Connecting Values, Process, and Project Design: Twinning the Trans-Canada Highway in Banff National Park in Canada

Terry McGuire (Phone: 403-292-4707, Email: terry.mcguire@pc.gc.ca), Director, Western Asset Management Service Center for the West and North Region, Parks Canada, 1300 635 8 Ave S.W. Calgary, Alberta T2P 3M3, Canada
Sheila Luey (Phone: 403-522-1197, Email: sheila.luey@pc.gc.ca), Communications Manager, Parks Canada, Box 213, Lake Louise, Alberta, T0L 1E0, Canada

Abstract

Extending from coast to coast, the Trans-Canada Highway (TCH) plays an integral role in Canada's social and economic wellbeing. For geographic and historical reasons, 83 of its 7,500 kilometers bisect Banff National Park, Canada's first and most popular park. Part of the UNESCO Canadian Rocky Mountains World Heritage Site and known worldwide for this park's spectacular landscapes and exceptional natural resources, Banff has long been considered a harbinger for the future of other parks and protected areas across the country.

Parks Canada is the federal agency responsible for managing national parks in Canada. Under its mandate, Parks Canada must preserve and protect the ecological integrity of national parks for future generations while fostering public use and appreciation of these areas. And while not truly part of the mandate, major highways that run within and through federal park lands have also fallen to Parks Canada to manage.

Between 1979 and 2005, in response to rising traffic volumes and public safety concerns, 43 of 83 kilometers of the Trans-Canada highway in Banff National Park were converted in phases from two to four lanes. Each of these phases sparked national public interest, the first two in particular becoming flashpoints for the many divergent views about development and conservation in protected areas. These divergent views were not limited to external stakeholders, as highway twinning was seen internally to compete with and divert limited Parks Canada's resources away from direct mandate-related needs. Adding to the complexity of the situation is the unique governance context with Parks Canada as land manager, decision-making authority, and project proponent.

This paper offers a 25-year perspective on Parks Canada's approach to developing context-sensitive solutions; specifically use of a collaborative, interdisciplinary approach for developing a transportation facility that preserves scenic, aesthetic, and environmental resources while maintaining safety and mobility. Through four separate phases of the Trans-Canada Highway Twinning Project, this paper details how the nature and substance of public participation has changed over time and how public input can be reconciled with scientific information, project objectives, a challenging agency mandate, and engineering and financial considerations. Lessons learned in earlier phases have been applied to the most recent phase, resulting in improved stakeholder relationships and satisfaction, as well as leading-edge highway and mitigation design.

Biographical Sketch: Terry McGuire graduated in 1975 from the University of Calgary with a civil engineering degree. He is currently the Director of the Western Asset Management Service Center for the West and North Region of Parks Canada. Within this position, his duties include responsibility for highway operations, maintenance, and reconstruction within the Canadian Rocky Mountain Parks of Canada. He is a professional engineer. Of prime concern to McGuire is the mitigation of impacts highways have on ecological integrity within these national parks, as well as highway safety for both through traffic and park visitors.

Environmental Imperatives and the Engineering Interface: How to Make Hard Decisions

Martin Jalkotzy (Phone: 403-267-6328, Email: martin_jalkotzy@golder.com), Senior Wildlife Ecologist, Golder Associates Calgary AB T2P 3T1 Canada
Bruce F. Leeson (Phone: 403-292-4438, Email: bruce.leeson@pc.gc.ca), Parks Canada Agency, Calgary AB T2P 3M3, Canada

Abstract

Parks Canada has been engaged in upgrading the Trans-Canada Highway in Banff National Park since 1979. A severe wildlife/vehicle collision problem existed and was predicted to worsen unless mitigation measures were employed. Permission to twin the highway from two lanes to four lanes was granted in phases, subject to exceptional environmental protection measures. Forty-five kilometers of highway have been twinned with 2.4-m-high fences and 24 large crossing structures. Parks Canada now is planning a 33-km continuance of the highway twinning project, with a 12-km segment presently under construction. Innovative environmental protection measures, based on the successes of earlier initiatives, are being employed.

The most obvious of these measures have been fences and wildlife crossing structures to safeguard the rich assembly of wildlife resident or transient in the Bow River Valley. Valued ecosystem components include 12 species of large, highly transient Rocky Mountain wildlife, all subject to habitat fragmentation and vehicle collision. The species include protected native fish, Harlequin ducks, and a rich biodiversity in a high profile World Heritage Site. Parks Canada has a legal duty to maintain or restore ecological integrity in such undertakings.

Research, planning, and design have high visibility in the presence of a motivated public who vigorously express divisive viewpoints. This presentation will explain:

- How new designs respond to scientific imperatives
- Science and social lessons learned
- How to manage the confrontation of rhetoric and reality
- How the future looks different than the past

Biographical Sketches: Martin Jalkotzy is a Senior Wildlife Ecologist with Golder Associates in Calgary, Alberta. Martin will be the senior reviewer and will provide on-going strategic direction throughout the project. He has authored or co-authored nine refereed publications and over 40 technical reports and papers and has filled the role of technical and quality assurance editor for several environmental assessments. During his 27 years as a wildlife biologist, he has specialized in the effects of human development on wildlife. He recently acted in a senior role during Golder's environmental assessment of twinning the Trans-Canada Highway from Castle Junction to the Continental Divide, which included a review of the effects of the project on grizzly bears, black bears, harlequin ducks, and boreal toads. Over the last two years, he coordinated a review of the cumulative effects of development on the Castle Carbondale region of southwestern Alberta. He was an invited wildlife specialist on the East Kootenay wildlife winter-range committee, which included the assessment of the effects of development on moose, elk, bighorn sheep, mountain goats, and caribou0. He completed an exhaustive review of the effects of linear corridors on wildlife, which included an examination of the effects of recreational development. His species-specific research in Banff National Park examined the effects of front and backcountry recreational use on habitat effectiveness for grizzly bears. Most projects involved the application of GIS to deal with spatially complex issues. His experience integrating GIS into complex projects will be an asset to this project.

Dr. Bruce Leeson has lived and worked in the Rocky Mountains since 1969. After graduating from Montana State University in 1972, Bruce took a position as an environmental scientist with Parks Canada, where he has since worked, primarily in the National Parks of western and northern Canada, most of them World Heritage Sites. Bruce's work has focussed on environmental planning, impact assessment, and stewardship issues inherent in managing protected areas. Bruce has worked on highways and wildlife issues since 1972, with responsibility for the environmental-planning elements of the Trans-Canada Highway through Banff National Park. Forty-seven km of highway have now been twinned and fenced with 23 wildlife-crossing structures. Positive results for wildlife and people have been exceptional. Dr. Leeson recently was Director of Environmental Affairs for the 2002 Kananaskis G8 Summit. Although Bruce has returned to his position as Senior Environmental Assessment Scientist for Parks Canada—Western, his involvement with G8 continues as Senior Environmental Advisor to undertake the Kananaskis G8 Environmental Legacy projects to enhance wildlife-habitat connectivity.

Improving Mobility for Wildlife and People: Transportation Planning for Habitat Connectivity in Washington State

Paul Wagner (Phone: 360-705-7406, Email: wagnerp@wsdot.wa.gov), Biology Branch Manager, Washington State Department of Transportation, Environmental Services, P.O. Box 47331, Olympia, WA 98504, Fax: 360-705-6833

Abstract

Washington State's Snoqualmie Pass area supports many native habitat types and provides important linkage for wild lands between the North and South Cascades. The fragmented state of habitats in this area has made it a focal point for efforts by agencies and other organizations concerned with protecting and restoring natural habitats and wildlife populations.

Interstate 90 crosses the Cascade Mountains at Snoqualmie Pass. The Washington State Department of Transportation (WSDOT) is currently developing plans for adding lanes to Interstate 90 east of Snoqualmie Pass between Hyak and Easton. Planning for this transportation project includes consideration of the ecological needs of the area. In addition to transportation objectives, this project design also involves a major emphasis to construct the new roadway so as to improve and restore connectivity for terrestrial and aquatic species through the roadway corridor. This is a true multi-species approach which takes into consideration high- and low-mobility species, mountain terrain and climate, and landscape-level habitat linkages, as well as very localized special habitats.

This effort involves extensive coordination and partnership with state and federal agencies, as well as with environmental groups. Numerous scientific studies and inventories have been conducted in the area to provide a sound foundation and a special planning process specifically for the connectivity elements. Larger structures are planned at stream crossings to not only provide for hydrologic functions and processes, but also to allow for wildlife passage in riparian areas.

Additional upland wildlife crossing structures are planned to allow movement of terrestrial species. Seven emphasis areas, called Connectivity Restoration Areas (CRA's), have been identified in the 13-mile project. These improvements form a comprehensive approach in conjunction with compatible land management by the U.S. Forest Service and land acquisition and protection by environmental organizations. Together, these efforts represent a public investment in the hundreds of millions of dollars and constitute one of the largest restoration efforts of its kind in the country.

This presentation will discuss how the many issues related to habitat connectivity come together in the development of a large and complex transportation project. This involves the process for assessing planning aspects of the project that will improve connectivity for terrestrial and aquatic species hydrologic processes including baseline studies, GIS modeling, multidisciplinary groups for mitigation planning, analysis of connectivity needs for various species groups, and stakeholder coordination.

Future direction for habitat connectivity at the state or regional scale will also be discussed, including new Department Policies relating to connectivity, agency, and stakeholder coordination.

Note: The following posters scheduled for presentation at ICOET 2005 are related to this abstract and project:

- Combining Transportation Improvements and Wildlife Connectivity on Freeway Rebuild in Washington's Cascade Mountains (Charlie Raines, I-90 Wildlife Bridges Coalition)
- I-90 Snoqualmie Pass East Project: Linking Communities in the Natural and Built Environment (Jason Smith and Randall Giles, Washington State Department of Transportation)
- Landscape Ecology in Transportation Planning (Patricia McQueary, Washington State Department of Transportation)

Biographical Sketch: Paul Wagner is a wildlife biologist with over 20 years experience in the field, including work with red-wolf reintroduction in North Carolina and studies of seabirds in Alaska's Pribilof Islands and ice-age mammals in Arctic Alaska. He is currently the Biology Branch Manager for the Washington State Department of Transportation and manages programs responsible for policy and interagency coordination related to wetlands, fish, wildlife, and habitat issues statewide. He has a B.S. degree in Natural History from Juniata College and graduate coursework in salmon ecology at Evergreen State College. Wagner has served on committees of the National Academies of Sciences, been involved in assessing the ecological effects of roads, and has been a steering committee member of ICOET since 1998.

Integrating Community Values and Fostering Interagency Collaboration Through Outreach With Interactive GIS Models

Mike McCoy (Phone: 530-795-3197, Email: mcmccoy@ucdavis.edu), Co-director, Information Center for the Environment, Department of Environmental Science and Policy, University of California, Davis, Winters, CA 95694

Candice Steelman (Phone: 209-723-3153, Email: candice@mcag.cog.ca.us), Public Affairs Manager, Merced County Association of Governments (MCAG), Merced, CA 95326, Fax: 209-723-0322

Abstract: The Merced County Association of Governments (MCAG) was chosen by the Federal Highway Administration, U.S. Environmental Protection Agency, and the California Department of Transportation to pilot a new program, Partnership for Integrated Planning (PIP), which aimed to: streamline planning and the project-delivery process; avoid environmental impacts; foster collaboration among planning, transportation, and environmental agencies; and engage the public at the beginning of long-term transportation planning.

Merced County provides a challenging test case through rapid population growth, cultural diversity, high unemployment, and increasing conflicts between stewardship of sensitive habitats and prime farmland and demands for transportation improvements and housing.

The Partnership for Integrated Planning (PIP) included the development of geographic information system (GIS) tools for modeling growth and environmental impacts to produce real-time maps and tables resulting from policy choices at public meetings. PIP engaged all regionally relevant planning, natural resource, and regulatory agencies in data-sharing exercises to integrate data important to each agency into the scenario testing and planning process. Most importantly, the Merced County Association of Governments (MCAG), which is the coordinating partner in PIP, led an extensive outreach program to engage the community in PIP.

To project land-use changes, we adapted UPlan, a rule-based land-use model developed at the University of California at Davis. UPlan incorporates user-controlled policy inputs ranging from general plan map choices, housing densities, and household labor rates to the ranking of environmental amenities. These are combined with user-settable infrastructure growth attractors to distribute population-growth estimates into spatially explicit land-use scenarios. UPlan stores all user-specified assumptions so many scenarios may be tested against one another in a transparent fashion. We evaluated information needs by asking planning agencies which features (such as roads and urban service boundaries) they considered attractions and discouragement factors for growth. Resource agencies were asked what environmental factors should discourage or constrain growth. All agencies were asked to provide all available and relevant data.

This shared information resulted in an Environmentally Sensitive Areas (ESA) map and a Prime Agricultural Lands map. These two maps were evaluated at a workshop attended by resource agencies' representatives, elected officials, and city and county planners. Contributors included over 20 federal, state, and non-governmental organizations.

Like most public agencies, MCAG has historically solicited public input for regional transportation planning from a few community workshops. For example, in 2001 the agency held seven workshops for its previous plan. Under PIP, MCAG held 20-32 meetings each quarter, for a total of 100+ public meetings in 18 months. In addition, MCAG replaced the previous narrow focus on transportation by asking county residents to develop a vision for land use, natural resources, and transportation throughout their community. MCAG mastered the use of UPlan and accompanying environmental data and improved substantially on both throughout the course of these public meetings.

Historically, transportation-plan approval has run into considerable public and agency opposition. Federal officials in the last decade have attempted to streamline the National Environmental Policy Act (NEPA), California Environmental Quality Act (CEQA, which is California's NEPA equivalent), and other permitting procedures. A goal of PIP was to find a method for responsibly arriving at a consensus plan with less conflict, particularly in the environmental-review phase. The Regional Transportation Plan was approved by the MCAG Governing Board and received no opposition during the CEQA Environmental Impact Report (EIR) public-comment period.

Results of the Partnership for Integrated Planning model include:

- 800 percent increase in public participation in the transportation-planning process
- 89 percent of participants said they enjoyed the PIP project
- 89.1 percent of participants said they learned more about transportation issues
- 30 percent increase in awareness of the Regional Transportation Plan (RTP) among all county residents
- New issues brought to the surface from county groups who had not previously participated in the process
- Better relationships were built at both the county and city level among civic organizations, agencies, and residents
- RTP was approved by the MCAG Governing Board and received no opposition during public-comment periods
- Development of an Environmentally Sensitive Areas map based on shared information from a variety of resource- agency databases
- Development of a Prime Agricultural Lands map based on input and information from a variety of agricultural interests

Further research is needed on the portability of this information and this tool-centered collaborative approach. Adjacent counties with similar needs are prime candidates for study. In addition, future projects should include measures of the social and political planning decision network structures existing before and after the conduct of such projects.

Background

The history of transportation and other project permitting in California is a study in "step-by-step" planning. The California Environmental Quality Act initial (scoping) filings for projects with potentially significant environmental impacts comprise over 15,000 EIRs filed for private and public construction projects since the inception of the act in 1972. Most of these projects concluded the need for one or more mitigation efforts (CEQAnet Database 2004).

This stepwise approach to planning, review, and mitigation has been costly and time-consuming and has led to a failure to appreciate the cumulative impacts of projects on such things as agricultural land loss, biodiversity, and wildlife-movement corridors (Landis et al. 1996). This practice has also missed the opportunity to provide more meaningful biological conservation through large area, multi-project planning.

The California Department of Transportation (Caltrans) has recognized this failing in single project planning and permitting. Caltrans management has long held an interest in finding methods to provide better management of cumulative impacts while streamlining the permitting process. In 1999, Caltrans convened the U.S. Environmental Protection Agency (EPA) and the Federal Highway Administration in a University of California, Davis facilitated dialog on the possibilities for innovative new approaches to planning.

These discussions resulted in the "Mare Island Accord," which committed the agencies to seek methods for cooperative, comprehensive planning and pledged the partners to creating a pilot project testing the principles of the Accord. A pilot project location was agreed to in Merced County, California, because of rapid regional growth pressure there and because GIS expertise was available and local leadership was willing to accept the challenge of creating a collaborative planning process. The result was the Partnership for Integrated Planning in which the Merced County Association of Governments led agencies to seek methods for cooperative, comprehensive planning.

Method

Agency partners

The first step in the process of establishing a collaborative, comprehensive framework for regional planning was to seek partners from among interested regulatory and resource agencies. Agencies were asked to provide two levels of input. One level was the provision of service on an administrative advisory board. The other level was contribution of personnel to a GIS and data technical-advisory board. It was necessary to insure that all interested agency partners have input to the process and the ability to review and comment on all data that would be used in a comprehensive regional-planning program.

Towards this end, 18 state and federal agencies were contacted and asked to participate in a series of technical and administrative meetings establishing the process, guidelines, and technical specifications for a planning process that would involve all parties in developing, understanding, and supporting a description of the natural resource and transportation context in which regional planning and project planning would take place in the future. Over 70 one-to-one and group technical and administrative meetings were held over a three-and-a-half-year period as agencies and institutions worked out their differences regarding the acceptability of data and the development of administrative agreements.

The first eye-opener was the realization that agencies did not even know what each other's mission statements were and if they conflicted with their own. A spreadsheet of participating agency mission statements was developed to help establish a foundation of understanding and appreciation. A second hurdle was asking reviewing agencies for a major shift in thinking from the project to the planning level. A third hurdle was, frankly, the level of trust among participants. Everyone recognized that only time and continuous communications could build this trust, and these activities, over time, proved to be productive. The one goal that was readily embraced by all participants was the desire to streamline the workload, especially in the face of reduced staff and other budget cuts. The challenge was in combining divergent expectations and processes.

What began as a slow "forming and storming" process gathered momentum as the result of relationship building and active listening over a period of time–and time should be stressed here. This is not an easy, readily agreeable, short-lived process. Eventually, agreement over a joint planning process, the nature of institutional relations, and the quality and usability of data were all issues that were significantly resolved.

The UPlan model tool

Overlapping and supporting the process of group consensus building was a process of urban-growth model development which supported the discussions and continued to bring a sense of urgency to the need for resolution of concerns on a regional scale. UPlan (an open source add-in for ArcView) was selected as the modeling tool for this project.

The UPlan urban-growth model was developed by Johnston, Shabazian, and Gao (2003). The model permits the user to identify a series of urban-growth attractors and discouragement factors which are then applied to the study region to direct the location of new households and employment according to local land-use plans. Two versions of UPlan are available, one in ArcView3.2 that uses Spatial Analyst and one in ArcGIS9 (ESRI, 2004). We used the Arc View 3.2 version for this project.

The UPlan urban-growth model is a rule-based grid model. It allocates the projected area needed by each land-use type to available areas through a set of rules based on projected population increases, local land-use plans, existing cities, and existing and projected roads

UPlan projects urban growth in seven land uses including four residential densities, industrial, and two densities of commercial development. The model is not calibrated on historical data because it is intended for use in long-range scenario testing. UPlan allocation rules simulate land markets broadly by using infrastructure and other features as surrogates for economic activity. UPlan assumes that population growth can be converted into demand for land use by estimating employment ratios and household sizes. It projects growth only into general plan uses which allow each type of land use unless otherwise instructed.

UPlan uses an additive model of weighting growth attraction and discouragement. Cells have different attraction weights because of accessibility to transportation and infrastructure or other features. Other cells, such as sensitive habitats and floodplains, will discourage new development. (See Figures 1 and 2.)

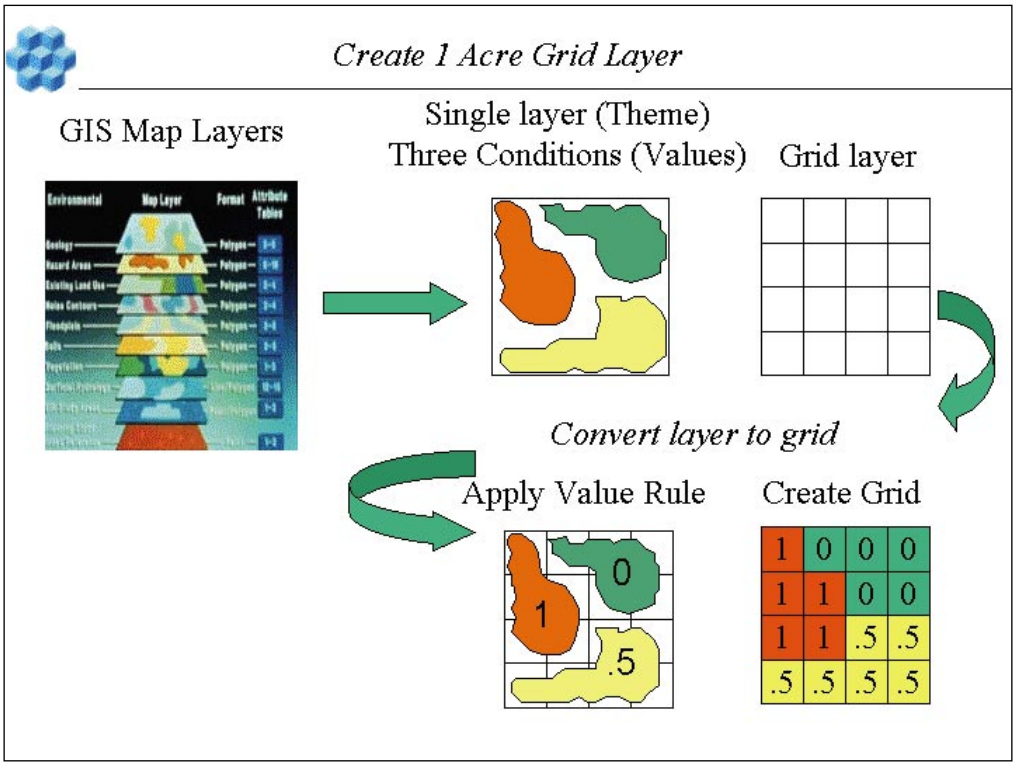

Figure 1. Create 1 Acre Grid Layer

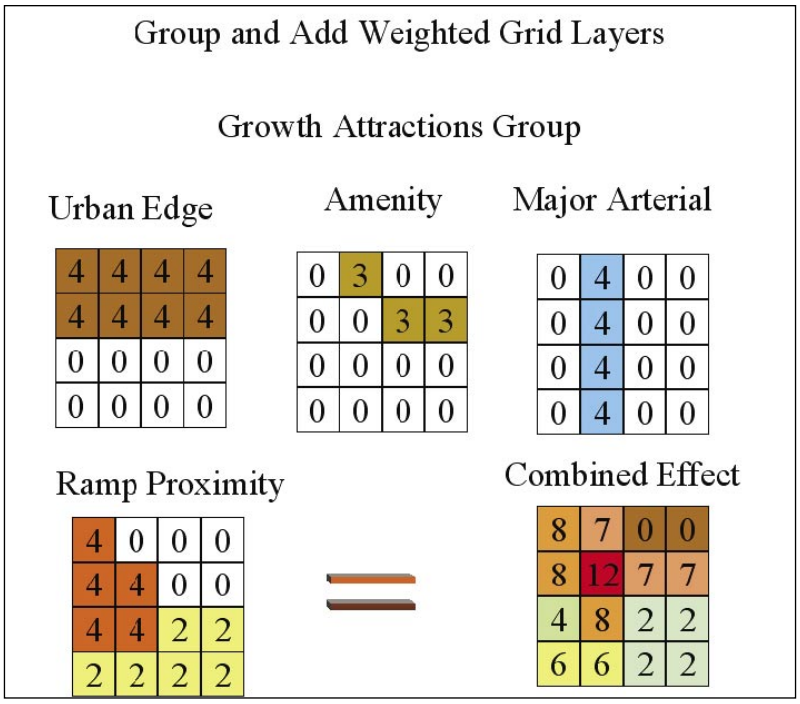

Figure 2. Uplan has a robust user interface which encourages non-GIS professionals to explore a variety of policy choices and value expressions that allow user control over everything from lot sizes to the value of vernal pools. Examples of planning variables and resource "discouragements" to development are given in Figures 3 and 4. The program is designed to run quickly to allow users to test many choices.

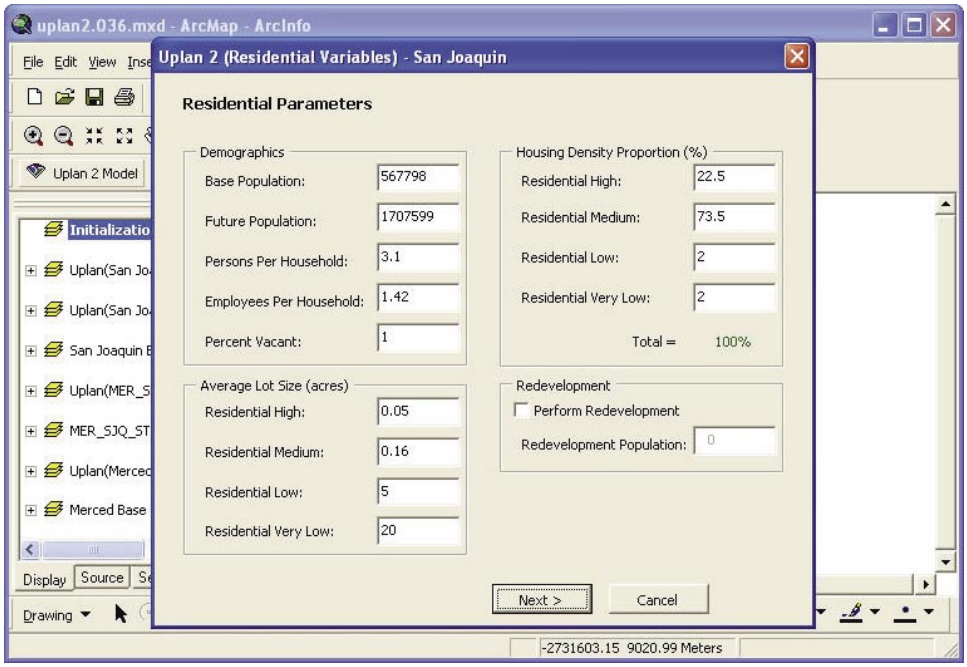

Figure 3. Screen Capture of UPlan 2 (Residential Variables).

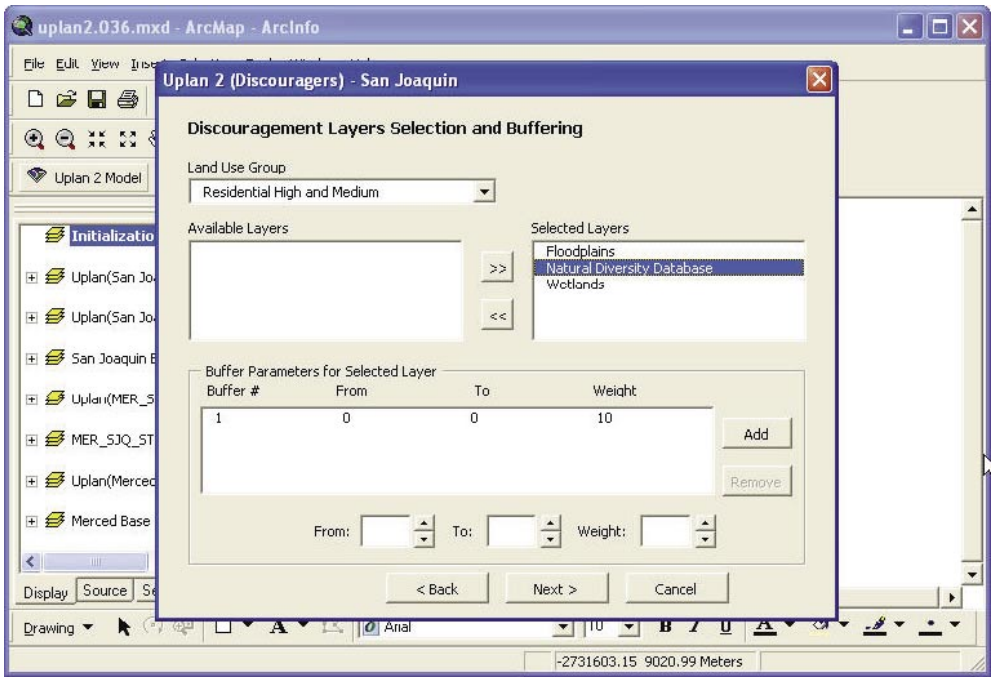

Figure 4. UPlan was used extensively at partnership meetings and public-participation meetings to help parties understand the implications of policy choices and value selections and, most of all, to help them communicate their interests to one another in the collaboration process.

Results

Based on what was heard at over 70 public meetings, five initial scenarios were developed: No Build, Current Policy, Some Changes, Alternative Modes, and Ultimate System. We did another round of 32 public meetings, plus allowed Internet users to provide input on the scenarios. An interesting phenomenon occurred. While many workshop attendees placed one checkmark to vote for the entire scenario, rather than vote for each component separately, most went out of their way to vote for the land-use description attached to the Alternate Modes scenario. (The overall favored scenario was Some Changes.) That description read, “Land is used differently. Higher densities, more mix of uses, walkable communities, and transit-oriented development receive priority.” MCAG has no land-use authority, and so this information was passed to the appropriate organizations.

In discussions on the original set of scenarios, residents expressed high interest in components of certain scenarios, particularly Some Changes and Alternate Modes, but not necessarily every component of one scenario. Thus, five “hybrid” scenarios were developed for the final public workshops (Current Policy, Some Change, More Changes, Alternate Modes, and Alternate Modes + Roads). The “More Changes” scenario was overwhelmingly selected for its ability to reduce future traffic congestion while doing the best job of preserving pavement. It also increases transit service and provides increased options for alternative transportation.

As part of the RTP, a countywide EIR was developed. The extensive outreach and thorough process of PIP created a higher comfort level for the report from agencies and groups likely to comment, resulting in a smooth and unremarkable comment period. MCAG hopes that acceptance of the EIR will result in more streamlining as project EIRs are released. Certainly, MCAG’s own process was streamlined as the agency was able to eliminate duplicate efforts in establishing a cumulative impacts analysis on a project-by-project basis by using the one developed for the countywide EIR.

The Partnership in Planning resulted in a well-developed and forward-looking Regional Transportation Plan–the first one in Merced County that was built on a common vision–that has significant backing from the public and the regulatory and non-regulatory members of the partnership. Perhaps just as important, the partnership has paved the way for future collaboration by creating relationships among the partners and the public which did not exist, or existed only weakly, prior to the partnership project.

The Partnership in Planning helped to develop a policy. Policy networks are informal relationships between various regional actors which can be established through communication, working on joint projects, or any kind of other shared activity (Hall 2004). Policy networks help establish the information and resource-sharing basis necessary to improve joint outcomes for affected agencies, local governments, and other relevant stakeholders. Policy networks provide communication channels by which local political entrepreneurs can organize other actors for collective action (Schneider and Teske 1992). The policy network resulting from the PIP process will be a key component of collaborative capacity in this region for the foreseeable future.

However, issues still remain. First, policy networks are strengthened by the commitment of all stakeholders. When one or two major stakeholders are not at the table, program results may be questioned. Second, policy networks are built on relationships. Not only does it take a long time to develop personal relationships, but even longer for that connection to seep upward and outward so that the relationship becomes one between agencies rather than individuals. When an individual leaves, the relationship often begins again from the ground floor. Third, for real change to happen, it must occur at the policy level in state and federal governments, where both relationship incentives and tone must be demonstrated.

The Partnership for Integrated Planning was a first step for most of the players. It was well-received and had many positive results. Components of the plan have been adopted by other Councils of Government and are being adapted by MCAG for other work elements.

Biographical Sketches: Mike McCoy is the co-founder of the Information Center for the Environment at the University of California, Davis. He leads research teams focusing on the use of modeling urban growth in resource-rich regions and the use of social-network analysis for the study of collaborative planning processes.

Candice Steelman has worked in public relations for over 15 years and is currently employed by the Merced County Association of Governments (MCAG) as the Public Affairs Manager, with responsibilities in media relations and legislative programs. Also, for the past six years, she has taught courses in Teamwork and Conflict Resolution, Marketing, and Public Relations for the University of Phoenix. For the pilot program, Partnership for Integrated Planning, funded by the U.S. Environmental Protection Agency, Federal Highway Administration, and California Department of Transportation, she designed the public-outreach program and worked with numerous state and federal environmental agencies to build environmental layers for a comprehensive GIS database. Her degrees include a B.A. in Journalism and a M.S. in Mass Communications, both from San Jose State University, California.

References

CEQAnet Database. 2004. Website for the California Environmental Quality Act. http://www.ceqanet.ca.gov/

California Transportation Investment System (CTIS) Tool. 2004. California Department of Transportation. http://www.dot.ca.gov/hq/tpp/offices/osp/ctis.htm

Environmental Systems Research Institute. 2004. ArcInfo GIS program. Redlands, California.

Hall, T. and L. J. O'Toole. 2004. Shaping Formal Networks through the Regulatory Process, Administration and Society. 36 (2): 1-22.

Johnston, R. A., D. R. Shabazian, and S. Gao. 2003. UPlan: A Versatile Urban Growth Model for Transportation Planning. Transportation Research Record. 1831: 202-209.

Schneider, M. and P. Teske. 1992. Toward a Theory of the Political Entrepreneur: Evidence from Local Government. American Political Science Review. 86 (3): 737-747.

Maine's Beginning With Habitat Program and Transportation Partnership

Richard Bostwick (Phone: 207-624-3100, Email: richard.bostwick@maine.gov), Supervisor of Field Studies, Maine Department of Transportation, 16 State House Station, Augusta, ME 04333-0016, Fax: 207-287-3292,
Barbara Charry (Phone: 207-781-6180, Email: bcharry@mainaudubon.org), Biologist/GIS Manager, Maine Audubon, Falmouth, ME 04105

Abstract: Transportation facilities and adjacent development are the greatest contributors to habitat loss and fragmentation in Maine. Transportation facilities present a linear structure that is either a physical barrier or zone of adverse habitat that has separated former habitat or, in the case of new facilities, a dividing or fragmenting influence on existing habitat. Maine's Beginning with Habitat (BWH) program and the Maine Department of Transportation have partnered to begin addressing transportation issues related to habitat and wildlife.

Beginning with Habitat is a collaborative, public-private partnership whose mission is to compile, integrate, interpret, and deliver the best available information, tools, and incentives to facilitate effective land-use planning and natural-habitat conservation at local, regional, and state-wide scales. In 2004, BWH won an Environmental Merit Award from EPA and the program is now serving as a model for other states that wish to integrate habitat protection with land-use planning. As Maine's landscape changes over time, the goal of the program is to sustain habitat that supports healthy populations of Maine's wildlife and native plants for current and future generations.

BWH was developed by a group of stakeholders concerned about the future of Maine's habitat and wildlife in the face of the increased rate of sprawling development. BWH provides all Maine towns with a collection of GIS maps and accompanying information depicting and describing various habitats of statewide and national significance found in the town. These maps provide communities with information that can help guide conservation of valuable habitats. During the last few years, BWH has met with over 140 towns and land trusts to give individualized presentations on the locations and conservation of high-value plant and animal habitat in their communities.

Current areas of synergy include:

- Developing Northeast regional relations with New England, the Canadian Maritimes, and Québec
- Creating a Maine Habitat and Transportation Working Group that has developed a six-point plan to integrate and act on habitat and transportation goals for the mutual benefit of Maine's transportatio networks and habitat
- Using BWH data for transportation scoping early in projects
- Using BWH Focus Areas of statewide ecological significance for transportation-project compensatory-mitigation planning
- Linking transportation and open space components of municipal land-use plans

In addition, an effort is underway to secure funding to develop a habitat-connectivity analysis for enhancement of BWH data and transportation planning. This analysis will use BWH data as well as other data to identify habitat connectivity areas in order to direct strategies to maintain and restore connections.

The partners of this cooperative program include:

- Maine Audubon
- Maine Coast Heritage Trust
- Maine Cooperative Fish and Wildlife Research Unit
- Maine Department Environmental Protection
- Maine Department of Inland Fisheries and Wildlife
- Maine Department of Transportation
- Maine Forest Service
- Maine Natural Areas Program
- Maine State Planning Office
- Maine's 13 regional planning commissions
- Nature Conservancy
- U.S. Fish and Wildlife Service

Introduction

Beginning with Habitat (www.beginningwithhabitat.org) was developed by Maine's natural resource agencies and organizations to address the biggest threat to wildlife in Maine: sprawl. An unexpected partnership has recently developed and continues to develop with Maine's Department of Transportation.

The Road and Planning Landscape in Maine

Most new road construction in Maine consists of local subdivision roads. These roads fragment habitat, decreasing its value for wide-ranging and area-sensitive wildlife species. Responsibility for land-use planning to oversee this incremental road development lies at the local level in Maine. Unlike most states that have strong county governments responsible for land-use planning, Maine has no official regional land-use planning. Instead, 492 individual towns in Maine make all their own land-use planning decisions, with only sporadic, voluntary coordination. Local decision

makers are mostly planning-board volunteers with little or no training in planning, ecology, or transportation issues. For transportation issues, four Municipal Planning Organizations (Portland Area Comprehensive Transportation System (PACTS) in the Portland area, KACTS in the Kittery area, BACTS in the Bangor area, and the Androscoggin Transportation Resource Center (ATRC) in the greater Lewiston Auburn area) are relied on to come up with the overall transportation scheme for the areas they cover. These regional plans are currently oriented to traffic and level of service. They do not have strong habitat planning incorporated at this time. Unfortunately, neither the forces behind sprawl nor wildlife see political boundaries.

Beginning with Habitat Program Background

The Beginning with Habitat program (BWH) was designed as a mechanism to assist these local planners with their land-use decisions. BWH is a cooperative, non-regulatory landscape approach to conserving native species on a developing landscape. Its strength and uniqueness lie in the collaboration of nonprofit organizations and state and federal agencies. This partnership started with several years of planning that produced a pilot phase of the program in 2001.

BWH has the potential to be a key vehicle in Maine for getting road-related habitat issues into local planning to reduce the impacts of roads on wildlife.

Through the BWH program, participants (mostly towns and land trusts) are provided ecological education, data, tools, and resources. The most up-to-date wildlife and plant-habitat information available for conservation and land-use planning is provided to municipal officials, land trusts, conservation organizations, and state and federal agencies through presentations, GIS maps and interpretation, digital data, and follow-up assistance. GIS allows BWH partners to produce map products showing many data layers in a format that citizen boards and municipal staff can easily utilize.

BWH promotes a landscape model designed to ensure that all of Maine's wildlife species, both common and rare, will continue to be viable for future generations. The model, which was developed by the University of Maine's Cooperative Fish and Wildlife Research Unit (CFWRU), has three main components, each of which is shown on an individual map. Together, these maps can be used to build a conservation landscape.

The first map or component is Riparian Habitat. The Riparian layer is considered as the skeleton of the landscape. Riparian areas provide habitat for the majority of Maine's vertebrate species and connectivity among other habitat areas. According to the CFWRU, strong conservation of these areas would ensure that about 50 to 75 percent of Maine's vertebrate species would continue on the landscape into the future.

The second component in the model and map consists of identified high-value plant and animal habitats. The model predicts that conservation of these areas, along with the Riparian Habitats, would support up to 80 to 85 percent of vertebrate species in Maine over the long term. This map includes locations of rare, threatened, and endangered plants and animals; Essential and Significant Wildlife habitats (designated under Maine's Endangered Species and Natural Resources Protection Acts); rare and exemplary natural communities; and important habitat for US Fish and Wildlife Service (USFWS) trust species (identified through the USFWS Gulf of Maine Program).

Finally, to ensure the long-term viability of the remaining 20 percent of vertebrate species in Maine, BWH identifies and encourages communities to conserve large, undeveloped habitat blocks. These are unroaded areas that provide habitat for large area-dependent species, ensure habitat for more common species, enhance the viability of habitats of management concern, and provide open space for other social and community values.

As of May 2005, 137 towns and over 40 land trusts and regional groups have received BWH presentations and maps.

Beginning with Habitat Program and Maine Department of Transportation Partnership

Habitat planning and transportation planning face some similar challenges in Maine. Both habitat and transportation systems function at a scale that is not easily addressed by local land-use planning. The Maine Department of Transportation (MDOT) and BWH have come together to explore the ways in which planning for transportation and wildlife can be mutually beneficial. From the BWH point of view, roads and associated development are the greatest cause of habitat loss and fragmentation. Improved habitat connectivity is possible through changes in road, bridge, and culvert designs. Additionally, some habitat-conservation opportunities can benefit both transportation and wildlife goals.

From the MDOT point of view, this partnership provides an opportunity for MDOT to fulfill its commitment to natural-resource stewardship, as well as another means to address human-safety issues related to vehicle and wildlife collisions. In addition, efficient and sustainable transportation systems are impacted by land-use decisions. For example, increased curb cuts decrease a road's long-term effectiveness and ability to move traffic. Curb cuts also impact large habitat blocks. causing habitat fragmentation and loss. Cost savings for transportation projects can be reduced via upfront planning for wildlife. BWH provides some of the tools needed to do this efficiently. Furthermore, required mitigation can be streamlined through information provided by BWH.

What's Been Done to Date

Introductory meetings between MDOT and BWH were held in 2003. As a result, the first Maine Conference on Roads and Wildlife for Planning, Transportation, and Wildlife Professionals was held in January 2004, sponsored by Maine Audubon, Maine Department of Transportation and Maine Department of Inland Fisheries and Wildlife (MDIFW). As an outcome, the Maine Habitat and Transportation Working Group was established. This group's mission is to integrate and act on habitat and transportation goals for the mutual benefit of Maine's transportation networks and habitat. Group members attended and presented at the first Northeast Wildlife and Transportation Conference in September 2004.

At this meeting, the work of the Habitat and Transportation Working Group was synthesized into the following six-point plan:

1. Integrate MDOT with Maine's Comprehensive Wildlife Conservation Strategy and find ways to integrate natural resource and habitat planning with transportation planning, including MDOT's 20-year, six-year, and work-plan scoping efforts.
2. Develop a statewide habitat-connectivity map.
3. Promote the use of the ecosystem-based approach to decision making.
4. Integrate wildlife and transportation efforts with regional planning activities.
5. Develop a "tool box" guidebook (what to do, how to do it, resources to make it happen) for transportation and wildlife targeting towns.
6. Education and outreach–get the wildlife and transportation message out.

Compensatory Mitigation and MDOT Research Grant

A very tangible outcome of the BWH and MDOT discussions and partnership is the use of BWH Focus Areas by MDOT. Focus Areas are areas of statewide ecological significance identified by BWH. These areas, which are based on available information from MDIFW, the Maine Natural Areas Program (MNAP), and USFWS, synthesize and simplify existing habitat data to help focus conservation effort on the most important targets. They are nonregulatory and are not "no development" areas.

Through discussions with BWH, the MDOT Natural Resource Mitigation Specialist learned about Focus Areas and took the initiative to use the information for a project impacting 1.6 acres of wetland along a state road. There were no on-site opportunities along the project roadway for wetland restoration that would have any real ecological value. But nearby was a Focus Area (Saco Heath) with significant conservation land, including wetlands of statewide ecological significance. An adjacent 45-acre parcel had been identified by the Nature Conservancy (TNC) and was available from a willing seller. MDOT was able to purchase the land and transfer it to TNC, thereby meeting the mitigation requirements and adding significantly to state habitat-conservation goals.

MDOT recognized the BWH Focus Areas as potential tools that would help streamline environmental review, improve the mitigation process, and serve as a starting point for a watershed-based mitigation approach. Specifically, the BWH Focus Areas can serve as a screening tool for early identification of resources of statewide or regional importance and deciding which projects to scope. The usefulness of BWH Focus Areas to MDOT made it clear that an accelerated process was needed to identify Focus Areas statewide. Currently, they are only identified for part of the state. In March 2005, MDOT awarded a research grant to finish BWH Focus Area identification statewide.

The Future

The partnership has identified several additional areas of synergy, including: developing northeast regional relations within New England, the Canadian Maritimes, and Quebec, particularly with respect to:

- Moose-vehicle collision issues
- Using BWH data for transportation scoping early in projects
- Linking transportation and open-space components of municipal land-use plans

Ongoing and future initiatives include:

- Continuing the Habitat and Transportation Working Group's efforts
- A statewide study to identify key elements of habitat connectivity
- Developing educational materials on roads and wildlife for the general public
- Identifying Focus Areas for the rest of the state

The potential benefits of a partnership between habitat and transportation planners and professionals are enormous. Through continued coordination and communication, we hope to realize a range of outcomes to benefit Maine's citizens and wildlife. The future we envision as a result of this partnership will include:

- Transportation projects that are less expensive due to early identification of habitat needs
- Roads that are safer for people
- Roads that are more permeable for wildlife due to well-designed and placed bridges, culverts, and roads
- Reduced fragmentation of large, undeveloped habitat blocks by new roads
- Mitigation that provides the highest possible benefit for wildlife and habitat

Biographical Sketches: Barbara Charry has a B.A. in English from Grinnell College in Grinnell, Iowa and a M.S. in environmental science from Antioch New England in Keene, New Hampshire. She has worked for Maine Audubon as a biologist and GIS manager since 1992. Areas of work have included endangered-species management, grassroots organizing, natural-history information, northern forest issues, and sprawling development's impacts on wildlife.

Richard Bostwick has a B.Sc. in biology from Mt. Allison University in New Brunswick, Canada. He has worked for the Maine Department of Transportation in the fields of transportation and biology since 1984. His background includes resource identification and assessment, environmental work on NEPA and other planning studies, and animal-vehicle crash study for the Maine DOT.

Quick Fixes: Working Together to Address Herptile Road Mortality in New York State

Debra A. Nelson (Phone: 518-485-5479, Email: dnelson@dot.state.ny.us), Environmental Specialist 3, Water/Ecology Section Head, New York State Department of Transportation, Albany, NY 12232
Mary Ellen Papin (Phone: 585-272-3407, Email: mepapin@gw.dot.state.ny.us), Environmental Specialist 2, Maintenance Environmental Coordinator, New York State Department of Transportation, Region 4, NY 14623, Fax: 585-272-7002
Timothy Baker (Phone: 315-448-7366, Email: tbaker@dot.state.ny.us), Environmental Specialist 2, Maintenance Environmental Coordinator, New York State Department of Transportation, Region 3, Syracuse, NY

Abstract: Traditionally, state transportation agencies have designed and built environmental enhancements in response to regulatory requirements to mitigate project impacts. More recently, state transportation agencies have embraced an environmental ethic that goes beyond compliance and encourages agencies routinely to incorporate environmental enhancements into projects and activities. Generally, in-house staff or resource/regulatory agencies identify opportunities to address concerns regarding high-profile species (e.g., large mammals, endangered species).

Taking stewardship one step further, the New York State Department of Transportation (NYSDOT) has demonstrated innovative responses to problems brought forth by concerned citizens regarding a lesser-studied group of wildlife–amphibians and reptiles (collectively termed "herptiles"). These responses have resulted in valuable partnerships with private citizens, colleges, and resource agencies, thus increasing the agency's credibility in its commitment to an environmental ethic and its reputation for getting things done.

This paper will establish how NYSDOT demonstrated its environmental stewardship on a working level with a quick response to expressed public concerns by highlighting two projects. In each instance, a private citizen alerted NYSDOT about their concern for high mortality rates of salamanders, frogs, and turtles in "hot spots" along the state highways. Common factors in these projects include: NYSDOT paid credence and a speedy response to a private citizen's concern; maintenance forces applied their practical skills to develop an in-the-field solution to the problem; NYSDOT formed fruitful partnerships with colleges, private citizens, and resource agency experts; and costs were minimized by using surplus material, on-hand equipment, and simple designs.

By highlighting two specific examples, we will demonstrate that some problems can be solved quickly by bringing the right group of people together with a variety of skills and knowledge and a determination to get the job done. Methodology, results, and lessons learned will be presented and discussed.

The Canandaigua Lake Herptile Crossing was built in 2002 in response to expressed citizen concerns regarding the high rate of turtle mortality. This project included constructing suitable nesting habitat for turtles on private property and constructing a physical barrier to funnel turtles to existing culverts. NYSDOT formed partnerships with Finger Lakes Community College, the New York State Department of Environmental Conservation, and a private landowner. The Labrador Hollow Herptile Crossing was installed in 2003 in response to a 2002 posting on an internet listerv soliciting help in the "simply phenomenal" herp movement. A 12-inch culvert was installed to serve as a "critter crossing" and surplus w-beam guide rail was imbedded into the ground to guide salamanders and frogs to the culvert.

NYSDOT formed partnerships with the State University of New York's College of Environment Science and Forestry (SUNY-ESF) and private citizens. These projects demonstrate how collaboration, flexibility, and responsiveness result in simple, creative designs with tangible benefits, fostering good will and a sense of stewardship.

This paper will also discuss research initiated by NYSDOT to identify and address the impacts of transportation on herptiles populations to guide future decision to address herptile-mortality concerns.

New York State DOT's Road to Stewardship

The New York State Department of Transportation (NYSDOT) is the state's largest public works agency. As such, the Department recognizes its obligation and responsibility to the people of New York State to protect, improve, and enhance the environment in the course of its business of planning, building, and maintaining a transportation system. Environmental stewardship builds on the values of the Department's employees to protect the natural and cultural resources of the state. Caring for the environment while providing a transportation network allows NYSDOT employees to feel good about being "good neighbors" that a community or an individual will welcome rather than shun. Environmental stewardship builds credibility, trust, and goodwill, as well as building staff enthusiasm and morale.

NYSDOT's environmental ethic has evolved over the last decade. In 1996, NYSDOT revised its mission statement to include "environmentally sound" alongside safe, efficient, and balanced transportation system. In 1998, the Department Environmental Initiative was launched (see http://www.dot.state.ny.us/eab/envinit.html). Since that time, NYSDOT has undertaken deliberate actions and adopted a more proactive approach to addressing environmental matters, including issuing Department-wide Environmental Initiative Guidelines and Procedures (http://www.dot.state.ny.us/eab/eieab3.pdf) and an Environmental Policy (http://www.dot.state.ny.us/eab/files/policyen.pdf).

In 2001, NYSDOT adjusted its organizational structure to establish environmental expertise on the ground to sustain its efforts of proactive environmental stewardship. Environmental support within NYSDOT has traditionally been provided by the Regional Landscape/Environmental Units housed in the Design Bureaus.

As environmental requirements and expectations increased, the need for maintenance and construction-phase assistance in the environmental field increased. To meet environmental-stewardship demands, the Department hired 22 seasoned environmental managers to work within the regional construction and maintenance units.

These managers' primary role is to identify and seize environmental stewardship opportunities, address various regulatory agency concerns, and make critical on-site decisions. This field presence of environmental staff maintains credibility with resource agencies and operation staff and provides ready access to machines, material, and manpower.

Presently, NYSDOT is undergoing a Transformation effort which continues to recognize the importance of environmental stewardship. This is evident in that "improving environmental conditions" has been identified as a priority result area, along with improving mobility and reliability, increasing safety, promoting economic sustainability, and enhancing security.

Herptiles and Roads in New York
New York State is host to 67 species of amphibians and reptiles. The state's diverse and widespread herptofauna includes most species present in New England and several additional species from adjacent northern, southern, and western regions. Each year, virtually all species of frogs, toads, and salamanders migrate from forest and fields to wetlands to breed. Turtles, in contrast, travel in the spring from waters to uplands in search of suitable nesting sites. This seasonal migration, along with their small size and slow rate of movement, make herptiles particularly susceptible to road mortality along NYSDOT's 16,500 miles of highway.

Efforts to Reduce Turtle Mortality–Canandaigua Lake Area Project
In New York State, turtles nest from late May to early July, depositing eggs in sandy or gravelly soil, lawns, mowed fields, roadsides, sphagnum moss, or sedge tussocks. During the nesting period, female turtles migrate from ponds and wetlands in search of suitable nesting areas, becoming vulnerable to mortality along roadways.

In western New York in the spring of 2000, NYSDOT was informed of an area of highway with high turtle mortality. A local citizen expressed concern about the high vehicular mortality of primarily painted turtles (*Chrysemys picta*) and common snapping turtles (*Chelydra s. serpentine*), both common species in New York, along a stretch of NYS Route 21 in Woodville at the south end of Canandaigua Lake. Initially, the citizen requested permission to erect "Caution Turtle Crossing" signs in the area. When that option was ruled out, other solutions were sought.

A partnership was formed among two NYSDOT Regions, the New York State Department of Environmental Conservation (NYSDEC), and Finger Lakes Community College. Collectively, these partners determined that to best reduce turtle mortality, a two-component strategy was warranted. This included (1) construction of suitable turtle-nesting habitat on the eastern side of Route 21 from where the turtles were crossing and (2) construction of a physical barrier approximately 1,400 feet in length to funnel turtles, frogs, and salamanders to four existing culverts to cross under the road.

This innovative solution resulted from utilizing the specialties of each of the collaborators. NYSDEC provided expertise on turtle biology and site selection, NYSDOT Region 4 assisted with planning and provided maintenance forces and equipment for project construction, NYSDOT Region 6 was also involved in project planning and provided funds for materials, Finger Lakes Community College performed a pre-construction assessment, and a private landowner permitted the turtle-nesting habitat construction on private property.

To create suitable turtle-nesting habitat, NYSDOT maintenance forces cleared a portion of an overgrown vineyard. Loose, gravelly fill from a nearby, recently cleaned ditch was placed in a crescent-shaped area approximately 30 meters by 10 meters (approximately 100 feet by 33 feet). A wooden barrier was placed between the newly created nesting area and Route 21 to discourage travel across the road.

In addition to the constructed turtle nesting habitat, NYSDOT installed a 1,400 foot (approximately 427 meter) wooden barrier along the Canandaigua Lake/wetland side of Route 21 to funnel herptiles to four existing culverts. This physical barrier is up to 16 inches high (41 cm) constructed of 2 inch x 8 inch (5 cm x 20 cm) lumber staked with metal sign posts.

This project was undertaken specifically to address the turtle mortality concern; it was not added on to a capital project or due to regulatory requirements. This field-designed solution took less than a week to construct and cost approximately $15,000 in materials. NYSDOT maintenance personnel and equipment were used during construction. Ongoing maintenance of the constructed turtle-nesting area consists of one late-season mowing each year to prevent overgrowth.

Facilitating Herptile Movement – Labrador Hollow Project
New York State is home to 18 species of salamanders and 14 species of frogs and toads. Of these, ten species of salamanders are affiliated with woodlands and temporary vernal pools. Each spring, these woodland salamanders migrate, oftentimes in large numbers, from upland forests to these salamanders' breeding ponds. Similarly, on warm spring and summer nights, frogs and toads emerge in great numbers to congregate in ponds. During migration, these herptiles become vulnerable to becoming roadkill as their journey takes them across roadways.

The Labrador Hollow project is another example of NYSDOT's efforts to address herptile roadkill in response to a citizen's concern. On April 1, 2002, a local birder posted a note on a birding listserv, indicating that he needed "to contact the right people to get a drift net and tunnel built for this area because the Herp Movement is phenomenal." The referenced area was along Route 91 in the Labrador Hollow area. The most prevalent species noted were spot-

ted salamander (*Ambystoma maculatum*) (430), wood frog (*Rana sylvatica*) (350+), and northern spring peeper (*Pseudacris c. crucifer*) (2000+).

An Environmental Specialist from NYSDOT's Environmental Analysis Bureau, an avid birder, noticed this note on the listserv the next day and contacted the person, a graduate student at the State University of New York, College of Environmental Sciences and Forestry (SUNY-ESF). Follow-up contacts were made with Dr. James Gibbs, a herpetologist at SUNY-ESF, and to the regional environmental/landscape staff in the Syracuse office. After all the right people were connected, the collaboration began.

Within eight days of the original posting, a NYSDOT landscape architect from the regional landscape/environmental unit met with the birder/herp enthusiast for site reconnaissance. The area of concern was a 3.5-mile (5.6-km) section of State Route 91 within the state Labrador Hollow Unique Area. Considering that the NYS Department of Environmental Conservation owned land on both sides of the highway, the NYSDOT landscape architect, via e-mail correspondence, recognized that "the opportunity for a partnership with both agencies as well as the College are (sic) excellent." NYSDOT contacted NYSDEC and facilitated a fruitful partnership between the resource agency, the transportation agency, and the research college.

The following spring, SUNY-ESF, in partnership with NYSDOT, established a study area and conducted field surveys to determine concentrated areas of mortality. Concurrently, the NYSDOT maintenance environmental coordinator was pursuing an option with the maintenance Resident Engineer to install a herp culvert/crossing using maintenance forces in the summer prior to a paving project.

The enthusiasm for the project was great. Regional environmental staff, sometimes accompanied by their spouses and children, conducted night surveys of herptile movement. E-mails included excerpts such as "great flow of ideas and interests!" and "Oh what fun we are having!" The camaraderie and enthusiasm was infectious.

During the summer of 2003, NYSDOT placed a 12-inch (30.5-cm) culvert across the road to serve as a "critter crossing" for amphibians and reptiles. The culvert consisted of two twenty-foot (6-meter) sections of 12-inch diameter corrugated metal pipe that were surplused in the maintenance yard. The culvert was placed prior to a planned paving job in the summer, thus signs of the installation were covered shortly after construction.

In the autumn of 2003, SUNY-ESF students, in cooperation with NYSDOT, installed drift fence in the woods to guide salamanders traveling down the forested slope to the crossing location. The drift fence consists of old, metal W-beam guide rail that was available for reuse in the scrap pile at one of the maintenance residencies. The drift fence was staked with cut rebar.

SUNY-ESF students conducted post-construction monitoring in the spring of 2004 to determine the number of mortalities along the road in the vicinity of the crossing. The study design was altered from the pre-construction study due to time constraints and limited volunteers. The findings of the spring 2004 study were inconclusive. Future monitoring studies are anticipated.

Similar to the Canandaigua Lake Project, the objective of this project was to address road mortality of herptiles specifically in response to a citizen concern rather than a capital project or regulatory need. This project, too, was conducted with maintenance forces and equipment, as well as volunteers. The resourcefulness of the maintenance staff to use scrap and surplus material is noteworthy. It took two days to install the pipe and another two-week period (not a fulltime effort) to install the drift fence. The collaborative efforts of NYSDOT, SUNY-ESF, and NYSDEC resulted in an inexpensive, field-designed, and quick solution.

Lessons Learned

There are several lessons learned from these projects. Firstly, the Department should establish a post-construction monitoring program prior to construction. NYSDOT has found that it is not feasible for agency forces to monitor the project after construction. Departments considering similar projects should explore partnering opportunities with other organizations (such as a local college or interested environmental group) to monitor the effectiveness of the project. Secondly, departments should anticipate the need for repairs and finishing touches, then plan accordingly. Though scheduled maintenance is working well, NYSDOT has found that each of the referenced projects needs repair or finishing on some sections.

Research

Though the quick, solution-oriented response to an identified herptile roadkill problem is commendable, NYSDOT recognizes the importance of research to guide and ensure well-informed decisions. To that end, NYSDOT developed and submitted a request for proposals in the fall of 2004 to initiate a research project exploring viable mitigation measures in the project process that address herptile crossings.

In the spring of 2005, SUNY-ESF was awarded a contract entitled "Effects of New York State Roadways on Amphibians and Reptiles: Research and Adaptive Mitigation Program." This research project is funded through the Federal Highway

Administration (FHWA) Statewide Planning and Research (SPR) program. The study duration is scheduled for four years; NYSDOT's share of the project cost is $189,000.

There are unresolved questions to which answers would facilitate better decision making. Dr. James Gibbs, SUNY-ESF, has articulated several of these questions for NYSDOT, such as:

- Is herptile roadkill really a problem for local populations?
- What mitigation structures will these animals actually use?
- What habitat factors are associated with road-crossing sites?
- Can these road-crossing sites be accurately predicted through habitat modeling?
- Can such models be built into geographic information system (GIS)-based transportation planning systems?

SUNY-ESF proposes an integrated research and adaptive mitigation program that addresses three primary objectives:

1. Document the impacts of transportation infrastructure on herptile populations.
2. Determine the landscape, local habitat, and architectural attributes of effective herptile crossing structures.
3. Employ habitat analyses to identify "connectivity zones" where crossing structures would be most appropriately deployed along New York State roadways.

In support of these objectives, the research team will conduct five integrated studies defined in these tasks:

i. Conduct literature review
ii. Evaluate effects of roadways on amphibian and reptile populations
iii. Assess the use and effectiveness of various crossing structures
iv. Determine the optimal field placement of functional crossing structures for amphibians and reptiles
v. Develop a GIS-based predictive model/expert system and planning toolbox

In the summer of 2005, SUNY-ESF graduate students initiated field studies. For Task ii, the investigators will perform field surveys of herptile populations at various distances from roadways to determine whether a "road effect" on populations occurs and, if it does, to estimate the width and breadth of the effect zone. To assess the use and effectiveness of the various crossing structures (Task iii), the investigators will create a behavioral choice "arena" that exposes many herptile test subjects to variations in crossing-structure type. The purpose is to identify those architectural attributes of crossing structures most associated with herptile usage and to develop a cost/benefit ratio (financial costs versus biological benefits) of various structure designs. Additionally, the investigators have commenced a literature review of road/herptile research.

Conclusion

NYSDOT prides itself as an agency committed to environmental stewardship and customer focus. The Department's actions outlined in this paper demonstrate these commitments. The Department's established environmental ethic and commitment to responding to public concerns are keys to success. Environmental staff working in the maintenance division provides on-the-ground forces to address environmental issues.

Additionally, maintenance forces that are willing to commit material, machines, and staff enable the Department to keep solutions cost-effect and simple. Forming partnerships with colleges, resource agencies, and environmental groups is essential to tapping into the necessary expertise and materials. Further research is needed to grasp the herptiles/road effect and develop solutions. Findings from the ongoing research undertaken by SUNY-ESF and funded by NYSDOT will facilitate the Department in making better-informed decisions to address concerns related to herptile road mortality.

Biographical Sketches: Debra Nelson joined the New York State Department of Transportation in 1992 and is the manager of the water/ecology section of the NYSDOT Environmental Analysis Bureau in Albany. Debra is a Certified Ecologist, a Professional Wetland Scientist, and a member of the Transportation Research Board's Task Force on Ecology and Transportation.

Mary Ellen Papin holds an M.S. degree in environmental science and a B.S. degree in biology. After working in the environmental-services field, Mary Ellen joined NYSDOT in 1994 as an environmental specialist. Since 2001, she has been the maintenance environmental coordinator for the Region 4 Transportation Maintenance Division.

Tim Baker has a B.S. in environmental science from Norwich University. Tim joined NYSDOT in 1998 after working for environmental services consultants. He is presently the maintenance environmental coordinator in NYSDOT's Region 3 office in Syracuse.

Science-Based Approach to Adaptive Management of the TCH Corridor: Canadian Rockey Mountain Parks

Anthony P. Clevenger (Phone: 403-760 1371, Email: tony.clevenger@pc.gc.ca), Senior Wildlife Biologist, Western Transportation Institute, Montana State University, P.O. Box 174250, Bozeman, MT 59717

Abstract: In November 1996, we began a long-term research project in Banff National Park (BNP), Alberta, Canada. Our primary study area is situated in the Bow River Valley along the Trans-Canada Highway (TCH) corridor in BNP, located approximately 100 km west of Calgary. The first 45 km of the TCH from the eastern park boundary (phase 1, 2, and 3A) is currently four lanes and is bordered on both sides by a 2.4-m-high wildlife-exclusion fence. The remaining 30 km to the western park boundary (phase 3B) is two lanes and unfenced. Between 2005 and 2007, approximately 12 km of phase 3B will be widened to four lanes with additional fencing and wildlife crossings. Twenty-two wildlife underpasses and two wildlife overpasses were constructed on the first 45 km between 1980 and 1998 to permit wildlife movement across the four-lane section of TCH.

The research carried out to date has provided science-based information for mountain park transportation planners and resource managers. The results have been uniquely used in development of Golder Associates' environmental-screening report (environmental-impact assessment) for Parks Canada's TCH phase 3B twinning project. Research of wildlife-crossing performance demonstrated that a longtime series of data is required to assess the function and performance of these critical cross-highway corridors accurately.

Recommendations from the Golder Associates' report for phase 3B strongly underscored the importance of continued, long-term monitoring of TCH mitigation measures in the Bow Valley. After 8 years of study, there still remain noteworthy areas of uncertainty regarding the effects or performance of the current mitigation on regional-landscape connectivity (demographic and genetic). The long-term cumulative effects (beyond 2020) of the phase 3B project and earlier twinning projects will hinge on the degree to which connectivity can be restored across the TCH.

Healthy functioning ecosystems require viable wildlife populations. Thus, it is critical to know the performance of crossing structures at the population level. Although intuitively these measures should enhance population viability, to date there have been no specific studies that actually address their population-level effects. Obtaining data on individuals in a population can be problematic because wide-ranging, fragmentation-sensitive species like bears typically occur in relatively low densities and have low reproductive rates. However, modern molecular techniques now make it possible to identify individual animals, their sex, and genetic relatedness with only a few hairs. These innovations could provide a powerful, relatively inexpensive, and noninvasive way to acquire critical information regarding genetic interchange facilitated by crossings without ever having to capture or see the animal.

This paper highlights:

1. Key research findings from the 8-year study
2. Mitigation myths that have been dispelled
3. Important lessons learned
4. Future research needs in the short and long term
5. Newly formed international, public-private partnership to meet many of the critical research questions needed for future management decisions

Upcoming Banff research will begin empirically assessing the conservation value of wildlife crossings in restoring landscape connectivity using population-level approaches and nonintrusive DNA-based methodologies.

Introduction

There are few places in North America where the intersection of transportation and wildlife corridors is as ecologically significant and received as much attention as Banff National Park's (BNP) Bow Valley. Banff and neighboring Yoho National Park in British Columbia are the only national parks in North America bisected by a major transportation corridor. More than 5 million visitors per year visit BNP, more than any national park in North America. The Trans-Canada Highway (TCH), the Canadian Pacific Railway mainline, built areas, and nodes of human activity have been recognized by Parks Canada as important landscape stressors to ecological integrity (Banff-Bow Valley Study 1996). Parks Canada's mandate is to maintain or enhance ecological integrity; therefore mitigating the TCH makes good ecological sense.

Transportation corridors present some of the most severe human-caused impacts in the Canadian mountain park ecosystem and in the entire Yellowstone-to-Yukon region. The amount of traffic a road carries can be a crude measure of its ecological impact (Forman et al. 2003). The summer average daily traffic volume of the TCH is 25,000 vehicles per day, with peaks of up to 35,000 (Parks Canada, unpublished data). The anticipated growth in population and projected highway improvement plans in the Rocky Mountain cordillera, coupled with the resounding concern for maintaining large-scale landscape connectivity will continue to generate interest in conservation tools and applications for addressing the diverse issues linking transport, ecology, and local communities.

Objectives

From 1996-2002, we conducted a long-term investigation in BNP. Our study focused primarily on the TCH, its permeability for wildlife, and effects in terms of wildlife mortality, movements, and habitat connectivity in the Bow River Valley. Means of mitigating road effects on wildlife were evaluated and recommendations made for future

transportation-planning schemes in the mountain parks. In 2005, with the formation of an international public and private partnership, we initiated a second phase of mitigation research in BNP's Bow Valley transportation corridor. The purpose of this article is threefold:

1. To show how science can be used in an adaptive-management process to guide transportation planning in Banff NP
2. To demonstrate how new scientific approaches may be used to further our knowledge of the design, monitoring, and evaluation of highway mitigation measures for wildlife populations in a regional landscape context
3. To describe an international public-private partnership for advancing road ecology in the Canadian Rocky Mountains

Study Area

Situated in southwest Alberta, BNP is approximately 120 km west of Calgary. Since the 1980s, fencing and wildlife crossings (overpasses and underpasses) have been installed along 45 of the 70 km of TCH in Banff (Woods 1990; McGuire & Morrall 2000). The mitigated sections of highway are referred to as phase 1, 2, and 3A. In 2005, expansion to four lanes with construction of fencing and nine wildlife crossings began on a 12-km section west of phase 3A near Lake Louise (phase 3B).

BNP highway mitigation is the only large-scale complex of wildlife-mitigation passage structures in the world. There is no other location with as many and as diverse types of wildlife-crossing structures or accompanying data on wildlife distribution, movement, and ecology. Besides having exceptionally diverse forms of wildlife-crossing structures (five designs) set in the landscape over two distinct time periods (recent structures built in 1997 and older structures built in the mid-1980s), Banff mitigation research can boast of having the world's longest year-round monitoring program and the most information on passage use by wildlife (9 years in November 2005). This alone has allowed the mitigation research in Banff to be on the leading edge of investigations regarding the effectiveness of highway-mitigation passages in maintaining landscape connectivity.

Banff National Park: Highway Mitigation Research, 1996-2002

Our mitigation research between 1996 and 2002 had three objectives:

1. To characterize road mortality of wildlife in the mountain parks (see Gunson et al, this volume)
2. To evaluate performance of the TCH mitigation measures
3. To use the empirical data from our study for planning phase 3B mitigation (see Clevenger et al. 2002)

Research Results, 1996-2002

The results from our research have been disseminated in a variety of venues. Some results have been published in previous ICOET (and ICOWET) proceedings between 1998 and 2003. A total of 13 articles have been published in peer-reviewed scientific journals (e.g. Biological Conservation, Journal of Applied Ecology, Conservation Biology). A comprehensive account of our research, methods, results, and management recommendations can be found in Clevenger et al. (2002).

The long-term monitoring has demonstrated its multipurpose utility in meeting transportation and resource-management needs. Monitoring data from the 24 wildlife crossings has aided BNP management in fulfilling a key objective of the BNP management plan–restoration of corridors and predator-prey relationships. The weekly monitoring has served as a bellwether and indicator of wildlife population status and trends, emulating one long, multi-species population-monitoring transect.

How have the research results been used in an adaptive-management process? In many ways, from removing one-way gates because animals could get through them to implementing our research-based recommendations on phase 3B (Clevenger et al. 2002).

The most novel and comprehensive use of our data was the environmental assessment of phase 3B by Golder Associates (see Jalkotzy, this volume). The Golder report predicted impacts and mitigation performance for phase 3B, using empirical data from our research on previous TCH mitigation phases and using valued ecosystem components (VECs, or indicator species) to evaluate road-mortality reduction and connectivity potential, i.e. performance of proposed wildlife crossings.

Although the Banff research data Golder used spanned 6 years, it is not complete and there are knowledge gaps. The research results are unable to tell us everything we need to know about mitigation performance with high precision and detail. Therefore, Golder concluded "the long-term cumulative effects of TCH mitigation will depend largely on the degree which connectivity can be restored across the TCH."

Pilot Study: Population-Level Study of Wildlife Crossings

There are many superlatives to describe Banff's Bow Valley, which also represents one of the world's best mitigation testing sites. There is a need for consistent evidence of performance and effects of wildlife crossings to support their continued and growing implementation by transportation and resource agencies.

Some important and unanswered research questions worth asking that would help management are:

1. For a given suite of wildlife crossings, what is the general level of connectivity occurring?
2. For a regional landscape with mitigation crossings, how much connectivity is necessary to maintain viable populations?
3. In other words, what are the population-level benefits of having wildlife crossings in place? To get at this population-level question, we began a pilot study in 2004 (Clevenger 2004, 2005a). Traditional means of study using mark-recapture and radio telemetry are extremely costly (even for single-species). Capturing an adequate sample of individuals is difficult logistically and is intrusive.

Today, advances in molecular technology and tools provide for DNA-based techniques that are low-cost, non-intrusive, and allow for greater sampling of individuals within populations of multiple species. Furthermore, compared to mark-recapture/telemetry methods for a single-species study, sampling DNA non-invasively allows for much greater sampling success within the population. Obviously, using one technique over the other depends on your research question, but for measuring genetic and demographic connectivity at crossings, the DNA-based technique shows great promise.

If animals could write their names, tell who are their relatives were, and how far they were from home, our problems would be solved. Since they are unable to do so, we began mitigation testing a technique where animals leave a bit of DNA (hair) when passing through an underpass. The Woodcock Foundation funded this testing.

The first year (2004) of the pilot study consisted of "research and development," where we tested different configurations and evaluated how animals responded to these configurations (Clevenger 2004, 2005a). We had varying degrees of success and response for each species; obviously some species can avoid hair-snagging devices quite easily. For several reasons, we decided our system should be targeted at bears (Clevenger 2004, 2005a). At the end of summer 2004 we felt confident that we had developed the best system for capturing hair from bears using underpasses.

Our pilot study took place at two of the Banff open-span underpasses (Healy, Duthil). The system consisted of two strands of barbed wire intertwined with a high-adhesive string and strung at a height of 35 and 75 cm above the ground (Fig. 1(a)). The barbed wire/sticky strings were securely fastened to a metal post staked to the ground. We placed the barbed wire/sticky string under one of the underpass structures (Fig. 1(b)). At a distance of 20-25 m from the barbed wire, we placed infrared sensors that activated video cameras when animals entered the underpass and broke the infrared beam. During nighttime hours, the system was configured to turn on infrared lights to illuminate the underpass.

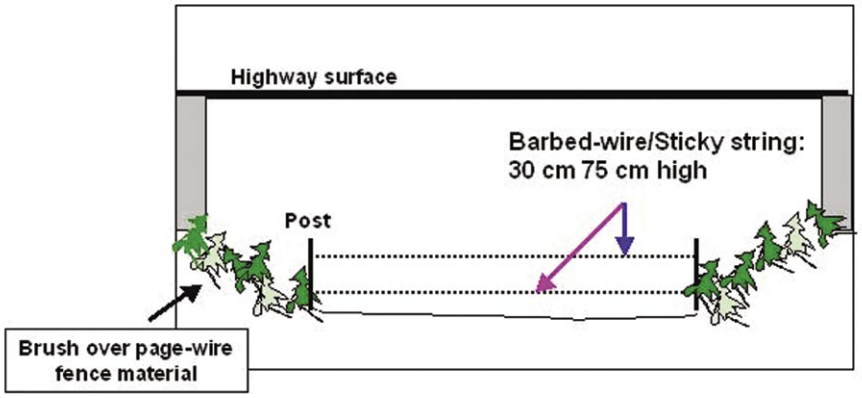

Figure 1(a). Ground-level view of DNA/hair sampling system at Banff underpasses.

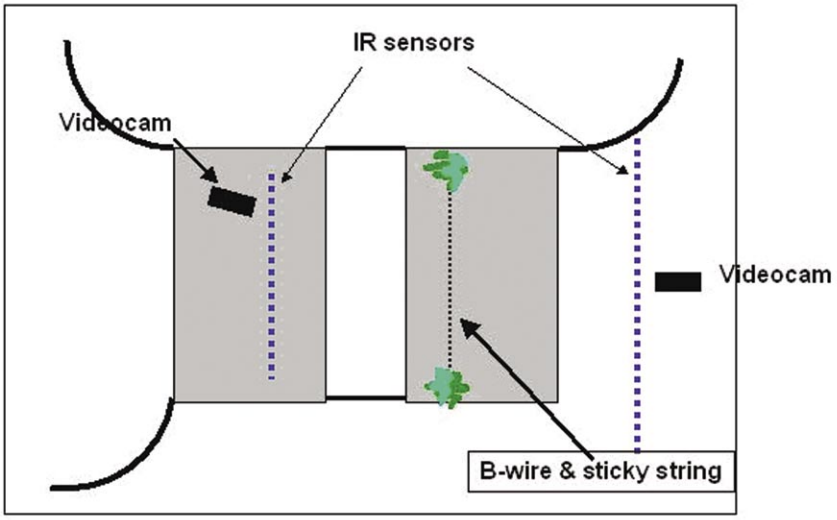

Figure 1(b). Aerial view of DNA/hair-sampling system at Banff underpasses and videocamera monitoring components. IR = infrared; B-wire = barbed wire.

The aim of our 2004-05 pilot study was to test the efficacy of the DNA/hair-sampling system to obtain hairs of passing large carnivores, primarily bears, when using the underpasses. We did this by quantifying the number of approaches, the behavior of animals entering the underpass (avoidance/turnaround or pass-through), and if they passed through, how successful were we at obtaining hair. When hair captures failed the results of video monitoring provided reasons why animals did not leave hair behind. Our 2005 field season ran from May to mid-August (3.5 months of monitoring). We checked the two underpasses daily and collected information on animal use of the underpass and DNA/hair-sampling success from racked trackpads, video cameras, and the hair-sampling system.

Results

There were a total of 56 approaches to the two underpasses by large carnivores; 43 approaches were by bear species (24 black bears, 19 grizzly bears; Table 1). Bears turned around or avoided the underpasses less than 10 percent of the time (two of 24 black bears and one of 19 grizzly bears turned around or avoided the underpasses). The hair-capture success rate was high for both bear species; more than 90 percent of the time, bears passing through the underpasses left hair. For grizzly bears, we were able to capture hair 94 percent of the time that they used the underpasses. Cougars can easily jump over the DNA/hair-sampling system, but in 2005 cougars used the underpasses five times. In three out of the five times (60 percent) that cougars used the underpasses, we obtained hair samples. Single wolves avoided the underpasses the first four times approaching; but each time one lone wolf successively came closer to the DNA/hair-sampling system. On the fifth and subsequent approaches, the wolf passed through the hair-sampling system. We obtained hair samples from the wolf during 3 of 5 (60 percent) times they used the underpasses.

Table 1. Summary data from 2005 pilot DNA/hair-sampling study in Banff National Park. Field study ran from May to mid-August 2005.

	N-approaches	N-Avoids (%)		Pass/No hair (%)	Pass/Hair (%)
Black bear	24	2 (8)		4 (18)*	18 (82)**
Grizzly bear	19	1 (5)		1 (5)	17 (94)
Subtotal	**43**	**3 (7)**		**5 (12)**	**35 (88)**
Wolf	9	4 (44)		2 (40)	3 (60)
Cougar	5	0 (0)		2 (40)	3 (60)
TOTAL	**56**	**7 (12)**		**9 (18)**	**41 (83)**

* Percent not including cubs.

** 91 percent not including cubs.

Application of DNA-Based Approach for a Population-Level Study

How might this particular DNA-based technique be used at wildlife crossings to help answer the important and unanswered research questions earlier?

The DNA/hair-sampling technique provides genetic and demographic data from individuals using the wildlife crossings, i.e., the individuals that are contributing to gene flow and demographic interchange between two populations that are hypothetically separated by a road or highway (in our case, the Trans-Canada Highway).

This is excellent information on ecological connectivity by itself. Even alone, some indices of connectivity could be determined to aid in assessing the conservation value of wildlife crossings. Yet a more realistic and comprehensive assessment of conservation value and population-level benefits of wildlife crossings could be obtained by contrasting DNA/hair-sampling data from crossings with background DNA data from the entire population. This could be done by using a common DNA/hair-sampling technique that consists of barbed wire around baited sites (Boulanger and McLellan 2001). These two sources of information (obtained from the crossings and the population) would allow for the determination of the type of connectivity (Clevenger 2005b) that is contributing to viable populations and healthy, functioning ecosystems.

An alternative to conducting a field-based study of wildlife-crossing performance at the population level is to model our desired performance criteria (viable populations). This can be done using models that account for variable (not static) landscape conditions, including accurate demographic parameters and real data on animal crossing frequencies and their response to different crossing types (e.g. see Clevenger and Waltho 2000, 2005). Modeling of this type, using readily available software such as RAMAS/GIS (Akcakaya 1998), can provide scenarios of varying highway/wildlife-crossing permeability, aid in assessing their conservation value, and provide a range of connectivity or permeability values that are needed to maintain viable populations.

An International Public-Private Partnership

How can we make studies of this type happen? Carrying out this work will require funding and support from not only Parks Canada, but also other external institutes and organizations.

A partnership was formed in February 2005 between public and private interests (agencies, institutes, and foundations) with the goal of promoting the integration of ecology into sustainable transportation systems and furthering road-ecology research in the Canadian Rocky Mountain parks.

A three-year program has been developed that consists of three main components: research, technology transfer, and education. The first component (research) will consist of field-based studies, analyzing existing and new data, and modeling. Research is the 'foundation' of the program we envision. The second component (technology transfer) addresses the 'current needs' of local transportation planners and land managers in the mountain parks, as well as beyond the park boundaries. This will be carried out by effectively disseminating science-based information through scientific publications, international conferences, workshops, and developing guidelines for management. The last component (education) is equally important as those above, and has the aim of educating future generations of transportation engineers and road ecologists. This will be achieved through university-based collaborations (graduate and postgraduate level research), professional development courses, and public education. The latter is critically important in influencing political change.

Conclusions

Sound scientific research needs to be the basis for management decisions in transportation and natural-resources management. Having proper funding mechanisms in place and adequate budgets to carry out research in road ecology is critically important, but probably never more urgent than today.

Transportation programs and projects are advancing forward at a rate much faster than the rate of collection of science-based data needed to properly inform and guide. More political and agency support for ecological research in transportation will make everyone's job easier, streamline processes, and (most importantly) begin building more-sustainable transportation systems.

Biographical Sketch: Tony Clevenger is a senior wildlife biologist at the Western Transportation Institute at Montana State University. In 1996, he was contracted by Parks Canada to carry out longterm research assessing the performance of mitigation measures designed to reduce habitat fragmentation on the Trans-Canada Highway in Banff National Park, Alberta, Canada.

Tony is currently a member of the U.S. National Academy of Sciences Committee on Effects of Highways on Natural Communities and Ecosystems. Since 1986, he has published over 40 articles in peer-reviewed scientific journals and has co-authored three books including, Road Ecology: Science and Solutions (Island Press, 2003). Tony has worked as a research wildlife biologist for the World Wide Fund for Nature–International (Gland, Switzerland), Ministry of Environment–France (Toulouse), U.S. Forest Service, and U.S. National Park Service.

Tony is a graduate of the University of California, Berkeley, has a master's degree in Wildlife Ecology from the University of Tennessee, Knoxville and a doctoral degree in Zoology from the University of León, Spain. He is currently an adjunct assistant professor at the Department of Ecology, Montana State University. He lives year-round outside Banff National Park.

References

Akcakaya, H.R. 1998. RAMAS/GIS: Linking landscape data with population viability analysis, version 3.0. Applied Biomathematics, Setauket, New York.

Banff-Bow Valley Study. 1996. Banff-Bow Valley: at the crossroads. Summary report for the Banff-Bow Valley Task Force. Canadian Heritage, Ottawa, Ontario.

Boulanger, J. and B. McLellan. 2001. Closure violation in DNA-based mark-recapture estimation of grizzly bear populations. Canadian Journal of Zoology 79: 642-651.

Clevenger, A.P. 2004. Pilot study: DNA profiling to identify individuals using wildlife crossings. Final report to Woodcock Foundation. New York.

Clevenger, A.P. 2005a. Population benefits of wildlife crossings using DNA methods. Transportation Research Board ADC10 (Environmental Analysis in Transportation), August 2005: 6-7.

Clevenger, A.P. 2005b. Conservation value of wildlife crossings: measures of performance and research directions. GAIA 14:124-129.

Clevenger, A.P. and N. Waltho. 2000. Factors influencing the effectiveness of wildlife underpasses in Banff National Park, Alberta, Canada. Conservation Biology 14:47-56.

Clevenger, A.P. and N. Waltho. 2005. Performance indices to identify attributes of highway crossing structures facilitating movement of large mammals. Biological Conservation 121:453-464.

Clevenger, A.P., B. Chruszcz, K. Gunson, and J. Wierzchowski. 2002. Roads and wildlife in the Canadian Rocky Mountain Parks–Movements, mortality and mitigation. Final Report. Report prepared for Parks Canada, Banff.

Forman, R.T.T., D. Sperling, J. Bissonette, A. Clevenger, V. Dale, L. Fahrig, R. France, C. Goldman, K. Heanue, J. Jones, F. Swanson, T. Turrentine, and T. Winter. 2003. Road ecology: Science and solutions. (Island Press, Washington, D.C.).

McGuire, T.M. and J. F.Morrall. 2000. Strategic highway improvements to minimize environmental impacts within the Canadian Rocky Mountain national parks. Canadian Journal of Civil Engineering 27: 523-32.

Woods, J.G. 1990. Effectiveness of fences and underpasses on the Trans-Canada highway and their impact on ungulate populations. Report to Banff National Park Warden Service, Banff.