryl Brehme, Carlton Rochester, and Robert Fisher, Western Ecological Research Center, U.S. Geological Survey, San Diego, California, United States*

We studied the use of eight large wildlife underpasses by small animals (mammals and herpetofauna) in San Diego County over two years using highly sensitive IR cameras. After the first year, we added a series of concrete block structures along the inside of half the underpasses to investigate their effectiveness in enhancing small animal use. Study results to date confirm that many small animals may avoid the use of upland wildlife crossings built for larger animals and that permeability can be enhanced with addition of internal ground structure and ledges.

The Role of Highway Fencing in Habitat Fragmentation and Wildlife Crossing Effectiveness

William (Bill) Ruediger*, Wildlife Consulting Resources, Missoula, Montana, United States*

Often wildlife must weave through a mosaic of fencing to reach a wildlife crossing. It is not unusual for ungulates to have to negotiate up to six fences to make a successful highway crossing. Rarely is this fencing well thought-out to ensure young and older animals of various species can negotiate the wildlife crossing, highway right-of way or existing bridge structure. Many highways, existing bridge structures and wildlife crossings in North America have fencing that is difficult, dangerous or impossible for wildlife to negotiate and directly results in lower use by wildlife. The author will explain how DOTs and Natural Resource agencies can take more care when planning highway right-of-way fencing, other fencing adjacent to highways and the fencing that wildlife must pass to use wildlife crossings. Recommendations for simplifying, modifying and reducing the number of fences will be discussed which would aid in reducing habitat fragmentation related to highways.

SESSION 408 | Emerging Issues and New Directions

10:30am–12:00pm | Room 306 B

Moderator: Jason Elliott, North Carolina DOT

Source to Server: Automating the Ingestion, Annotation, and Management of Wildlife Camera-Trap Photographs

David Waetjen *and Fraser Shilling, Road Ecology Center, University of California, Davis, California, United States*

Remote wildlife camera traps provide photographic evidence of an "animal occurrence", including at wildlife crossing structures. We describe a broadly-useful and semi-automated web-platform to support wildlife-image management by conservation and transportation scientists (*http://wildlifeobserver.net*). We present the methods used to ingest these data into the system, using manual, bulk uploading and automated uptake from cell and wifi-communicating cameras. Benefits include: 1) reduced staff time, 2) structured image database, 3) web-based management of camera-trap projects and data, 4) group identification and identification-consensus for animal species, and 5) an online querying and analysis system. This set of open source tools and techniques can be easily adopted by other agencies and organizations to manage wildlife-monitoring projects.

Leveraging Emerging Technology to Achieve Streamlining Initiatives: Wetland and Stream Modeling for Transportation Projects

Morgan Weatherford *and LeiLani Paugh, North Carolina Department of Transportation, Raleigh, North Carolina; and Sarah Schwarzer, North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina, United States (Andy Kiley, NCDENR, presenting)*

The North Carolina Department of Transportation (NCDOT) selected the US 70 Kinston Bypass as a pilot project for the project planning streamlining initiative. NCDOT, in partnership with the North Carolina Division of Water Resources (NCDWR), developed GIS-based predictive models using Light Detection and Ranging (LiDAR) to generate spatial datasets of wetlands and streams for the project study area. By substituting traditional field delineations of the detailed study alternatives with the model outputs for the same areas, NCDOT was able to substantially reduce the project delivery time and costs.

Random Forest Classification and Automation for Wetland Identification based on Digital Elevation Model (DEM) Derivatives

Sheng-Guo Wang *and Jing Deng, University of North Carolina, Charlotte, North Carolina, United States; Mingzhi Chen, University of North Carolina, Charlotte, North Carolina, United States, and Fuzhou University, Fuzhou, China; Morgan Weatherford and LeiLani Paugh, North Carolina Department of Transportation, Raleigh, North Carolina, United States*

This paper presents our research work to improve and automate the initial modeling efforts based on DEM derivatives by random forest (RF) classification method and full automation process that exemplify how innovative technologies can be used in lieu of extensive field wetland delineations and ultimately reduce transportation project delivery time and costs while protecting the environment. The results show that the RF method significantly improves the prediction accuracy for wetlands by reducing error about 10 times comparing with the Logistic regression method, and the automation process as an innovation makes the whole prediction process vividly easy and speed.

The Future of Road Ecology Research and Practice: The Global Perspective of Hundreds of Practitioners

Rodney van der Ree *and Dave Kendal, Australian Research Center for Urban Ecology, Parkville, Victoria, Australia*

Linear infrastructure, in all its forms, dissects almost all regions of the globe and efforts to quantify and mitigate their ecological impacts date back 30 to 40 years. Based on the results of an on-line survey in 2013 and from editing *The Handbook of Road Ecology* (2015), we summarise the international state of road ecology research and practice and provide future directions for the field. The overwhelming response of the ~600 respondents was that most research is generally useful, applied and well-managed. Specifically, research is initiated almost equally by university researchers and governments, but primarily conducted by universities. Research conducted by universities and government are both generally perceived as being robust and reliable, with university research ranked slightly higher. Interestingly, industry perceived university research as being less robust and reliable than university researchers themselves. Most research is currently funded by road agencies, and most respondents contend this trend should continue. Most research is currently focused on quantifying barrier effects, rates of wildlife-vehicle collision and rates of use of wildlife crossing structures, however this should shift and focus more on quantifying population-level effects of linear infrastructure and effectiveness of mitigation.

ICOET extends its gratitude to the many professionals and their organizations supporting our 2015 conference. The individuals recognized here have contributed valuable time and expertise to advise, plan and conduct this year's event. Their dedicated service—along with our presenters, moderators, sponsors, and participants—continue to make ICOET a success. **Thanks to you all!**

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