Monitoring the Recovery of Decommissioned Roads With Citizen Scientists in the Clearwater National Forest, Idaho

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Abstract: Road decommissioning is an increasingly important tool for restoring watersheds on national forest lands. Wildland roads can result in a number of negative impacts leading to decreased terrestrial and aquatic habitat quality. It is believed, therefore, that road decommissioning can have significant positive effects on a watershed—cleaner water, improved fisheries, and restored habitat for terrestrial animals.

However, very little research has been conducted to quantify these benefits. In 1998, the Clearwater National Forest (CNF) and Nez Perce Tribe (NPT) began an intensive road decommissioning program after extensive flooding caused hundreds of landslides in 1995-1996. Since the program's inception, more than 500 miles of roads have been decommissioned. Neither the CNF nor the NPT can sustain the budget and personnel necessary to monitor how effectively these projects are restoring fish and wildlife habitat.

Data collected through a citizen monitoring program will fill this need. Citizen science is a popular and powerful way to monitor the long-term trends and conditions of natural systems while also encouraging a stewardship ethic for the resources being monitored. The information gathered by "citizen scientists" can help land managers make more informed decisions about how best to care for public and private land. We have created the first citizen monitoring program that focuses on the ecological recovery of decommissioned roads. We developed monitoring protocols for citizen scientists, recruited and trained volunteers, and led monitoring trips in the field every weekend during the summer and fall of 2005, engaging, thus far, some 20 volunteers.

As this project is still in progress, all conclusions and findings reported are preliminary. We can, however, make general observations on the efficacy and accuracy of employing citizen scientists to measure ecosystem recovery as a result of road decommissioning. In addition, a second year of funding has been obtained for this project. We anticipate that next year's program will be a success in forwarding our objectives for this project.

Background

The importance of wildland road removal

The effect that roads can have on ecosystems has become an extremely popular area of scientific comment, theory, and research. The presence of roads is associated with the presence of non-native weeds, invasions of non-native animals that are attracted to edge habitat, and other alterations in the structure and function of communities of animals and plants (Trombulak and Frissell 2000). Restoration of watersheds through road removal is an increasingly important tool for land managers, including the U.S. Forest Service. However, very little research has been conducted to quantify the perceived benefits of such restoration. The Forest Service's long-term transportation policy calls for removing up to 25 percent of its existing road system during the next 20-40 years. Wildland roads are a target for restoration because, while they can provide economic and social benefits, they can also degrade the quality of both aquatic (water) and terrestrial (land) habitats (Trombulak and Frissell 2000).

Aquatic Impacts

Removing roads from national forest lands can have a number of beneficial effects. Major beneficial effects include increased infiltration of surface water and reduced surface erosion, which can, in turn, lead to reduced landslide risk and decreased sediment delivery to streams and lakes (Switalski et al. 2004). Road removal and the accompanying decrease in sedimentation can be an important step in protecting aquatic species which need streams nearly free of suspended sediments (for example, most species of salmon and trout). Sediments can harm salmon and trout fisheries through direct mortality, by hindering the development of eggs and larvae, disrupting natural movements and migration, and disrupting fish feeding behavior as a result of reduced visibility (Newcombe and MacDonald 1991).

Terrestrial Impacts

Many species of terrestrial wildlife are influenced by roads as well. Wisdom et al. (2000) reviewed the impacts of forest and range roads on animals and reported that roads and road-associated factors had a negative effect on over 70 percent of the species reviewed. Roads directly or indirectly lead to habitat loss and fragmentation, poaching, overtrapping, snag reduction, down log reduction, negative edge effects, movement barriers, displacement or avoidance, harassment or disturbance at specific use sites, and chronic negative interactions with humans. Additionally, more intact forests (habitat which has not been fragmented by roads) have been shown to provide better habitat for various species of wildlife. We predict that removing wildland roads and restoring habitat to a more intact system will benefit wildlife.

The Clearwater National Forest road removal program

Ecological Conditions in the Clearwater
Idaho's Clearwater National Forest covers nearly two million acres of land in the north-central portion of the state, from the Bitterroot Mountains in the east to the Palouse Prairie in the west. It is the ancestral home of the Nimi'ipuu, or Nez Perce Tribe and forms a nearly contiguous block with the Selway-Bitterroot Wilderness Complex to the south—wild country where old growth cedars, larch, and pine still stand, and where clear, cold water is birthed—much of which flows, eventually, into the Lochsa Wild and Scenic River to the north.

A noted premier whitewater recreation site, the Lochsa River is also home to several protected species of fish, including spring Chinook salmon and steelhead and bull trout—fisheries which supported the Nez Perce when the rivers west of here still ran free, and the draw of which continues to support communities economically who have grown to focus on tourism as a main source of revenue. Additionally, hunting outfitters and guides profit from leading paying visitors to the full complement of native terrestrial wildlife (with the exception of the grizzly bear) which still thrives in the CNF.

On the north side of the Lochsa, however, things are not quite so unspoiled. A legacy of logging over several decades has left the Forest heavily roaded and greatly reduced the quality of much of the habitat on the forest, with more than 4,500 total miles of roads in the forest, some areas have road densities as high as 30 miles of road per square mile. That's higher than in metropolitan areas like New York City. In an area already heavily landslide prone, roads, especially in densities such as these, increase the risk of landslides by interrupting natural water flow patterns and threatening water quality and fish habitat with high influxes of sediment.

The Road Removal Program
In the winter of 1995-96, extensive flooding caused hundreds of landslides, nearly half of which were directly traced to old, abandoned, and overgrown logging roads which had previously been considered stable (McClellan et al. 1997). Similar flooding events had occurred approximately once every 10-15 years, with the number of landslides increasing as the road mileage increased. In 1998, with an influx of cash from emergency federal funding, the CNF partnered with the NPT to begin an ambitious road-decommissioning program in an attempt to restore watershed health and protect the valuable fisheries that still exist in the area (Wildlands CPR 2003). Since the program's inception, more than 500 miles of roads have been decommissioned, hundreds of stream channels have been restored, and planning is underway to restore many more watersheds by decommissioning hundreds more miles of roads. The Clearwater National Forest road-removal program is now one of the largest road-restoration programs in the country.

The goal of ongoing road decommissioning on the CNF is "to reduce watershed impacts by reclaiming roads that are no longer a necessary part of the Forest's transportation system" (USDA FS 2003). The primary objectives are to reduce erosion from road surfaces, reduce the risk of mass failures, restore drainage patterns, stream channels, and site productivity and to protect and restore fish habitat. These habitat improvements should benefit many fish and other aquatic species. Decommissioned roads would presumably create habitat for a variety of terrestrial animals as well. Some wildlife biologists argue that road decommissioning will reduce grizzly bear mortality risk (USFWS 1993) and increase elk-habitat security. Unfortunately, as with many projects that are ambitious but strapped for funding, in-depth monitoring of watershed restoration across the Forest has been somewhat less than adequate, because resources to monitor the effectiveness of this restoration activity are slim. Adding to the complexity of the problem, it will very likely take several years to detect significant changes in watershed health once monitoring has begun and after decommissioning has occurred.

Citizen science is a powerful tool to monitor restoration
The primary goal of ecological restoration (like road decommissioning) is to return ecosystem structure, functions, and processes to natural conditions (Block et al. 2001). It is often assumed that if restoration is "successful," ecological conditions will be favorable for the native plant and animal species. Although this assumption is rarely tested, it should be, and citizen monitoring can play a key role in that testing. Often, project monitoring is not completed by federal, state, or private land managers because of lack of funding. But without that monitoring, the effectiveness of particular restoration techniques is unknown. Without monitoring, restoration techniques cannot improve.

Citizen Scientists Fill in the Gaps
Citizen science is a powerful way to monitor the long-term trends and conditions of natural systems while also encouraging a stewardship ethic for the resources being monitored. This method is popular across the United States. According to the U.S. Environmental Protection Agency, in 1998 there were more than 772 citizen monitoring projects across the country (US EPA 1998). Participants in these monitoring projects can become intimately acquainted with the systems they are monitoring and often develop into exceptional advocates for their protection and conservation as a result of that relationship.

One of the most important roles of citizen scientists is to help fill in the blanks that cannot be covered by government or private personnel because of funding constraints. Therefore, these citizen scientists can provide a more complete picture to public-lands managers and decision-makers. Limited resources mean limited time and personnel to carry out essential monitoring projects. The information gathered by citizen scientists through monitoring can provide vital help to land mangers as they make more informed decisions about how best to care for public and private land.

The Clearwater National Forest as a Citizen Science Testing-Ground
The Clearwater National Forest is ideal for developing and implementing a citizen monitoring protocol for several reasons. First, the Forest Service and Nez Perce Tribe have worked in close partnership on this project since 1998, creating a strong cooperative bond that extends beyond the reach of these two entities and into the surrounding communities. Second, the CNF and NPT have developed active education programs to promote road decommissioning in their communities, which has enabled them to significantly reduce the controversy that often accompanies such work. Because several local communities are already relatively supportive, there are local citizens interested in engaging in this volunteer project. Third, the CNF, as the leader in road removal on Forest Service lands, has several hundred miles of roads identified as candidates for decommissioning as funding becomes available. Fourth, the scale of road decommissioning on the Clearwater National Forest affects entire watersheds; consequently, monitoring stream response in these watersheds may yield meaningful data. The Forest Service does not have the budget or personnel to expand their monitoring of stream-habitat conditions and conduct population assessments of fisheries and wildlife. Citizen science has the potential to be an effective, low-cost solution, while also increasing local involvement and support for watershed restoration.

Benefits of Citizen Science on the Clearwater National Forest
Participation in this citizen-science program will result in a number of long-term benefits to local communities. Most importantly, informed local communities will better understand why road decommissioning is a critical component of watershed restoration. Additionally, by investing community time and energy in monitoring, citizen science promotes community stewardship and cooperation. With a greater understanding of watershed restoration, this community will be more supportive of the benefits of watershed protection and sustainable management practices.

In addition to benefiting local communities, this project could act as a model for other programs across the U.S. Extensive road decommissioning efforts are occurring across the western coastal states (Washington State, Oregon, and California). Although some monitoring is occurring in these locations as well, there is no universal protocol to allow comparison and meta-analysis. By implementing a protocol and promoting citizen science programs in other areas of the country, we will increase the amount of data available to analyze the benefits and impacts of road decommissioning—a topic that remains almost completely unstudied.

Objectives
Seeing this need and perceiving a possible solution, the CNF and NPT teamed up with Wildlands CPR and the University of Montana's Environmental Studies program to create a citizen monitoring program which would fulfill several objectives simultaneously. Our specific objectives for this project were twofold: 1) to assist Forest Service and tribal personnel in obtaining vital monitoring data regarding their road decommissioning program in several areas of the forest, and 2) to engage and educate members of the public about the existence of road-decommissioning projects and their benefits and impacts. Each of these objectives was achieved by fulfilling various goals set out at the beginning of the project in a detailed planning process undertaken as a part of the original grant-application procedure.

Methodology

The project was divided into two main components with separate and clearly definable purposes. The first component was to develop monitoring protocols specifically geared toward monitoring decommissioned roads with citizen scientists and plan for their implementation. The second component was to recruit citizen scientists from local communities within and nearby the Clearwater National Forest to carry out the implementation of the aforementioned protocols.

Developing monitoring protocols and ensuring their usefulness
Initially, during the summer and fall of 2004, we assessed existing monitoring protocols and programs and adapted them to create our own unique citizen monitoring program, focused on road decommissioning. The protocols outline aquatic and terrestrial sampling methods (see list 1), including pebble counts, erosion pins, vegetation surveys, measurement of water temperature, collection of macroinvertebrates, and the use of photo points. Wildlife-sampling methods, including remote-sensor cameras and tracking stations designed specifically for use on decommissioned roads, were incorporated into these protocols (see Townsend and Switalski 2004). Simultaneously, we developed a quality-assurance plan to ensure that the data collected would be accurate and useful. We also field tested several of the monitoring protocols during the fall with students from the University of Montana's (UM) Wilderness and Civilization class.

Recruiting Citizen Scientists
The following winter we developed an outreach plan to guide outreach activities in various target communities and groups. This plan helped us identify local citizen leaders and organizations interested in long-term, consistent volunteer opportunities. During the spring of 2005, we actively recruited volunteers via schools, county groups, local businesses, and environmental and conservation organizations from small communities in Idaho such as Kamiah, Kooskia, and Orofino, as well as from larger communities such as Moscow, Lewiston, and Missoula (Montana). Individual recruitment presentations were made at local chapters of Trout Unlimited, as well as at several university and high school classrooms. That spring, we also prepared for the field season by developing an informational data entry and analysis website (online at www.clearwaterroads.com) and citizen comment surveys with the help of the University of Montana's Wilderness Institute. The website allows volunteers to remotely upload data collected in the field to a central database, as well as perform some basic analyses.

Preparing for Citizen Scientists in the Field

Before we brought volunteers into the field, we identified seven monitoring segments on the CNF and set up monitoring equipment in preparation for data collection. Our broad goal was to compare the results of decommissioning across drainage types for a watershed-level assessment. Our sampling design, therefore, included monitoring segments that exist in unroaded (or nearly so) drainages, drainages that have overgrown (un-decommissioned) roads slated, and drainages where a great deal of restoration through decommissioning and culvert removal has occurred. We also monitored an area that will remain roaded. Comparisons between data collected at the watershed level can increase the scale of the overall picture gained from monitoring. We attempted to choose sites in drainages which were as similar to one another as possible, with similar topography and soils composition, and which drained to a similarly-sized creek. Included in our monitoring sites are a roadless area, a decommissioned area, a site slated to be decommissioned, and an area which will remain roaded. Once the monitoring sites, protocol, and data-entry website were all in place, citizen monitoring began.

List 1. Monitoring methods used by citizen scientists:

- Pebble counts
- Macroinvertebrate surveys and temperature measurements
- Vegetation transects
- Erosion pins
- Photo points
- Wildlife surveys (cameras, track stations)

We trained citizen scientists to collect various ecological data using the protocols specifically developed for their use on decommissioned roads. Citizen scientist teams of 2-10 participants were created from communities throughout the Clearwater region, with a goal of creating long-term, self-sustaining volunteer partnerships at these and other study sites.

Results

Our monitoring season began in late June and will continue through mid-October. Through our wildlife-monitoring methods, we have already recorded use of decommissioned roads by black bear, cougar, gray wolf, coyote, fisher, white-tailed and mule deer, elk, moose, squirrels, chipmunks, and voles. We have set up erosion pins and conducted five vegetation surveys. Three pebble counts have been completed in target streams and three macroinvertebrate surveys are planned for the fall. The season will continue through mid-October, when we anticipate snow will prevent access to our study sites, and will begin again after the snow melts in May or June. More than 30 volunteers will participate in this inaugural field season, including members of eight separate environmental organizations, students from four high schools and two universities, and residents of six different communities within two states. The rural nature of the area has been one of the primary challenges to developing a larger citizen science program.

Discussion and Conclusion

Lessons learned

In terms of practical lessons we have learned, there are several things that have been achieved. We have learned that we can capture photos and tracks of wildlife on decommissioned roads using our modified tracking methods. Additionally, we have found that our protocol for collection of data by citizen scientists works. We discovered some technical limitations of the projects, such as the fact that cameras don't work in very cold temperatures. Weather also can limit our access to sites and snow has prevented us from beginning our sampling.

We have also found that it is essential to build a strong foundation for a citizen monitoring program. Ensuring that quality data can be collected over time is a must. Once we developed a protocol, created our online database with the capacity for analysis, we could begin field sampling. The next step was to get the volunteers on the ground and begin collecting high-quality data following the detailed guidelines laid out in our protocols. In our first year of field work with citizen scientists, there have been few observable problems with employing citizen volunteers. Many of the complications of using citizens for field work may have been offset by our development of protocols specifically tailored to use by citizen scientists, thus preventing initial confusion and difficulties in following guidelines.

In terms of getting the word out, we have found that advertising the project opportunities has created a local "buzz" that will continue and we hope help build community support of restoration on the CNF. Above all, the partnerships which were created during the project have been essential to its being carried out successfully—without these partnerships, citizens could never have become engaged.

List 2. Partnerships created during this project are essential to its success, now and in the future. Wildlands CPR has worked closely with the following:

- The Nez Perce Tribe, Clearwater National Forest, and University of Montana helped review the protocol, assisted in deciding priorities for monitoring on the forest, and provided logistical support.
- Conservation & Education groups helped find citizen leaders and recruit volunteers: the Palouse-Clearwater Environmental Institute, the Three Rivers and West Slope Chapters Trout Unlimited, the Native Forest Network, Friends of the Clearwater, the Watershed Education Network, and the Flagship Program.
- Schools helped generate volunteers: Willard Alternative High School, Hellgate High School, Kamiah High School, Clearwater Valley High School, Orofino High School, Lapwai High School, the University of Montana, and the University of Idaho.

Future research needs

Future research should examine the accuracy of data collected by citizen scientists. Also, more work is needed to determine how to make a citizen science program self-sustaining and how to promote citizen involvement in road decommissioning in other regions.

Final thoughts

The potential for good things to come from this project is massive. We anticipate many beneficial effects. As with all projects begun from the ground up, things are bound to move slowly at first, especially in rural areas where communities are often resistant to change and to anything that might be perceived as coming from the outside. However, excellent groundwork has been laid for what will very likely be a successful program as work progresses over the next few years. It is our hope that, if we can prove that this type of monitoring is valuable, other forests with similar road-decommissioning programs will also see the potential and begin to employ citizen scientists. In time, citizen scientists may help national forests all over the country complete essential research on road decommissioning, which will in turn allow forests to make more informed decisions about where restoration should occur and how to accomplish it.

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Biographical Sketch: Katherine Court is a graduate student in the Environmental Studies Program at the University of Montana. She obtained a B.A. in environmental studies from Eckerd College in 2002. Adam Switalski is the science coordinator for Wildlands CPR. Len Broberg is the director of the Environmental Studies Program at the University of Montana. Rebecca Lloyd is a hydrologist with the Nez Perce Tribe of Idaho.

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National Implications of Regional Deer-Vehicle Crash Data Collection, Migration, and Trends

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Abstract

The magnitude and trend of the deer-vehicle crash (DVC) problem in the United States can only be grossly estimated. Data that could be used to define this problem more closely are not consistently collected. However, at least two "national" surveys have attempted to estimate the number of DVCs in the United States and their results critically have been evaluated and presented. The number of fatalities and estimated non-fatal injuries in the United States due to animal-vehicle collisions will also be included.

The inability to properly define the DVC problem in the United States is primarily related to the misunderstandings produced by the collection, estimation, and combination of several data sets (with varying characteristics) that can be used to describe it. During the last four years the DVCIC staff has completed a DVC data collection and management survey and also collected (if available) 10 years of police-reported DVCs, deer-carcass numbers, and deer-population estimates for a five-state region (i.e., Illinois, Iowa, Michigan, Minnesota, and Wisconsin). The survey was primarily completed to document, compare, and/or combine the state-level DVC data collected properly Representatives from the Departments of Transportation and Natural Resources from each state were surveyed and used to collect the data.

The results of the survey, and the analyses and evaluation of the data collected, will be included in this presentation and paper. Summaries of the information gained from the survey and the data collected will be used to recommend activities to improve the current understanding of the DVC problem in the United States.

Biographical Sketch: Professor Knapp is an assistant professor/program director in the Engineering Professional Development Department at the University of Wisconsin and is jointly appointed with the Civil and Environmental Engineering Department. He has over 14 years of experience in the areas of transportation consulting and research. He has experience in the analysis of traffic operations and safety, roadway design, and traffic control. His primary areas of research are the safety and mobility impacts of roadway system characteristics. Prior to joining the University of Wisconsin, Professor Knapp was an assistant professor at Iowa State University and manager of the Traffic and Safety Program at the Center for Transportation Research and Education. He is a registered professional engineer in Iowa, Illinois, Michigan, and Wisconsin.

He has a B.S. in civil and environmental engineering degree from the University of Wisconsin-Madison, a masters of engineering in civil (transportation) from Cornell University, and a Ph.D. in civil engineering from Texas A&M University.

Planning a Sustainable Community: Infrastructure Development and Natural Areas Management

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Abstract: Sarasota County is a Florida gulf-coast community working to alleviate growth and development pressures and provide a balanced community of citizen amenities, economic growth, and a healthy natural environment. To meet this end, county government has been pursuing two main objectives: the acquisition and protection of ecologically significant lands and the minimization of roadway impacts in ecologically valuable areas. In 1992, a committee of citizens was appointed to evaluate the ecological value of undeveloped lands and facilitate a land-acquisition program. Subsequently in 1999, Sarasota voters approved a referendum to fund the Environmentally Sensitive Lands Protection Program (ESLPP). This program has since enabled the acquisition of over 15,000 acres of environmentally sensitive habitat for a total of nearly 105,000 acres of protected land throughout the county. In 2003, the land-acquisition agenda was expanded through the development of the Regional Environmental Mitigation Program, which was designed to facilitate the purchase and restoration of natural lands as compensation for unavoidable environmental impacts associated with county infrastructure projects. Despite protections afforded lands acquired by these land-protection programs, fragmentation continues to threaten ecologically intact landscapes in the county. To address this matter, the Board of County Commissioners initiated an investigation of the habitats and wildlife fragmented by transportation infrastructure. Field-investigation methods have involved reviews of aerial photography with local data overlays (*e.g.* Florida scrub-jay habitat, panther sightings, etc.), evaluation of significant habitats and protected wildlife, use of motion-sensory cameras, creation of animal-track sand pits, and incorporation of mortality surveys. Data collected continue to be used to identify and recommend promising areas for innovative design of infrastructure, land-acquisition priorities, and habitat-restoration measures. As a result of the current initiative, road projects are increasingly scrutinized for alternative alignments, sound ecological improvements, and defragmentation opportunities. Sustainable design is now a bona fide consideration of Sarasota County road-design teams.

Introduction

Population growth and development are threatening the quality of Florida's natural ecosystems and native wildlife. As a government entity, Sarasota County is working to alleviate these pressures and encourage a sustainable community of citizen amenities, economic growth, and a healthy natural environment. To this end, county government has been pursuing two main objectives: the acquisition and protection of ecologically significant lands (Natural Ecological Corridors) and the minimization of roadway impacts in ecologically valuable areas (Artificial Ecological Corridors).

Sarasota County government understands the inherent value of protecting native landscapes. This value is realized through the establishment of two significant land-protection initiatives: the Environmentally Sensitive Lands Protection Program (ESLPP) and the Regional Environmental Mitigation Program (REMP). Ultimately, however, local government is responsible for providing public infrastructure to reduce traffic congestion and ensure evacuation routes from coastal communities, as well as convenient access to interstate highways. Despite protections afforded environmentally sensitive public lands and parks, fragmentation from infrastructure provisions continues to threaten ecologically intact landscapes, inevitably impacting habitat corridors and wildlife populations. Realizing this threat, the Board of County Commissioners (BCC) initiated a countywide investigation of the habitats and wildlife affected by transportation infrastructure. To better evaluate the effects of road projects on these ecological communities, county staff, alongside PBS&J (private) consultants, conducted three ecological evaluations between 2003 and 2005 along future and existing transportation corridors: the Englewood Interstate Connector, Honore Avenue-Pinebrook Road Extension, and Interstate 75.

The purpose of these evaluations was to identify significant ecological features and critical landscape corridors and to discover opportunities for defragmentation of isolated habitats. An equally important aspect was to facilitate improved inter-agency and departmental coordination during the design and permitting stages of road-improvement projects. It was presumed that the identification of important ecological corridors would allow more efficient planning, permitting, and resource-management activities on a landscape scale.

Several county and state road-improvement projects currently in the planning and design stages are situated adjacent to environmentally significant lands (protected and unprotected). Consequently, these projects have precipitated the collection of field data with the hope of identifying critical areas for ecosystem connectivity and to recommend areas for innovative design of future infrastructure, land-acquisition priorities, corridor restoration, and mitigation opportunities.

Land-Acquisition Programs (Natural Corridors)

Environmentally sensitive lands protection program

Initiated in 1992, the Environmentally Sensitive Lands Protection Program (ESLPP) has become one of Sarasota County's most celebrated land-acquisition programs. In 1999, Sarasota voters approved two referenda to help fund ESLPP: one approving an increase in the ad valorem tax and the second to approve bonding. The county also passed Ordinance 99-004, establishing the citizen-appointed Environmentally Sensitive Lands Oversight Committee to facilitate the program and evaluate the ecological value of undeveloped lands. Working with willing-seller property owners,

the Nature Conservancy (TNC), the Southwest Florida Water Management District (SWFWMD), and several other state partners, the program has enabled the acquisition of over 16,000 acres of environmentally sensitive habitat for a total of nearly 105,000 acres of protected land throughout the county.

Parcels are nominated for the ESLPP program based on habitat quality, connectivity, habitat and species rarity, water-resource protection, and manageability. The ESLPP program has had great success in acquiring environmentally sensitive lands through obtaining supplemental grant funding and developing partnerships with state agencies, non-profit organizations, and other county divisions and departments. Even with these successes, numerous challenges face the ESLPP program, including competition with developers, an escalating real-estate market, and and management and security costs.

Regional environmental mitigation program

Sarasota County's land acquisition agenda was expanded in 2003 through the development of a Regional Environmental Mitigation Program (REMP). The program was designed to promote ecologically significant mitigation facilities to compensate for unavoidable environmental impacts associated with Sarasota County infrastructure projects. A regional-mitigation perspective represents an environmentally and fiscally responsible approach to mitigating unavoidable environmental impacts. Traditionally, environmental compensation for jurisdictional wetlands, mesic hammocks, and listed wildlife focused on small, ecologically fragmented tracts adjacent to the project impacts. Unfortunately, this dogma often restricted the mitigation projects to areas with limited landscape value at best. The regional approach provides an avenue to fund land acquisition in concert with significant habitat creation, enhancement, restoration, and preservation projects.

REMP benefits from economies of scale in terms of land-acquisition costs. In addition, as the cost of vacant land continues to rise, the purchase of land in anticipation of future needs has already resulted in considerable savings to the county. Furthermore, the mitigation program should derive significant reimbursement funds by selling mitigation and floodplain credit for county infrastructure projects, selling excavated fill, and through mitigation funds derived from the Florida Department of Transportation for local interstate-mitigation needs. Additional savings include consolidations of design, permitting, construction, and maintenance. Finally, planning and building mitigation facilities today, as compensation for impacts anticipated over the next 10 to 20 years, should expedite the permitting and construction of future county-infrastructure projects.

To date, two parcels (totaling 160 acres) have been acquired through this program, based largely on landscape position, location with respect to watershed basin, and regional ecological value. A third mitigation parcel was purchased prior to the establishment of REMP, but has since served as a mitigation facility for the federally threatened Florida Scrub-jay (*Aphelocoma coerulescens*) impacts. Sarasota County exists within four state-recognized watershed basins, two of which comprise significant portions of the county. The currently permitted regional-mitigation parcels exist within the Southern Coastal Watershed Basin, and include Curry Creek Regional Mitigation Site, Fox Creek Regional Mitigation Site, and Lemon Bay Preserve. Acquisition and permitting of additional vacant lands within the Myakka River Watershed Basin are under evaluation at this time. These could serve as future mitigation facilities to offset impacts associated with infrastructure projects occurring within that watershed.

Curry Creek Regional Mitigation Site

The 19.2-acre Curry Creek Regional Mitigation Area, located adjacent to Curry Creek in Venice, Florida, was the county's first permitted regional mitigation facility. At a cost of approximately $500,000, the county acquired the Curry Creek parcel in 1997 to accommodate stormwater. Prior to purchase, this coastal site faced strong development pressure due to an adjacent navigable waterway.

Aerial photography dating to 1948 was used in developing the design for this historically human-altered area, with the final layout designed to mimic site conditions similar to those existing prior to human disturbance. Currently under construction, this project involves conversion of two excavated finger canals into an emergent saltmarsh habitat and the creation of a meandering tidal creek. In addition to the hydrologic restoration of wetland habitats, the Curry Creek effort will result in the preservation, enhancement, and management of native uplands. Once complete, the site will provide a mosaic of habitat types, including mangrove forest, estuarine marsh, tidal creek, hydric flatwoods, oak hammock, and scrubby flatwoods.

The restoration of historical hydrologic conditions at the Curry Creek site will improve both onsite and adjacent offsite aquatic environments, as well as compensate for unavoidable wetland impacts associated with multiple county road projects. The preservation of upland and wetland communities along Curry Creek will also protect a riparian habitat corridor connecting adjacent ESLPP lands, provide a buffer for Curry Creek, and prevent coastal development of the parcel.

Fox Creek Regional Mitigation Site

The Fox Creek Regional Mitigation Site consists of 140 acres of restoration and enhancement opportunities. In 2003, the county purchased this property, originally slated to become a residential development for about $4 million. Once completed, the site will comprise a network of freshwater marshes, forested wetlands, pine flatwoods, wet prairies, estuarine marshes, and scrubby flatwoods. The site will also feature several unique aspects, including large

compensation areas for the state-protected Sherman's Fox Squirrel (*Sciurus niger*) as well as the Florida Scrub-jay. The Fox Creek site will derive phased-mitigation credit for unavoidable wetland and wildlife impacts associated with county-infrastructure projects.

Existing aquatic landscape features directly contiguous to the parcel include Fox Creek, Shakett/Salt Creek, and Cow Pen Slough. The utilization of these waterways by wildlife has been documented (see the Honore Avenue-Pinebrook Road Extension ecological evaluation below). Although Interstate 75 creates an impediment to wildlife movement at the eastern border of the Fox Creek site, one of the reasons for acquiring this parcel was to protect a vital piece of the natural linkage between estuarine areas of Shakett Creek to the southwest, and protected lands to the east (Knights Trail Park, Pinelands Reserve, and Myakka River State Park).

Lemon Bay Preserve
As part of a multi-departmental effort, Sarasota County purchased the Lemon Bay Preserve (LBP) in 1998 for $3.9 million. This 165-acre coastal scrub and estuarine parcel is bordered to the west by the intercoastal waterway and connects to a series of conservation easements, private preserves, and ESLPP parcels that together comprise an area primarily focused on affording protection to the Florida Scrub-jay. Currently, LBP supports two scrub-jay families, as well as sporadic transient birds. One family has served as compensation for impacts associated with a county road project and the parcel has received "credit" for one future scrub-jay impact. Land management efforts have included prescribed fires, scrubby flatwoods enhancement, exotic plant control, hydrologic restoration, and coastal upland and wetland plantings.

Infrastructure Development (Artificial Corridors)

Despite the protection afforded ESLPP and REMP lands, fragmentation continues to threaten ecologically intact landscapes in the county. In response to this concern, the Sarasota Board of County Commissioners (BCC) called for evaluations of the habitats and wildlife affected by transportation infrastructure. To address this BCC directive, county staff has been working closely with PBS&J consultants to evaluate local road-improvement projects currently in the planning and design phases. Specifically, three ecological evaluations were initiated in 2003 focusing on three prominent roadway arteries: the Englewood Interstate Connector, the Honore Avenue-Pinebrook Road Extension, and Interstate 75. Through these evaluations, data regarding the effects of existing and future infrastructure alignments on habitat connectivity and wildlife mortality may help identify significant ecological features, critical landscape corridors, and opportunities for defragmentation of isolated habitats.

Ecological evaluations

Englewood Interstate Connector
Design for this hurricane evacuation route began late in 2004. The ecological evaluation was conducted beginning in June 2004 and the final report concluding the study (Kurz et al. 2005a) was completed in July 2005. The ecological evaluation at this site focused on wildlife utilization of all culverts (of varying hydrologic function) along this rapidly developing corridor. Key habitat zones severed by the roadway, but not currently connected by culvert were also monitored. Large tracts of protected public land exist along this roadway (including ESLPP parcels, the Jelk's Preserve, and Myakka State Forest). Ecologically significant private land is also present and was evaluated with respect to quality and connectivity potential. Other ecologically significant features (the Myakka River and Sweetwater Gully) exist along this transportation corridor, and all features, severed or otherwise, were evaluated for defragmentation opportunities.

Honore Avenue–Pinebrook Road Extension
A two-year, ecological evaluation was conducted along this future road corridor as part of the planning process, ultimately to serve as a guide during roadway design. The study, paid for by the Honore Avenue-Pinebrook Road project, involved evaluation of lands and highway projects surrounding the proposed road extension. Surrounding road projects concurrently evaluated included the Central Sarasota Parkway Interchange and Interstate 75. The Honore Avenue-Pinebrook Road is being designed to help alleviate transportation demands currently plaguing the adjacent Interstate 75.

Interstate 75
The widening of Interstate 75 through Sarasota County has prompted county-funded ecological evaluations along two environmentally sensitive segments of this highway: one adjacent to the future Honore Avenue-Pinebrook Road Extension and the second, further south between ESLPP and publicly owned lands. The Interstate 75 upgrade is proposed to accommodate traffic projected through the year 2020. Communications between Sarasota County, the Florida Fish and Wildlife Conservation Commission, the Water Management District, The Nature Conservancy, and the FDOT have ensued as part of the PD&E along this stretch of highway to help establish a coordinated effort.

Evaluation Methods
The three major road-expansion projects mentioned above were chosen for habitat and wildlife evaluations based on their proximity to ecologically important landscape features (e.g. ESLPP and public lands, Myakka River, etc.). For each roadway-expansion project, data were collected from adjacent public lands, drainage easements, and undeveloped lands. Data consisted of historical accounts and aerial photography, on-site field assessments of habitats and wildlife (including field identification of tracks and helicopter over-flights), use of motion-sensory cameras, and

mortality surveys. Field-investigation methods were primarily intended to note the occurrence of certain habitats and wildlife, identify zones of high wildlife mortality, and recognize species-movement patterns across the study areas. The evaluations were also intended to assess the benefits and drawbacks of incorporating artificial-wildlife corridors into roadway-expansion projects. Publicly owned lands, drainage easements, or areas under conservation easement were often given higher priority in terms of recommendations for defragmentation, but private land-development plans and specific infrastructure-project needs (mitigation, stormwater, and floodplain) were also considered.

Historical Accounts and Aerial Photography
Wildlife-species lists for Sarasota County were referenced from the Florida Natural Areas Inventory (FNAI), United States Fish and Wildlife Service (USFWS), and Florida Fish and Wildlife Conservation Commission (FWC) databases (see also Kurz et al., 2005a). Local wildlife data were obtained from Sarasota County Natural Resources' databases. Aerial photographic images augmented by local data overlays (e.g. those for the Florida Scrub Jay and Florida Panther (*Felis concolor coryi*) were referenced during the course of each evaluation. Project Development and Environment (PD&E) studies, conducted as part of each infrastructure project, included threatened and endangered species surveys and wetland- and water-quality evaluations. Data from the PD&E studies were evaluated to help clarify field data-collection efforts associated with each ecological evaluation.

On-Site Field Assessments
Both terrestrial and aerial surveys were conducted to evaluate wildlife use broadly in each study area. Terrestrial surveys were conducted on foot and/or from off-road vehicle and were focused on habitat quality evaluations, identification of restricted corridors (dense exotic vegetation), presence of wildlife tracks, and general evidence of wildlife use. Aerial surveys via helicopter were conducted during the spring and summer of 2003 and 2004, with wildlife (predominantly mammals and birds) and nests quantified and their coordinates recorded during each flight (see also Kurz et al. 2005a).

Motion-Sensory Cameras
Remote cameras (DeerCam and Moultree Feeders cameras) were used to document wildlife utilization of existing culverts and suspected game trails (see also Kurz et al. 2005a). DeerCam 35-mm cameras housed in camouflaged plastic cases and equipped with "passive" infrared/heat sensors were installed at major creek crossings and drainage-conveyance structures. Cameras were carefully mounted on fence posts, tree branches, shrubs, stakes, and concrete pillars, regardless of the limitations the area posed to wildlife movement. Camera locations were modified seasonally based on the success/failure of previous surveys. Wildlife utilization and avoidance was documented at existing span underpasses, wet and dry culverts, and along bisected wetland boundaries. In certain instances, sand pits were installed in conjunction with cameras in areas where capturing wildlife images proved challenging. Each sand pit consisted of a layer of sand placed on a suspected game trail that appeared to be frequently utilized by wildlife.

Mortality Surveys
Road-kill surveys were conducted to evaluate wildlife presence and movement associated with each study area. Due to seasonal changes in wildlife behavior, hydrology, and plant-community composition, surveys were conducted intermittently from summer through autumn in 2003, all year in 2004, and during winter and spring in 2005. Surveys were conducted only sporadically during 2003, while four to seven surveys were conducted during each season in 2004 and 2005. Surveys were conducted by vehicle, driving at 5-10 mph along the roadway shoulders. Safety measures were utilized during data collection to ensure the protection of motorists and field staff. At each road kill site along the survey route, the animal was identified and the coordinate recorded using a hand-held Global Positioning System (GPS) unit. GPS data were organized into a master file in ArcGIS 9.0 (ESRI 2004), enabling statistical comparisons. Digital photographs were also taken of certain representative species (see also Kurz et al. 2005a).

Results and Discussion

Ecological evaluations and data-collection efforts have thus far been only cursory, spanning the last 1-2 years (depending on location). Although largely anecdotal, interpretations of the data collected over the course of these evaluations have started proving valuable for identifying existing impediments to wildlife posed by roadway infrastructure. Subsequent recommendations to road-design teams will likely focus on the realized need for improvements in habitat connectivity and reductions in wildlife mortality. All three roadway evaluations (the Englewood Interstate Connector, the Honore Avenue-Pinebrook Road Extension, and Interstate 75) have provided unique contributions to the combined data.

Englewood Interstate Connector
It is believed that the existing highway corridor extending along River Road and Winchester Boulevard has impacted historic wildlife movements within the Myakka River floodplain. Currently, the Englewood Interstate Connector (EIC) corridor is marked by a number of hydrologic culverts beneath the road; however, the majority of these culverts appear inadequate for wildlife utilization due to restrictions imposed by construction activity, high water, or impenetrable vegetation. Despite the paucity of suitable crossings, wildlife was nonetheless documented utilizing two existing concrete culverts (24" and 36" diameter) within the study area (Kurz et al. 2005a).

Future and existing development has limited the scope of wildlife-amenity recommendations proposed along this corridor. Many properties along the EIC are under private ownership, and a growing number of these parcels are

currently under construction or have submitted plans for development approval. Since so much of the area is slated for development, creating linkages to and from these areas may be counterproductive to protecting wildlife (as many local populations would likely be lost to road mortality and/or habitat destruction, Kurz et al. 2005a). Recommendations to the EIC design team for artificial wildlife corridors and advanced land acquisition were prioritized based on a number of factors including proximity to public lands, drainage ways and easements, acquisition potential, and mitigation opportunity.

Two artificial wildlife passages have been proposed as part of the design phase of the road. The first, involving the connection of a conservation easement to the Jelk's Preserve along a forested waterway, proposes a small mammal shelf to allow animal passage during a range of seasonal water fluctuations. Foresman (2004) showed that species prone to use culverts opted to use shelves when water was present. In fact, the same study explained that activity in experimental culverts (with shelves) remained high or even increased when water levels rose, due to consistent use of shelving by wildlife (Foresman 2004). The second artificial wildlife corridor proposes the connection of a different conservation easement to the Jelk's Preserve through a residential development. This second passageway is intended to restore an east-west habitat corridor from the Jelk's Preserve to a series of preserved "residential" habitat corridors west of the interstate highway.

Another effort underway as part of this road project is the advanced acquisition of two parcels naturally contiguous to the Jelk's Preserve. These priority sites were initially identified by the ESLPP due to their connectivity, habitat value, and location along the Myakka River. The parcels are of dual interest to the EIC design team due to mitigation potential for stormwater, wetlands, floodplain and mesic hammock impacts. The county's road-program team anticipates additional value to other road projects "on line" for the future.

Honore Avenue–Pinebrook Road Extension
Several landscape corridors were identified throughout this project area; however, due to the extent of existing and future infrastructure, their suitability for wildlife utilization is currently limited. Historic aquatic landscape features that exist in this area include South Creek, Fox Creek, Cow Pen Slough, and Shakett/Salt Creek. Utilization of these waterways by wildlife was documented during the study, but historic wildlife movement has also likely been altered by infrastructure. Undeveloped lands bordering the area include the Fox Creek REMP, Oscar Scherer State Park, and a Sarasota County buffer parcel. The protection and enhancement of vital habitat linkages between these lands west of Interstate 75 and protected lands east of the Interstate (e.g. Knights Trail Park, Pinelands Reserve, and Myakka River State Park) was an important consideration during this study and will remain a high priority during the design phase of the Honore Avenue-Pinebrook Road Extension. In addition, coordination with FDOT on wildlife improvements along Interstate 75 is anticipated.

Several artificial wildlife corridors have been proposed as part of the Honore Avenue – Pinebrook Road Extension project, although land-ownership obstacles continue to hinder the establishment of finalized locations and make determination of the magnitude of improvement difficult. The focus during the design process will be toward the restoration of historic corridor linkages. This may include continued negotiations with land owners, establishment of conservation easements, removal of restrictive fencing, installation of appropriately placed barrier fencing, upgrades to culverts, incorporation of mammal shelves, creation of earthen bridges, and design of span bridges suitable for unrestricted wildlife movement.

An upgrade to an existing span bridge at Fox Creek was requested by local wildlife agencies as part of the Interstate 75 PD&E study through this area. Additional improvements to this bridge must include the reconfiguration of barrier fencing to direct (rather than prohibit) wildlife movement beneath the roadway and modest management of vegetation. Agreements with adjacent landowners will also be necessary for this passage to reach its full potential, ensuring connection with protected lands east of Interstate 75. Sarasota County has agreed to match all upgrades proposed at Fox Creek by FDOT, as well as at other nearby span bridges. For example, considerable wildlife utilization of the floodplain under the Salt Creek span bridge has been documented, with noticeable reductions in wildlife mortality on the roadway above. The county has proposed a wide span crossing over this creek. Additionally, a dual-purpose earthen bridge is proposed at Cow Pen Slough, a deeply cut, human-altered canal. Finally, barrier fencing at wetland-highway interface zones and culvert upgrades with mammal shelves will be considered at specific locations along the Honore Avenue – Pinebrook Road Extension.

Interstate 75
Ecological evaluations have been conducted along two environmentally sensitive segments of Interstate 75: the segment associated with the Honore Avenue – Pinebrook Road Extension, and a six-mile segment further south which bisects large expanses of publicly-owned lands adjacent to the Myakka River and Deer Prairie Creek. In the southern area, Florida Panther sightings have been documented one mile north of the I-75 corridor on the T. Mabry Carlton Memorial Reserve and on Schewe Ranch, while a Scrub-jay family has been recorded along Deer Prairie Creek, a tributary of the Myakka River. Florida Scrub-jays have also been documented using span bridges beneath the interstate at Fox Creek in the northern study zone.

The Interstate 75 expansion project provides an opportunity to restore crucial habitat connectivity between state-owned and ESLPP lands. Continued infrastructure expansion (I-75 and EIC) and development (North Port) have

inadvertently isolated these environmentally sensitive habitats. Failure to take advantage of the I-75 widening to restore connectivity will likely have long-term ecological implications for the success of wildlife populations dependent on movement across this barrier. Large-scale artificial-corridor enhancements will therefore be important to improving habitat connectivity between these otherwise separated areas. In particular, artificial corridors should be designed to accommodate wildlife requiring larger geographic ranges, such as is required by the rare Florida Panther.

Overall
Data collected as part of the three ecological evaluations have provided evidence of a variety of wildlife utilizing areas beneath span bridges, low water hydrologic culverts, and one specifically designed small mammal crossing. Data have also suggested substantial wildlife mortality associated with unsuccessful roadway crossings. Currently, road-design engineers and environmental staff are working together to design artificial wildlife corridors to help allow safe wildlife passage around, under, and through barriers at each of the three road-expansion projects.

Road-kill mortality surveys documented impacts to at least 70 different species of wildlife. These species include white-tail deer (*Odocoileus virginianus*), river otter (*Lutra canadensis*), coyote (*Canis latrans*), flying squirrel (*Glaucomys volans*), American woodcock (*Scolopax minor*), American alligator (*Alligator mississippiensis*), gopher tortoise (*Gopherus polyphemus*), eastern diamondback rattlesnake (*Crotalus adamanteus*), and pig frog (*Rana grylio*). In addition to resident wildlife, migratory species such as the American Robin (*Turdus migratorius*) were significantly impacted as they moved through the area. Although road kill surveys were conducted over the course of two years, the frequency of surveys was not sufficient to evaluate fully the consequences of roadway expansion on local wildlife populations. Often, animal remains were unidentifiable by species, suggesting that additional species (beyond those recorded) were likely affected. The data also do not account for injured wildlife that expired in areas beyond the survey zones, predation by scavengers, removal by collectors, or disintegration caused by weather or traffic. Nonetheless, these data suggest that animal dispersal into habitats separated by roadway barriers is reduced, as documented for small mammals by Oxley et al. (1973).

Wetlands bisected by roadways appeared to affect movement patterns of herpetofauna noticeably. Air temperature also played an important role in the activity levels of many animals, particularly ectotherms (Kurz et al. 2005a). During the course of the surveys, an increase in herpetofauna mortality occurred during summer and fall, with a noticeable increase in frog mortality during October. This may coincide with precipitation events and nesting and breeding behaviors, but such was not specifically examined. Water levels for many of the wetlands in the study area were at or near their seasonal high levels during October of both 2003 and 2004, and thus were situated closer to the highway interface (Kurz et al. 2005b). Although amphibian and reptile mortality was documented, few specific recommendations have thus far been made to accommodate these animals' movements. At this time, culvert materials appropriate for use by these species are being considered and barrier wall-culvert systems and culvert size are being researched for use along the Honore Avenue-Pinebrook Road Extension.

Small mammals were negatively affected annually throughout the evaluated areas. Studies have shown that the effects on small mammals are magnified when highways bisect unique habitats such as wetland communities or forested areas historically serving as wildlife corridors (Foresman 2004). The implications of these findings are quite relevant to our evaluations given the abundance of wetlands, waterways, and forested lands associated with potentially impacted areas throughout Sarasota County. Although higher wildlife mortality was expected at wetland-highway interfaces in our evaluations, differences in mortality between these and more upland areas were not always observed. However, vegetated drainage swales established parallel to highways may artificially inflate the prevalence of persistent wetland-highway interface zones.

A noticeable reduction in mammal mortality was observed in a few key areas. These areas appeared to correspond to span bridges over creek corridors. Six span bridges exist in the evaluated areas, but fencing restrictions and human use may limit exploitation by wildlife. Seasonal fluctuations in water level and artificial and vegetative barriers appeared to influence small mammal use of artificial structures (culverts) negatively, while the size of the structure and the "tunnel effect" appeared to have less of an influence. Small mammals appeared to favor dry or mostly dry culverts. Given the success of capturing motion-sensory camera images at several dry (passable) span bridges, the failure to capture images of wildlife at other crossings suggests that those structures may not be as conducive to wildlife movement (Kurz et al. 2005a). One particular well-used dry culvert (36") was devoid of vegetation (other than sod) and extended beneath four lanes of roadway ("tunnel-effect"), while other unused culverts (>1 m) were often full of water and/or impeded by dense populations of Brazilian Pepper (*Schinus terebenthifolius*) or cattail (*Typha sp.*). Game trails leading to the road surface were often observed bypassing these "unacceptable" culverts.

Summary

Sarasota County continues to strive toward a balance between ecological sustainability and economic growth. The acquisition and protection of ecologically significant lands (Natural Corridors) and the minimization of roadway impacts in eco-geographically valuable areas (Artificial Corridors) have become top priorities of elected officials, planners, road-design, engineers and county environmental staff. Community support for these approaches has also been overwhelming, providing continued momentum toward their success.

The county's land-acquisition programs continue to move ahead. ESLPP has realized great successes over the past year, boasting critical land-acquisition achievements along the Myakka River corridor. The REMP program has employed unique and creative permitting approaches (generating healthy discussions) to pursue fiscally (and ecologically) appropriate land acquisitions with high restoration potential for use in future infrastructure projects.

The three county-initiated ecological evaluations (EIC, Honore Avenue-Pinebrook Road Extension, and Interstate 75) were chosen based on their proximity to ecologically important landscape features and continue to provide road design teams and environmental staff with a better understanding of the environmental challenges posed by development. Unfortunately, creating and improving wildlife corridors and avoiding ecologically valuable lands is often complicated by property ownership, development plans, political lines, and fiscal limitations. Designing a road incorporating every possible artificial-corridor improvement can be cost-prohibitive. Instead, publicly-owned lands, drainage easements, or areas under conservation easement were often given higher priority for defragmentation, but specific infrastructure project needs (mitigation, stormwater, and floodplain) and private land-development plans were also considered.

As long as county ecological evaluations continue to identify priority areas for advanced land acquisition, mitigation, and innovative design of future infrastructure, these programs should continue to move forward in spite of the challenges. This new county initiative has resulted in increased scrutiny of county infrastructure projects through alternative road alignments, sound ecological improvements, and defragmentation proposals. Sustainable design is now a genuine consideration of county road-design teams. It is our hope that Sarasota County can provide a model for sustainable development applicable to other communities across the country.

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Biographical Sketches: Sherri R. Swanson is a project scientist for Sarasota County Natural Systems Management. Her professional responsibilities involve project management and oversight of the county's Regional Mitigation Program, through which she serves as liaison between transportation and natural-resource interest groups. She holds a bachelor of science degree in environmental, soil and water science from the University of Arkansas. Her professional experiences involve permitting and natural resource and wildlife management.

Dr. Ray Kurz is a senior environmental scientist and program manager for PBS&J's West Florida Sciences program based in Sarasota and Tampa. He currently serves as a project manager to several public-agency clients for projects related to transportation improvements, watershed management and restoration, water-quality evaluations, and natural-resource management. He holds a bachelor of science degree in zoology and a master of science in fisheries and aquatic sciences, both from the University of Florida. He earned his Ph.D. in public health, with a focus on environmental health, at the University of South Florida in 1998.

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Quantifying and Mitigating the Barrier Effect of Roads and Traffic on Australian Wildlife

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Abstract

The network of highways, freeways, and other major roads in Australia and around the world continues to expand in length and width as new roads are built and existing roads widened. The effects of roads and traffic on the survival and movement of indigenous wildlife are potentially numerous and profound. Successful mitigation of these effects relies on the detailed definition of the nature and extent of the problem and appropriate analysis of the effectiveness of amelioration.

Habitat loss across large areas of Australia has been so extensive that many landscapes currently support less than 5 to 10% of indigenous vegetation. Ironically, much of the remaining vegetation occurs adjacent to existing roads or in unused road reserves. Consequently, new roads will dissect these vegetation remnants, potentially disrupting the movement of animals along these linear corridors. Similarly, the widening of existing roads will typically result in the removal of valuable habitat for wildlife.

In our study, we investigated the effect of a new road on the movement and ecology of the Squirrel Glider *Petaurus norfolcensis* in southeastern Australia. The squirrel glider is an endangered species restricted to forest and woodland in eastern Australia. Its primary form of movement is by gliding between trees. We radio-tracked nine individuals for a two-month period in the vicinity of a new dual-carriageway freeway and an existing single-carriageway highway. A total of 488 radio-tracking fixes revealed that animals were resident adjacent to both roads and that the rate of road crossing varied by sex and road width. Females were never observed to cross the dual carriageway, while a single male was located on opposite sides at a ratio of 1:0.4. Both females and males crossed the single carriageway regularly. Two of the nine gliders disappeared during the study.

The results of this study are being used to design a major collaborative research project that aims to more fully quantify the negative effects of roads and traffic on Australian wildlife. At present, there is a poor understanding of the ecological effects of roads and traffic in Australian ecosystems and on Australian wildlife. In particular, we are focusing on the population-level effects in order to determine the extent that population viability has been reduced. A range of taxa with different levels of vulnerability are being studied, including arboreal marsupials, ground-dwelling mammals, geckoes, and invertebrates. We will incorporate studies of movement patterns with genetic techniques and meta-population-viability analyses to elucidate effects at the population level. The project will then test the effectiveness of various mitigation measures by determining the extent to which population viability has been improved.

Biographical Sketch: Dr. Rodney van der Ree is the ecologist at the Australian Research Centre for Urban Ecology (ARCUE). He obtained his Ph.D. in 2000 from Deakin University, where he studied the impacts of habitat fragmentation on arboreal marsupials in northeastern Victoria. He used the principles of landscape ecology to investigate the response of fauna to a landscape where the habitat was arranged as a network of linear strips along roads and streams. Rodney now brings this knowledge and skill to ARCUE to investigate the response of mammals to urbanization. Rodney will be investigating the distribution and abundance of mammals within the greater Melbourne area, with a focus on the rate of species decline, their habitat requirements, and survival prospects.

The Return of the Eastern Racer to Vermont; Successful Conservation Through Proactive Project Development and Interagency Collaboration

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Abstract: During fieldwork for the Vermont Reptile and Amphibian Atlas Project, a population of Eastern Racers (*Coluber constrictor*) was found utilizing a parcel of state land managed by the Vermont Agency of Transportation (VTrans) in southeastern Vermont along Interstate 91. This species was thought to have been extirpated from Vermont for nearly 20 years. Until 2003, the last positively identified Racer in Vermont was a road-killed specimen in Putney in 1985. But the recent discovery along I-91, resulting in the species being listed as State Threatened in Vermont, proves that a few hardy individuals are making their way back to the northern fringes of their geographic range. To date, a minimum of eight individuals have been identified in Vermont, and researchers feel that this is a very encouraging sign that the Racer is making a comeback in Vermont.

Introduction

The discovery site has been scheduled for reconstruction as a truck weigh station. This puts the snakes' habitat on a collision course with the bulldozers. Taking a proactive approach to this potentially contentious situation, VTrans has been working closely with the Vermont Department of Fish and Wildlife (VDF&W) and the Vermont Department of Forest and Parks to develop an advance habitat-mitigation plan for these snakes.

All stakeholders involved feel that the collaborative approach taken here is an example of how multiple state agencies can work together as partners to protect the needs of a State Threatened Species while keeping an important transportation project on schedule.

The following objectives were set by VTrans and VDF&W:

- Identify common goals for VTrans and VDF&W.
- Formalize an agreement between state agencies to work collaboratively.
- Monitor snakes to determine habitat functions of VTrans site and population size.
- Develop a plan to replace habitat impacted by the VTrans project.
- Continue to manage and maintain the VTrans site without harming snakes.
- Create new habitat to compensate for habitat taken for re-development project.

Eastern Racer Description

The Eastern Racer is a very charismatic, strikingly attractive, and sleek creature. It is a large, strong, and active snake, well known for its feisty disposition and surprising speed. The smooth black scales of adult Racers are somewhat iridescent and can have a bluish tint. Juveniles have a pronounced dorsal pattern on a grayish or brownish background. The Eastern Racer is not venomous, but will almost always try to defend itself vigorously by biting and thrashing if handled. Given the choice, a Racer, almost without exception, will flee when confronted by a perceived threat or remain still if it thinks it is hidden. Racers have been known to charge toward humans when they feel threatened. However, sometimes a run for known cover can be misinterpreted as a charge if the observer is between the snake and its intended destination. Racers rely heavily on their vision for hunting and defense and will hold their head up several inches off the ground to facilitate their view (Harding 1996).

Methods

VTrans hired a herpetologist to guide the Agency through the process of considering the habitat needs of a State Threatened Species while planning and designing this transportation project. To meet the needs of the project and the needs of the VDF&W, the following steps were undertaken:

- A study funded by VTrans and FHWA has been undertaken to determine the function and importance of the habitat at the re-development site.
- Two large adult Racers were captured and implanted with radio transmitters so that their movements could be monitored on a weekly basis (during their active season) for two years.
- Passive integrated transponders have been implanted into all known Racers from this population.
- Open and frequent communication, as well as regular meetings between VTrans and VDF&W, are essential components of this joint effort.

Results

Since the initial discovery of this population of Racers, VTrans has continued to maintain an aggressive schedule for the re-development of this site. VTrans and VDF&W agree that both the project schedule and the welfare of this population of snakes are important. Both agencies anticipate that the proactive effort put into the habitat issues will keep this project on schedule and ensure that the habitat needs of the snake are met before, during, and after construction of the new truck weigh station. The accomplishments are encouraging.

- An interagency Memorandum of Understanding (MOU) was developed between VTrans and VDF&W to outline an advance mitigation plan and detail VTrans' responsibilities while re-developing the project site.
- Mowing and maintenance protocol has been adopted by the VTrans District 2 Maintenance staff to protect the safety of the Racers during scheduled maintenance activities.
- Mapping of habitat mitigation area has begun.
- In addition to answering some very pragmatic questions related to the development of the VTrans weigh station project, the study of this small group of snakes is providing new information on the behavior and habitat needs of Eastern Racers.

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