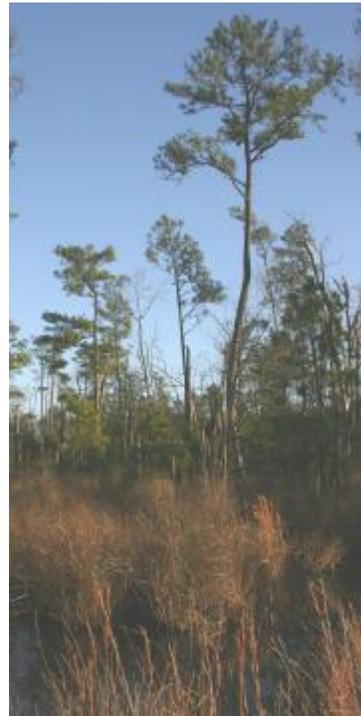
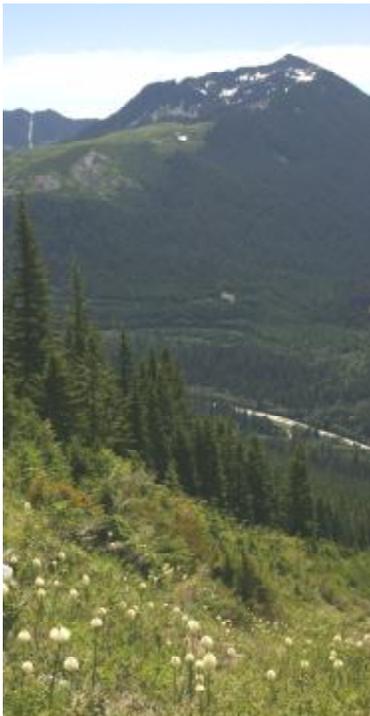




Linking Conservation and Transportation: Using the State Wildlife Action Plans to Protect Wildlife from Road Impacts



This report was supported by
The Doris Duke Charitable Foundation
and Surdna Foundation



This report was made possible with the generous support of
The Doris Duke Charitable Foundation and Surdna Foundation.



ABOUT DEFENDERS OF WILDLIFE

Defenders of Wildlife is a national, nonprofit membership organization dedicated to the protection of all native wild animals and plants in their natural communities.

AUTHORS

Patricia White, Defenders of Wildlife
Julia Michalak, Defenders of Wildlife
Jeff Lerner, Defenders of Wildlife

RESEARCH

Jesse Feinberg, Defenders of Wildlife

PRODUCTION

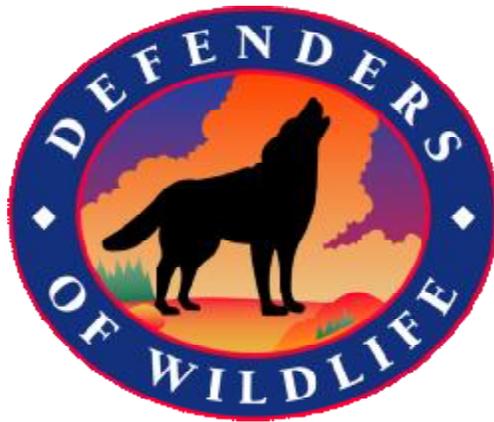
Kassandra Kelly, Defenders of Wildlife
Allison Barra Srinivas, Defenders of Wildlife

COVER PHOTOGRAPHS

- Sam Hancock
- Courtesy of California4Life and Flickr.com
- Courtesy of Parks Canada
- Julia Michalak

© 2007 Defenders of Wildlife
1130 17th Street NW
Washington D.C. 20036
202.682.9400
<http://www.defenders.org>

**Linking Conservation and Transportation:
Using the State Wildlife Action Plans to Protect Wildlife from
Road Impacts**



DEFENDERS OF WILDLIFE
Washington D.C. • May 2007

TABLE OF CONTENTS

Executive Summary	1
Wildlife and Roads	5
Why Link Conservation and Transportation Planning?	5
SAFETEA-LU Section 6001	6
How can the State Wildlife Action Plans help?	6
How did the State Wildlife Action Plans address Transportation Planning?	7
Threat Summary.....	8
Alteration of the physical environment.....	10
Mortality from road collisions.....	11
Modification of animal behavior	12
Alteration of the chemical environment	13
Spread of exotic species	14
Increased human use of an area	15
Mortality from construction.....	15
Action Summary.....	16
Spatial Actions and Transportation Planning.....	17
Linking Transportation and Conservation	20
Transportation Planning Process	20
Best Management Practices	25
Vegetation Management	29
Partners in the Transportation Planning Community.....	31
State Transportation Agencies (Departments of Transportation - DOTs).....	31
Metropolitan areas over 200,000 people.....	31
Cities over 50,000 people	31
Small communities and counties	31
Interagency Coordination.....	32
Connecting Transportation and Land Use Planning.....	35
Recommendations for Starting a Cooperative Transportation Planning Program	37
Learn the Transportation Planning Process.....	37
Provide Meaningful Technical Assistance.....	38
Target Education Strategically.....	39
Increase Capacity.....	40
Conclusions	42
Literature Cited	43
Appendix A: Annotated Bibliography of Relevant Transportation Planning Resources ..	45

EXECUTIVE SUMMARY

The placement and design of transportation infrastructure has significant impacts on wildlife and biodiversity protection. Most obviously, roads, highways and vehicle travel cause immediate mortality through vehicle collisions. However, roads also destroy and fragment habitat, increase air and water pollution loads, spread invasive species, modify animal behavior and increase human access to previously remote areas (Trombulak and Frissell 2000). Scientists can measure these impacts up to 100 meters from the road's edge (Forman et al. 2003). As a result, researchers estimate that each mile of highway has measurable effects on 48 acres of habitat (Council on Environmental Quality 1974) and, collectively, our transportation system negatively affects one fifth of the land area in the United States (Forman et al. 2003).

Habitat loss, degradation and fragmentation are widely viewed as among the most significant causes of species imperilment in the United States (Wilcove et al. 1998). The Endangered Species Act currently lists 1,878 species as either threatened or endangered. However, an additional 15,000 species in the United States are considered globally "at risk" by conservation organizations (NatureServe 2006). It makes both economic and ecological sense to protect these at risk species before they reach the point of endangerment. The transportation planning process offers an important opportunity for proactive conservation work. If transportation planners have information and technical assistance about important conservation resources, they can do a better job of avoiding impacts to important areas and minimizing or mitigating unavoidable impacts.

Enacted in 2005, section 6001 of the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU) requires that transportation planners consult with available conservation and biodiversity plans during their long-range planning process.

As of October 2005, every state in the U.S. completed a State Wildlife Action Plan aimed at assessing conservation needs for at risk species. The development of these Action Plans means that all states, the District of Columbia and all U.S. territories have biodiversity plans that can inform transportation and help fulfill the section 6001 planning requirements.

We reviewed the Action Plans from all 50 states and the District of Columbia to determine to what extent they identify roads and highways as a threat to wildlife and how they can be used to help alleviate that threat. We searched each of the Action Plans for references to transportation key words including roads, highways and vehicles. We then coded each reference into a series of threat and action themes and identified commonalities across all Plans.¹

We found that all 51 Action Plans recognized that roads and highways have a negative impact on wildlife. Eleven states indicated that transportation infrastructure constituted a priority statewide threat (AK, AL, AR, DC, FL, MI, NH, OR, SD, VA and VT); eight states prioritized transportation infrastructure as a threat to particular regions, habitats or species taxa; and TX and WY strongly emphasized transportation threats (see Map 1 on page 8).

¹ Our report focuses on public highways that are built and maintained by county, state and federal agencies and used by the general driving public. We excluded references to the impacts of logging roads, off road trails, illegal roads or roads built to facilitate oil and gas exploration from our analysis.

In most of these passages, states referenced transportation infrastructure as part of larger-scale issues like habitat fragmentation and general development. The remaining 30 states did not rank or emphasize transportation infrastructure as a threat to wildlife. In contrast, Defenders' found that 37 states identified development as a significant issue either statewide or to a particular region or habitat type within the state (Michalak and Lerner 2007).

Collectively, the Action Plans included references to all seven categories of ecological effects of roads on wildlife as identified by Trombulak and Frissell (2000): alteration of the physical environment (referenced by 48 Plans), mortality from collisions (35 Plans), behavior modification (31 Plans), alteration of the chemical environment (28 Plans), increased invasive species (21 Plans), increased human use of area (9 Plans) and mortality from construction (6 Plans). The Plans called attention the transportation network's contribution to habitat loss and fragmentation, mortality from vehicle collisions, barriers to migration and dispersal, pollution through runoff, salt and exhaust, spreading invasive plant species and increased recreation use.

We also reviewed the Plans to determine the actions that the states propose to address transportation threats. Using these references, we identified a series of action themes which we grouped into the following categories: improve interagency coordination, integrate planning efforts, design roads to minimize impacts, apply vegetation management, continue research and monitoring efforts, protect land, educate the public and increase capacity. More Plans included actions relating to coordination with transportation planners

than any other action category. Congress required the states to include "plans for coordinating the development, implementation, review, and revision of the State Comprehensive Wildlife Comprehensive Plan [Action Plan] with Federal, State, and local agencies and Indian tribes that manage significant land and water areas..." (US FWS 2001).

Although the majority of Action Plans identified actions to improve coordination and integration of transportation planning and biodiversity conservation, almost none identified specific points in the transportation planning process where this integration could take place. Only 13 Action Plans indicated that transportation planners were either invited or in fact participated in the Action Plan's development.

Transportation planning is an extremely convoluted and extensive process. It will help resource agencies and conservationists significantly to have a firm understanding of all phases of transportation planning in their state. Traditionally, resource agencies and biologists get involved with a transportation project during the permit review and environmental assessment stages. At this late stage, making significant changes means delays, added costs and usually little environmental benefit. Instead, state wildlife agencies and other conservationists can have a far more productive and effective influence by getting involved during both long and short range planning. The former covers a 20 year time

horizon while the latter focuses on the next 2-5 years. Working with planners at these stages can help ensure that especially damaging projects are either removed or noted before significant resources are dedicated to a specific project. Transportation planning revolves around maps and spatial analysis. In order to work effectively with transportation planners, natural resources agencies will need to provide them with spatially explicit data.

Twenty-five states included maps of priority conservation areas in their Action Plan. Only eight states included sharing spatial data with transportation planners as an action. This stands in sharp contrast to the 39 states that included sharing spatial data with land use planners as an action to help address sprawl and development impacts.

The recently authorized section 6001 of SAFETEA-LU has significant implications for implementation of the Action Plans.

The requirement for comparing conservation and transportation plans offers an opportunity for a proactive, non-regulatory approach to reducing transportation impacts. In addition, SAFETEA-LU authorizes transportation agencies to fund liaison staff positions, invasive species control and further planning. Finally, transportation mitigation funding for unavoidable impacts can provide much needed dollars for land protection and restoration.

Based on the findings in this report, we have identified a set of implementation recommendations for natural resource agencies interested in getting more involved in transportation planning. These include:

Learn the Transportation Planning Process: Transportation planning is a complicated

process that involves scores of planners and occurs over long time frames. Understanding the various phases of this process and being familiar with the time frames and deadlines for transportation planning in your state will be essential in order to engage transportation planners effectively. This report offers a very general overview of transportation planning. To learn more about transportation planning, talk with your state transportation agency and review some of the literature highlighted in Appendix A of this report.

Provide Meaningful Technical Assistance: Transportation planners are likely to have little to no background in wildlife conservation. Wildlife agencies and conservationists can play a significant role by providing meaningful technical assistance. In the case of transportation, this means sharing spatial data for priority species, habitat and conservation area locations with planners. Transportation planners absolutely rely on maps and spatial analysis to do their planning and will have significant difficulty using non-spatial data. In addition, resource agencies can create sustained and consistent partnerships between transportation and natural resource planners. Doing so will ensure that transportation agencies have a trusted contact they can access reliably for questions and assistance.

Target Education Strategically: Target elected officials, metropolitan planning organizations and long-range transportation planners to inform decision makers about the impacts of roads on wildlife and ecosystems. Wildlife agencies can provide workshops and training sessions about biodiversity and how transportation planners can use their State Wildlife Action Plan as a guide for protecting biodiversity.

Increase Capacity: Keeping on top of transportation planning, new projects, public involvement and conservation needs relating to road and highways is a full time job. Luckily, the federal government provides billions of dollars to the states for transportation planning and construction. The state agencies are authorized to use part of that funding to create joint positions with resource agencies, research transportation impacts and best management practices and further conservation and transportation planning efforts. Furthermore, the strategic use of mitigation dollars for priority land conservation and habitat restoration can provide a much needed boost to existing conservation resources. Given the resources available, every state should have natural resource staff engaged in transportation planning.

The State Wildlife Action Plans are officially known as Comprehensive Wildlife Conservation Strategies (CWCS). Several states have chosen unique names like Florida's Wildlife Legacy Initiative and Nebraska's Wildlife Legacy Project. This report refers to all the Plans as State Wildlife Action Plans (SWAPs) or simply as Action Plans or "State Plans."

WILDLIFE AND ROADS

That roads have a negative impact on wildlife is no surprise to any American who has traveled the vast network of highways in the United States. Drivers and passengers across the U.S. risk collisions with wildlife of all types and sizes every day that they drive. In the case of large animals, these collisions threaten not only the animal's life, but the human passengers' as well. In addition to posing a significant hazard to drivers, wildlife-vehicle collisions can contribute to species level decline. In spite of the efforts by many organizations and policymakers to reverse declines among native animals and plants, the list of species at risk continues to grow. There are currently 1,878 species listed as threatened or endangered under the Endangered Species Act (USFWS 2006), but an additional 15,000 species are considered globally at risk in the United States (NatureServe 2006). The familiar mortality from wildlife-vehicle collisions can be a significant contributor to this decline.

Habitat loss and fragmentation from road construction is a more insidious, although less readily apparent, threat to biodiversity. After more than a century of road building, the United States is covered with over four million miles of pavement, adding 5,500 new miles every year. For each mile of highway, up to 48 acres of habitat is destroyed (Council on Environmental Quality 1974). With only 40% of the historic native vegetation remaining (Bryer et al. 2000), habitat loss, fragmentation, and degradation are the leading causes of species imperilment in the United States (Wilcove et al. 1998). Urban development in particular consumes 2.2 million acres across the country every year (NRCS 2000), much of it wildlife habitat.

The ecological impacts of our transportation system extend beyond the boundary of the roads themselves. Roads can alter animal

behavior by causing animals to shift their home range, changing migration patterns, altering reproductive success, affecting escape responses and influencing an animal's physiological state (Trombulak and Frissell 2000). Research shows that impacts, such as traffic noise that disrupts avian nesting behavior, can be measured over 100 meters from the road's edge (Forman et al. 2003). Roads lead to habitat degradation by increasing pollution run off, reducing water quality and facilitating the spread of invasive species (Trombulak and Frissell 2000). Based on these far reaching effects, researchers estimate that our transportation system negatively affects one fifth of the land area in the United States (Forman et al. 2003).

Why Link Conservation and Transportation Planning?

There are two mechanisms for reducing the impacts of roads on wildlife: 1) alter the design of existing roads to facilitate safe wildlife crossings and reducing surrounding environmental impacts, and 2) proactively incorporate wildlife into transportation planning so that new roads avoid sensitive areas and habitats to begin with. As we enter the 21st century, we are well equipped with the science and technology to achieve these goals. What we do need is a new level of cooperation between wildlife agencies, conservation advocates and transportation planners. Transportation planning provides a key opportunity for conservationists to influence where roads are built, how they are designed and how effectively transportation agencies mitigate for unavoidable impacts.

Successfully designing a transportation system to have minimal impacts on wildlife requires that conservationists get involved in the early stages of planning. Long-range transportation planning extends over a 20 year time horizon with periodic updates every few years.

Traditionally, environmental concerns are addressed during the environmental review process near the end of a project's approval. At this point, the transportation agency and associated land use planners have invested significant resources in the project and it is difficult and costly to change course in any meaningful way. If wildlife biologists can participate in the *early* stages of transportation planning, they have a better chance of influencing transportation policy successfully.

SAFETEA-LU Section 6001²

The need for greater coordination between transportation planning and environmental protection was confirmed by the most recent federal transportation bill. In 2005, the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU) was signed into law, funding the nation's highway program through 2009 with \$265 billion in federal funding. In the final bill, Congress included provisions that require transportation planners to consider wildlife conservation early in the transportation planning process. Under new law, each metropolitan planning organization (MPO) and state department of transportation (DOT) must consult with federal, state, tribal and local land use management, natural resources, wildlife, environmental protection, conservation and historic protection agencies while developing their long range transportation plans. The law states, "**Consultation under clause (i) shall involve comparison of transportation plans to State and tribal conservation plans or maps, if available, and comparison of transportation plans to inventories of natural or historic resources, if available.**" Each plan will include a discussion of the type and location of potential mitigation activities that will offset unavoidable environmental impacts resulting from the proposed transportation development.

These provisions constitute a revolutionary change in transportation law, with the potential to protect millions of acres from unplanned development and provide funding to restore

habitat connectivity, relieve traffic pressure on our public lands and prevent the spread of roadside invasive species. For the first time in history, wildlife conservation will be one of the first factors considered in transportation planning, rather than the last.

How can the State Wildlife Action Plans help?

As part of the federal State Wildlife Grants Program, each state and U.S. territory was required to complete a comprehensive wildlife conservation plan (Action Plan) that addresses species of greatest conservation need and their major threats. For the Action Plan development and implementation, Congress required the wildlife agencies to coordinate with other government agencies and land managers and to use extensive public involvement. The intent was for the Action Plans to be the best available and most complete compilation of conservation information in each state. Although there are no doubt missing data sets, the Action Plans are a valuable central resource for conservation information.

The Action Plans provide an especially significant opportunity for states to adopt a proactive approach to transportation planning. SAFETEA-LU section 6001 provides the incentive for transportation agencies to work with wildlife agencies early on in the planning process. For the first time, transportation agencies will have access to comprehensive natural resource data at the planning stage, rather than waiting until environmental review. The State Wildlife Grants Program has ensured that every part of the United States currently has a conservation plan available to compare with transportation plans.

In addition to providing critical information to transportation planners complying with SAFETEA-LU, the Action Plans can also raise awareness about road impacts on wildlife, coordinate conservation activity among state, regional and local agencies and conservation organizations and identify solutions to transportation/wildlife conflicts.

²<http://www.defenders.org/habitat/highways/safetea/safetea.pdf> 6

HOW DID THE STATE WILDLIFE ACTION PLANS ADDRESS TRANSPORTATION PLANNING?

As part of the State Wildlife Grants program, Congress required the states to address certain elements in their Action Plans. The elements most relevant to transportation planners and SAFTEA-LU are the identification of species of greatest conservation need, priority habitats, conservation threats and actions to address those threats. The Plans presented some of this information spatially and 25 states included maps of priority conservation areas. In addition, the states are required to coordinate the development and implementation of their Plans with federal, state and local agencies that manage significant lands and waters in their state or whose activities have an impact on wildlife. Therefore, the Plans can not only provide transportation planners with lists of priority species and habitats, but also suggest road design and landscape level planning best practices that will reduce the impacts of roads on wildlife.

To identify transportation issues and themes across all states, we searched the Plans from all 50 states and the District of Columbia for references to transportation, roads, highways, and vehicles. We then coded each passage for threat and action themes and consolidated the codes into broad categories. Our report focuses on public highways that are built and maintained by county, state and federal agencies and used by the general driving public. We excluded references to the impacts of logging roads, off road trails, illegal roads or roads built to facilitate oil and gas exploration from our analysis. Many states discussed these important issues and we highly recommend that a similar assessment be done for these other road types. We only used threats and actions that were clearly linked with transportation in the text. For example, although virtually all the plans

included acquisition as a general conservation action, it was only included in this analysis if it was clearly proposed in response to transportation development as a threat.

Transportation planning is tightly wedded to land use planning and residential and commercial development. Residential and commercial development patterns and intensity strongly influence a community's transportation needs and there is broad consensus that newly constructed roads can encourage additional development (Moore and Thorsnes 1994). It is possible that states implied transportation infrastructure in their discussions of general development threats. Although we excluded passages that did not specifically mention transportation or roads, Defenders completed a separate report that analyzes how the Plans address land use planning and residential and commercial development impacts. We conducted separate analyses of transportation and land use issues because they are both critical issues individually and because the actions to address each differ. The land use report found that all 51 Plans included development as a threat and 37 Plans indicated that it was a significant concern. We encourage readers to view these reports together to get a more comprehensive picture of how the Action Plans can help address overall development threats.

We categorized threat passages according to the seminal article, *Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities* by Stephen Trombulak and Christopher Frissell (2000). None of these effects (see Table 1) occur in isolation and the presence of a road will ultimately lead to many or even all of these impacts. As a result, we coded each threat

reference for as many of the threat categories as was appropriate. For instance, by altering the physical and chemical environment, roads facilitate the spread of invasive species. Due to increased human activity, some wildlife species may modify their behavior and avoid otherwise suitable habitat near roads.

Table 1 Transportation Threat Categories

Transportation Threat Category (number of Plans referencing each category)	Category Description
Alteration of the physical environment (48)	This category includes references to habitat loss and fragmentation, impacts to hydrologic regimes, increased sedimentation of waterways and changes in heat or noise levels.
Mortality from collisions (35)	Related references included roadkill, road related mortality or vehicle collisions.
Behavior modification (31)	This category includes references to roads as barriers to wildlife movement, dispersal, or migration (for either terrestrial or aquatic species), disruption of social structures, reduced reproductive success or reduction in overall fitness.
Alteration of the chemical environment (28)	These Plans included references to road salt application, pollution run-off from non-point sources or due to contaminants such as oil, gasoline, metals or other chemicals.
Increased Invasive Species (21)	This category includes references to the connection between roads and invasive species. States in this category noted that roadsides disturbed by road construction frequently provide ideal conditions for spreading invasives. In addition, some transportation agencies have or still do actively plant fast growing non-native species to stabilize slopes along roads.
Increased human use of area (9)	A few Plans recognized that roads facilitate human access to adjacent areas. The presence of a road can encourage residential or commercial development or increase access for people interested in recreation, poaching or overexploitation of hunted or fished species.
Mortality from construction (6)	A few Plans referred to habitat degradation from road construction activities that cause erosion or sedimentation.

Alteration of the physical environment

Forty-eight states linked transportation infrastructure to alterations of the physical environment. Roads destroy and fragment the habitat wherever they are built and transform the environment well beyond the pavement's edge. At ground level, soil water content and density change leading to altered surface-water flow, run off patterns and sedimentation. By opening the canopy and removing vegetation, the amount of light and heat increases.

Additional light invites different plant species,

often replacing native communities. Road surfaces store heat, creating heat islands that attract species like birds and snakes. Traffic stirs up dust and other contaminants that settle on plants, blocking necessary processes like photosynthesis and transpiration. In addition, traffic noise can make roadside areas inhospitable to certain nesting songbirds (Forman and Deblinger 2000).

References to Alterations to the Physical Environment

Arizona: "Roads contribute to habitat fragmentation and are linked as well to other major habitat altering factors such as timber removal, fire ignition and suppression, fuel wood collection, and recreation" (pp. 71).

Florida: "Roads were identified as one of the most critical sources of many of the stresses identified for terrestrial, freshwater, and marine systems in Florida. Not only do roads have direct effects on habitat destruction, fragmentation, sediment movement, hydrological and fire regimes, etc., but they also exacerbate development and conversion effects. Thus, the ecological effects of roads far exceed their footprint across habitats" (pp. 459).

Michigan: "Priority Threats: Altered sediment loads - accelerated erosion from human sources has been described as the most significant cause of pollution in the Midwest region (Waters 1995). Poor soil erosion control methods during construction and other earth disturbing activities, operation of hydropower facilities, poorly designed and maintained road crossings in stream and wetland systems, and recreational activities on stream banks all lead to high sediment loads in aquatic systems. When sediments overwhelm a system, the geomorphology (pattern, dimension and profile) may be disrupted, leading to undesirable changes and further instability of the system (Rosgen 1996)" (Ch 1, pp.58).

North Dakota: "In the last 150 years, the landscape has changed dramatically. Although tracts of native prairie still exist in many areas, they are traversed by a road nearly every mile" (pp. 35).

Virginia: "The decline and fragmentation of habitat emerged as an area of concern in all input sessions. This issue was consistently ranked as one of the highest priority concerns across the sessions. Loss of habitat due to commercial, residential and roadway development was repeatedly mentioned. Lack of land use controls and development sprawl are viewed as major contributing factors to the increases fragmentation of existing habitats and wildlife corridors" (pp. 3-42).

Mortality from road collisions

Perhaps more than any other impact, roadkill has been very well documented for certain species. Vehicle collisions claim individual animals regardless of age, sex or condition of the individual animal, and can have substantial effects on a population's demography.

Thirty-five of the Action Plans included mortality from vehicle collisions as a threat and frequently connected collisions to habitat fragmentation and increased road density in migration corridors. Some Plans identified species that are particularly at risk for vehicle collisions, such as "western toad, western pond turtle, salamanders and Columbian white-tailed deer" (WA). Twenty Action Plans highlighted mortality from roads as a significant concern for herpetofauna, signifying a serious threat to an entire taxonomic group. Pennsylvania points out that while road mortality is a significant mortality factor for terrestrial species that rely upon daily or seasonal movements, road mortality is also significant for airborne species like barn owls and Indiana bats who are hit in mid-air collisions with large trucks passing through their foraging corridors.

Delaware states "virtually every taxonomic group of wildlife is vulnerable to road mortality in Delaware." At least two Plans cite actual roadkill statistics for their states (AZ, NM).

References to Mortality from Road Collisions

Alabama: "The U.S. Highway 90 causeway is a major source of mortality to females and hatchlings, which should be minimized with the use of turtle barriers and other appropriate devices" (Ch 4, pp. 204).

Arizona: "In a 10 year period the Department has documented 456 elk/vehicle collisions over a 30km stretch of Arizona State Route 260" (pp. 51-52).

Virginia: "Statewide Threats: Road-related mortality is largely related to reptiles. Snakes and turtles are killed in large number on Virginia's roadways. It also includes early-successional birds, which may use habitat immediately adjacent to roadways and are thus susceptible to vehicular mortality" (pp. 3-27).

Transportation Threats to Amphibians and Reptiles

Thirty-seven states identified roads as being particularly damaging to reptile and amphibian species (often referred to together as "herptiles" or "herps"). Collectively, the states identified 56 reptile and amphibian species that are at risk due to the effects of transportation infrastructure. Specific road related impacts that are especially damaging to these species include: spreading invasive species, pollution and sedimentation run off, vehicle collisions, loss, degradation and fragmentation of habitat, hindrance or barrier to movement and migration, and climate change.

The Plans suggest a variety of actions to protect herptiles from road-related impacts including:

- Avoiding building roads near important habitat and breeding grounds
- Develop a spatially-explicit statewide population viability analysis incorporating recent data on road mortality and movement ecology
- Identify areas of high herp road mortality
- Fencing roads to inhibit herps from crossing
- Providing adequate safe crossing opportunities including tunnels and culverts
- Close roads during breeding season

Modification of animal behavior

The mere presence of a road in wildlife habitat can be enough of a disturbance to alter animal behavior. Roads and highways that bisect habitat can cause wildlife to shift entire home ranges, modify movement patterns and escape responses and change reproductive success and physiological state.

Thirty-one of the Action Plans included modification of behavior as a threat. By far, the most often cited cause for modification of animal behavior is the barrier effect roads impose when built within natural dispersal

paths. The Action Plans recognized roads as barriers both to seasonal and lifetime migrations, plant and animal species and terrestrial and aquatic species. However, some Plans point out that roads can make dispersal nearly impossible for species of low mobility such as amphibians, reptiles and some small mammals. Oregon's Plan says it best, "For example, a two-lane highway may pose an insignificant barrier to elk, but may be impossible for a turtle to cross" (pp. 56).

References to Modification of Animal Behavior

Indiana: "As opposed to the dirt paths that once existed, roads and highways are now major barriers to plant and animal dispersal throughout the state. As the landscape of Indiana changes through highway construction, farming and urban development in rural areas, forests become separated from each other, creating barriers to migration and genetic health of species that are dependent upon these areas" (pp. 51 and 59).

Iowa: "Road construction is a *High* stress for amphibians and reptiles because it interrupts travel corridors needed during seasonal and breeding migrations, dispersal, and movements due to environmental changes" (pp. 94).

Massachusetts: "The two major causes for habitat loss and fragmentation are human development and road networks, which break up habitats into smaller pieces and isolate those habitats by creating barriers and resistance to animal movement" (Ch 8, pp. 223).

Michigan: "Telemetry studies on massasauga rattlesnakes in southern Michigan indicate a high reluctance to cross an asphalt-paved access road recently constructed through an area frequented by the snakes (Kingsbury et al. 2004). Isolation of populations of less mobile species will lead to reduced breeding potential, disruption of dispersal patterns, and diminished genetic variability (Whitcomb et al. 1981, Kingsbury and Gibson 2002)" (Ch 1, pp. 47).

Oregon: "Migration is a strong urge in species, and migration routes are often used over decades or centuries, by generations of wildlife. So, when a new obstacle pops up in the route, like a roadway or a housing development, wildlife may try to find a way through the area, rather than avoid it. This can lead to increased mortality to wildlife on highways and can endanger human safety as well. [...] In rural areas, the impacts of roads on wildlife movement will depend on the type of road and the level of use, with impacts increasing with the amount of traffic" (pp. 55-56).

Alteration of the chemical environment

Beyond the road itself, the vehicles that use the road instigate their own problems. Cars and trucks produce carbon dioxide that contributes to global warming and ozone and heavy metals that contaminate the air, soil, plants, animals and water near roads. Because roads accelerate runoff, they reduce the buffering effects from riparian vegetation and deliver high levels of sediment, nutrients and pollutants to nearby waters. Twenty-eight Plans linked roads to the alteration of the chemical environment.

Among the concerns are reduced water quality from chemicals, metals, oil, gasoline and other contaminants entering water as non-point source runoff from roads and parking lots.

Transportation agencies often spread salt or sand on roads to melt ice, increase traction or control dust. Salts then wash off the road and into the soil and water nearby, altering pH and elevating chloride and sodium levels. Over time, the accumulation of salt can literally change patterns of succession in aquatic vegetation and disrupt ecological dynamics in lakes. Ten Plans expressed concern about road deicing salt changing soil composition and chemistry and polluting nearby water sources. The Plans recognize impacts to vegetation and even small vegetative communities. Vermont expressed concern that polluted water sources cause decreased fecundity and increased mortality rates for aquatic species like brown trout (pp. 4-9). Arizona noted that large game species are indirectly endangered by road salt. Deer and elk are attracted to and can often be seen licking roads where salt has built up, leading to more wildlife vehicle collisions (pp 77). Salt is a problem even in states like Arizona and Delaware that receive little snowfall and use deicing salt infrequently. "Delaware receives less than 20 inches of snowfall annually, thus road salt application is relatively infrequent. Nonetheless, when

References to Alteration of the Chemical Environment - General

Rhode Island: "Sources of contamination from roads are particularly invasive, primarily to aquatic life forms, and coordination with DOT should attempt to mitigate affects from drains and other road run-off into nearby wetlands. Contaminant runoff into Narragansett Bay is a continuing need to be addressed" (pp. 110).

Texas: "Chemicals produced and used by people, such as oil from roads and parking lots, enter waters as non-point-source runoff. This has lowered water quality in waters and wetlands adjacent to urban developments" (pp. 475).

References to Alteration of the Chemical Environment - Salt

Michigan: "Road salts can affect vegetation and small vegetative communities. A small pocket of unique wetlands in southeastern Michigan that contains a relict forested bog is in jeopardy due to increased salinity from road runoff (MNF 2005)" (Ch 1, pp. 78).

Massachusetts: "Road runoff carrying salts has allowed invasion and expansion of *Phragmites* into peatlands" (Ch 8, pp.305).

snowfall averages higher than normal statewide or in localized areas, the effects of road salt on key habitats and species can be detrimental" (pp. 37).

Spread of exotic species

The construction and presence of roads create perfect conditions for non-native, invasive species to move in and ultimately displace native vegetation. Exotics are able to take advantage of the disturbed, altered conditions created when a road is originally built and native species are stressed or removed altogether. Roads also act as vectors for “hitchhiker” seeds that attach themselves to vehicles. Some roadside exotics are no accident. Transportation agencies have historically planted rapidly growing exotic species on bare ground and slopes after construction to control erosion.

Nearly all of the Plans cite invasive species as a conservation threat in their state, but 21 Plans specifically make a connection between exotic species and roads. Plans generally describe the disturbance caused by construction activities and how roads serve as “conduits” (NV) or “vectors” (LA) for the dispersal of non-native and invasive species. In California, nearby roads have spread invasive species like Russian thistle, Saharan mustard and planted tamarisk to dunes, where they stabilize dunes with extensive root systems and block natural migration and shifting of sands (Ch 8, p 144).



Photo Courtesy of theunabonger on Flickr

Invasive species like Scotch Broom (Yellow on Left) in the Western United States often spread rapidly along road right-of-ways.

References to Spreading Invasive Species

Illinois: Under Invasive Species: “...the highly disturbed landscape of Illinois (developed and agricultural lands, fragmented and degraded natural areas) increases the probability of introduced species becoming established; and the state’s massive transportation infrastructure facilitates the spread of established invasive species throughout the state and the continent (Cox 2000).” (III. Statewide Overview, E. Priority Conservation Actions, pp. 81).

Nevada: “Road development, both in association with development projects and as a stand-alone independent effect, can cause habitat fragmentation, direct mortality and disturbance of wildlife, and impacts from highway runoff including erosion, sedimentation and contamination. The improper placement of road developments in riparian corridors and meadows can compound the core effects of this activity, and roads of any kind serve as conduits for invasive species” (pp. 19).

New Mexico: “Roads, highways, railroad, and utility corridors serve as a means of dispersal for many non-native and invasive plant species. Ground disturbance associated with the creation and maintenance of these facilities provides additional opportunities for establishment of non-native species (Parendes and Jones 2000)” (pp. 76-77).

Increased human use of an area

Roads are built for many uses -- from mere access into remote areas to full blown development -- but they are all built for human activities. Roads increase access to formerly remote areas, thus increasing the frequency and intensity of human activity -- both legal and illegal.

Nine Plans cited road related changes in human use of land and water as a threat. The most commonly noted change in human use of land and water attributed to roads is the associated development and loss of habitat. As Georgia's Plan states, "Much of the development of industrial and commercial sites has occurred along Interstate Highway 75 and other major highways" (pp. 57 and 100). A handful of Plans also describe the connection between roads and poaching. Both Arizona and New Mexico say roads facilitate legal and illegal killing and collection of many species, from large game to sensitive reptiles and birds.

Mortality from construction

In the course of clearing the work site in preparation for road construction, any slow moving organisms are killed. Species that nest underground, like gopher tortoise (*Gopherus polyphemus*) are often buried alive or "entombed" when their dens are bulldozed and eventually paved over. Since 1991, 74,000 of them have been lost beneath highways, golf courses and supermarkets. Compared to mortality from road collisions, few studies have been done on the direct mortality caused during road construction. The actual clearing and construction may last for only weeks or months and few, if any wildlife agency staff would be on the construction site to witness and record the mortality. Our analysis revealed that six Plans included mortality from construction activities in their threats discussion.

References to Increased Human Use of an Area

Alaska: "Although transport systems are essential to Alaska's economy, they are also one of the critical challenges for wildlife and land managers. By their nature, these systems increase the risk that wildlife, primarily species that are hunted, trapped or fished, may be overexploited" (pp. 117).

Delaware: "Delaware's rapid growth forces a seemingly endless cycle of road projects of all sizes, including rerouting of major highways, expansion of many secondary roads, and frequent replacement of culverts and bridges" (Ch 5, pp. 5-3).

References to Mortality from Construction

Massachusetts: "As with new developments, road construction, bridge and culvert replacements and pipeline stream crossings can have impacts during both construction and operation. If best management practices for erosion and sedimentation control are not strictly adhered to during construction, streams can be negatively impacted through sedimentation, releases of petrochemicals and construction debris, destabilization of stream banks, and other changes in riparian habitat. Conversely, if the projects are not designed properly in the first place, new bridges and culvert replacements can act as an impediment to fish movement within the streams, while pipelines buried in the streambed can alter the stream gradient" (Ch 4, pp. 79).

Utah: "Mountain Plover -- Specific Threat: Nest sites vulnerable to road construction" (pp. 6-31).

Action Summary

Using references to transportation from the Plans, we identified a series of action themes and categories including: improve interagency coordination, integrate planning efforts, design roads to minimize impacts, apply vegetation management, continue research and monitoring efforts, protect land, educate the public and

increase capacity. More Plans included actions relating to coordination with transportation planners than any other action category. Well over half the Plans included at least one action relating to coordination, integrated planning, and road design. Increasing funding and public education were the two least frequently included categories (see Table 2).

Table 2 Actions Categories and Themes

Action Category (Number of Plans including at least one related action)	Action Themes (Number of Plans mentioning a similar action)
Coordination (40)	<ul style="list-style-type: none"> • Transportation agency represented at meetings (13) • Coordinate with transportation planners (38) • Enter into an MOU for preventative planning (4) • Share spatial data with transportation planners (8) • Participate in the permitting process (4) • Provide transportation planners with technical assistance (7)
Planning (41)	<ul style="list-style-type: none"> • Incorporate wildlife into transportation planning (15) • Create a system to integrate wildlife and transportation planning (5) • Integrate transportation plans with existing plans (6) • Use effective mitigation (7) • Reduce road density (AR, WI) • Avoid building roads in sensitive areas (31) • Plan roads to minimize fragmentation (18) • Encourage fixing roads rather than building new ones (FL) • Site roads to avoid important water resource buffers (riparian, wetland, etc.) (16) • Close or restore old, underutilized or severely damaged roads (9)
Site Design (39)	<ul style="list-style-type: none"> • Promote Best Management Practices (18) • Install wildlife-friendly road crossings (eg. Over or Underpasses) (19) • Remove unnecessary fences or barriers to wildlife movement along rights-of way (AZ, CO) • Encourage wildlife friendly fencing (AZ, UT, WA) • Develop wildlife-friendly fencing guidelines (AZ) • Use fences to keep wildlife away from roads or to guide them to over passes (12) • Remove barriers to fish passage/design adequate crossings for aquatic species (16) • Design or maintain roads to reduce sediment run-off (10) • Design roads to reduce pollution run-off (11) • Design roads to address stormwater issues (6) • Install animal crossing warning signs (6) • Design roads to minimize impacts on herpetofauna (20)

Table 2 Actions Categories and Themes (continued)

Action Category (Number of plans including at least one related action)	Action Themes (Number of plans mentioning a similar action)
Vegetation Management (16)	<ul style="list-style-type: none"> • Use appropriate herbicides to control invasive species along highways (AZ, CT, ME, MI) • Use seed traps to deter invasives from spreading (AZ) • Use native plants in landscaping (11) • Use seed-free hay in sediment control (AZ) • Alter maintenance (i.e. mowing) to minimize harm/maintain grassland (7)
Research (30) and Monitoring (10)	<ul style="list-style-type: none"> • Explore bioaccumulator plants for roadside buffers (AZ) • Develop Best Management Practices (18) • Compile information on growth management efforts outside the state (AZ) • Develop wildlife migration models/identify barriers/crossings/corridors (14) • Compile information on stresses caused by roads (12) • Identify roadkill hotspots (CT, FL, NJ, VT) • Research wildlife crossing design (9) • Monitor road density (AR, CA, RI, WA) • Monitor roadkill rates (6)
Land Protection (11)	<ul style="list-style-type: none"> • Protect land from transportation development using easements, acquisition, or incentives (11)
Education (8)	<ul style="list-style-type: none"> • Public Education (eg. Vehicle collisions, feeding wildlife) (8) • Encourage clean-up efforts along highways (AZ)
Funding (5)	<ul style="list-style-type: none"> • Plans suggest a funding sources (5) • Examples of funding suggestions: CA - Motor vehicle and highway impact fees (gas and vehicle registration tax), DC – Transportation Bill, FL – Road mitigation budget, GA – TEA21 transportation enhancements, recreational trails, PA – Surcharge on speeding tickets.

Spatial Actions and Transportation Planning

Transportation planning is an inherently spatial exercise. The long range transportation planning process identifies future transportation needs and presents a strategy to address them through a combination of expanding existing corridors, adding addition corridors, or expanding alternative transportation options. Where these corridors are located will have a significant impact on wildlife. Not all areas of the landscape harbor

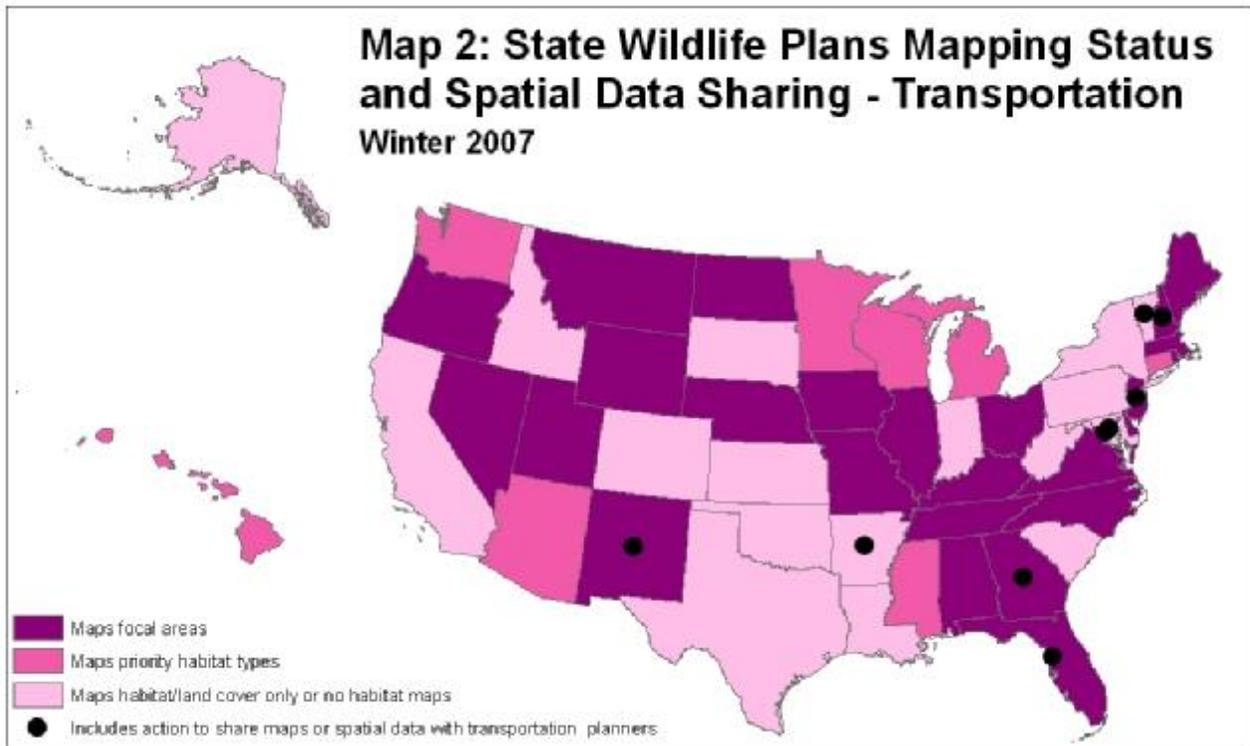
high quality wildlife habitat. Species and habitat types are distributed unevenly across the landscape and therefore some areas are more important for protection than others. By identifying these areas and sharing this information with long range transportation planners, conservationists have the opportunity to inform the transportation planning process before specific projects are launched. Sharing spatial data with transportation planners early on gives all

stakeholders the opportunity to see potential trade-offs between development and natural areas protection and find workable solutions before projects progress too far.

Only 25 states included maps of priority conservation areas in their Action Plan. An additional eight states included maps of priority habitat types. The remaining 18 Plans did not include maps of priority habitats or places (see Map 2). Maps can be an effective means of communication between biologists and transportation planners and can also provide clear guidance to transportation planners as the move forward with their plans. areas protection and find workable solutions before projects progress too far.

Thirty-one Action Plans recommended that transportation planners alter or prohibit road construction to avoid impacts to high priority

conservation areas. Other Plans suggested closing old and underused roads, fixing old roads rather than building new ones and *effectively* mitigating for road impacts. In order to implement these actions, wildlife agencies must have, and share with transportation planners, a landscape-level conservation plan that identifies priority conservation areas, or sensitive areas, to avoid or protect through mitigation. Taking a landscape-level view of a region's conservation needs allows both transportation and conservation planners to understand the trade-offs inherent in various development scenarios. Without this landscape perspective, habitat connectivity and integrity will continue to degrade incrementally, one new road at a time. Only eight states included actions indicating that they were interested in sharing spatial data with transportation planners (see Map 2).



Spatial Actions

Arkansas: “An immediate need for implementation of this multi-site strategy was realized in the planning for the I-69 corridor, which will run through the ecoregion. Strategy implementers will attempt to ensure I-69 impacts UWGCP portfolio sites minimally if at all, through preventative planning. Implementers will share the ecoregional plan’s areas of significant biodiversity with all levels of appropriate planning entities and agencies” (Ap 3.3, pp. 1929-1930).

Georgia: “Develop an MOU between DNR and GDOT to facilitate collaborative efforts to minimize impacts from road construction projects to high priority species and habitats. Share information on locations of rare species and significant natural communities and sites that are suitable for mitigation activities. Emphasize protection of sites that will conserve high priority species and habitats and expand public recreational opportunities” (pp. 32).

New Hampshire: “Identify significant travel corridors for species of concern to provide guidance to transportation planners” (pp. 4-59).

Vermont: “A statewide GIS habitat database for use as a predictive model for making transportation decisions related to habitat connectivity. The database utilizes data collected by VTrans Operations and Maintenance road crews as well as data from the Vermont Fish and Wildlife Department” (pp. 2-29 - 2-31).

Conclusions

The states all acknowledge that roads and highways have negative impacts on wildlife, and many states recognize the need to coordinate with state transportation agencies in order to address this issue. However, the Action Plans do not discuss transportation planning in detail or identify the key points in the process where sharing wildlife data and interagency coordination will be most productive. Furthermore, very few states explicitly recognized the need to share spatial data with transportation planners. Given the

inherently spatial nature of transportation planning, it will be difficult for transportation agencies to work productively with wildlife agencies without having access to maps of priority species and habitat locations.

The transportation planning process offers many key opportunities to provide additional protection to species of concern and their habitats. The remainder of this report gives a general overview of transportation planning, the key players involved, and how wildlife biologists can improve this important process.

LINKING TRANSPORTATION AND CONSERVATION

As the Plans clearly indicate, roads and highways have a significant influence on wildlife populations and ecosystem functions. Transportation planning can provide a key leverage point for influencing development at multiple levels in each state. Firstly, in addition to the impacts from the roads themselves, transportation corridors often serve as a catalyst for future residential and commercial development. As particular areas become more accessible, development in those areas is more desirable. Secondly, the inherently regional and interconnected nature of our road and highway systems provides an opportunity to improve regional and national coordination, which is critical for protecting wildlife and natural systems. Finally, the Federal Highway Administration and state level transportation agencies provide a more centralized target audience than local land use planners. Therefore, although working with land use planners is critical, conservationists and wildlife biologists can put their expertise to good use by working with transportation planners.

The Transportation Planning Process: Tool for Conservation

The transportation planning process offers many opportunities to enhance wildlife conservation activities. The first and best option for protecting wildlife is to avoid placing roads in ecologically significant areas. The transportation planning process itself goes through numerous phases where spatially explicit conservation information can help inform transportation decisions. In addition, there are avenues for advancing wildlife protection by improving transportation best management practices and vegetation management plans to minimize additional impacts of existing and future roads.

The majority of the Action Plans advocated for

general integration of wildlife and ecological principles into transportation planning and/or planning road locations to avoid sensitive habitats and important natural resources. Very few Plans outlined a system for how this integration could take place or suggested establishing a process for linking wildlife and transportation planning. Facilitating this integration is a key role for state wildlife agencies. Wildlife biologists can provide transportation planners with technical assistance that includes informing planners of where “sensitive” habitats and species are located.

Transportation planning occurs at the federal, state and metropolitan levels of government. Although the Federal Highway Administration provides some guidelines and standards for transportation planning, these guidelines are not requirements and most states do things somewhat differently. Therefore the following discussion on transportation planning gives only a general outline of the process.

Within each state, state wildlife agencies and conservationists have the opportunity to work with the state department of transportation (DOT)⁴ and regional metropolitan planning organizations (MPOs). Both levels do their own long-range transportation plans and short-range transportation plans. The former generally covers a planning horizon of at least 20 years while the latter focuses on the next 2 to 5 years. Both planning timeframes (at both the state and MPO levels) provide an opportunity for integrating conservation and transportation planning. Importantly, these planning efforts occur *before* the agencies and governmental bodies invest heavily in specific projects. Evaluation of environmental impacts occurs far later in the planning process when specific projects have already been chosen and significant investments have already been made.

⁴State transportation agencies go by a variety of names. For simplicity, in this report we refer to them collectively as DOTs.

At that late stage, it is unlikely that developers and DOTs will be willing or financially able to change their project location. Instead, environmental impacts are often mitigated on-site as an afterthought to the entire process. Conservationists have an opportunity to get involved in transportation planning from the beginning, before developers and DOTs have invested in specific projects. Doing so requires an understanding of the variety of planning processes relating to transportation.

Long-range Transportation Planning

Both state and MPO planners produce long-range transportation plans (LRTPs). Congress mandated long-range planning, but does not specify the details of how those plans are created. As a result, jurisdictions have approached the task differently. Some long-range plans provide a broad vision for transportation in the planning region, but lack details about how to make that vision a reality. In contrast, other plans provide an assessment of transportation needs in the region with specific strategies for meeting those needs.

Transportation planners create long-range plans based on models that illustrate future transportation needs and the impacts of different transportation options. These models currently focus on the number and distribution of trips across a particular region and compare the results to the capacity of the current transportation system. This modeling phase offers an opportunity to view the various environmental impacts associated with different transportation scenarios. Some transportation planners perform impact analyses that assess the impacts to air quality, noise, quality of life, and “life-cycle” costs from various transportation scenarios. Frequently, transportation models focus on automobile travel to the detriment of alternative modes of transportation. Mass transit and other automobile alternatives can benefit wildlife by reducing the pressure to build new roads,

getting more cars off existing roads and reducing carbon emissions that contribute to global warming. As ecological models are developed and improved, they can be integrated with the transportation planning process at this stage. In the meantime, providing maps of priority conservation resources offers the best opportunity to evaluate the impacts of different transportation scenarios.

Broadening the scope of long-range transportation planning to include assessments of wildlife habitat intactness and connectivity will result in significant benefits for wildlife. These comparisons can help transportation planners avoid citing new corridors that will fragment important habitat or block migration corridors. During the planning stage, both conservationists and transportation planners have the opportunity to find creative solutions, alter road and highway locations, identify where wildlife crossings should be cited and begin to understand the levels of mitigation that will be required. By identifying the areas where corridors will have significant impacts on wildlife, transportation agencies can avoid conflicts with environmentalists in during the environmental review process.

Short-term transportation planning - Transportation Improvement Programs (TIP, or STIP for Statewide Transportation Improvement Programs)

States and MPOs also create more concrete near-term plans that focus on possible transportation improvements projects that could occur over the next two to five years. This list is “fiscally restricted” meaning that projects must have an identified potential funding source to make it onto the short-term plan. In addition, all federally funded projects must be part of the STIP list. However, not every project on the plan list actually makes it to implementation.

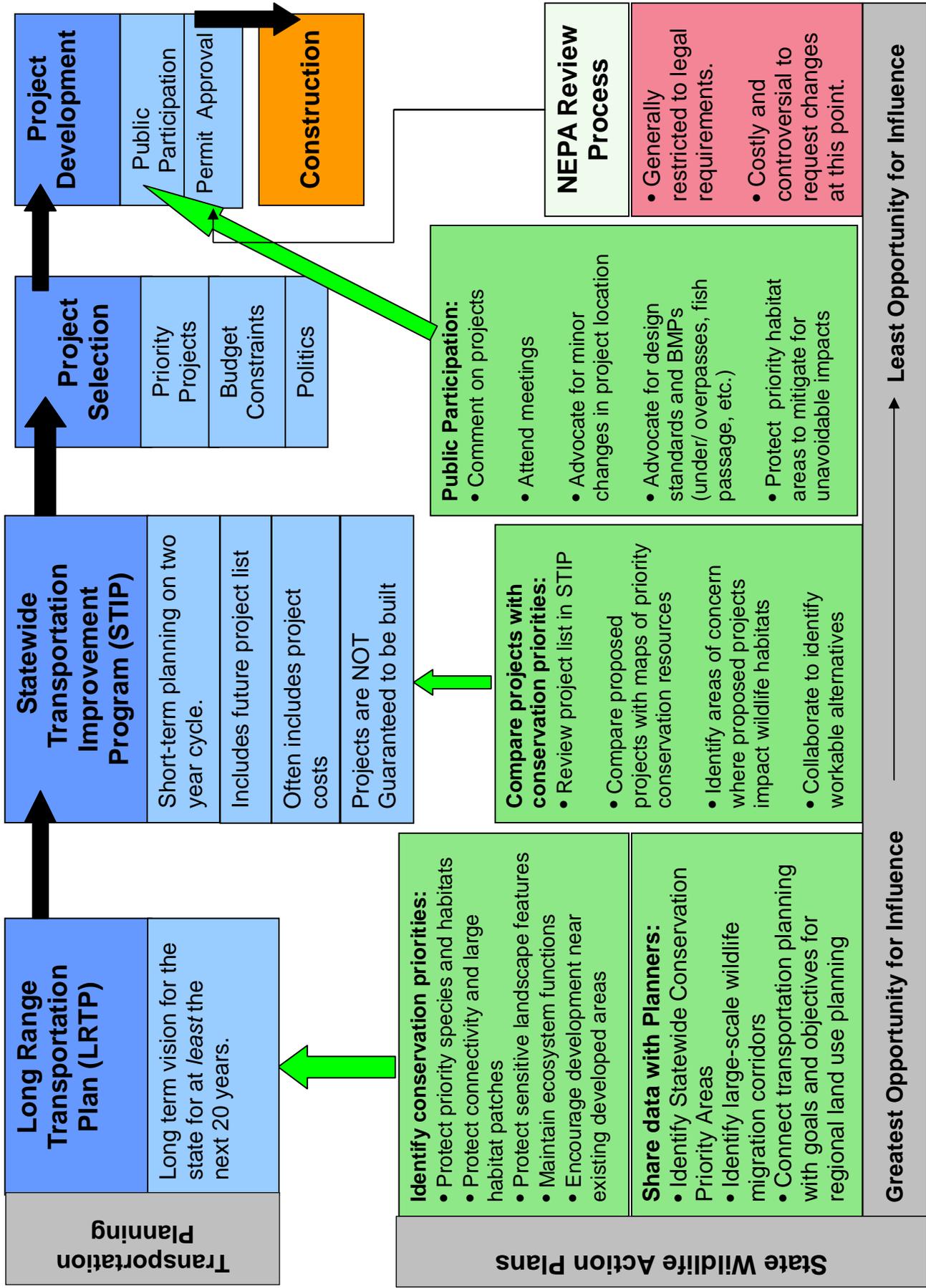


Figure 1: Diagram of points of intervention between the Action Plans and the transportation planning process.

Conservationists can review the projects on the short-term lists, compare them with maps of important conservation resources and corridors, and identify where conflicts with wildlife are likely to occur. Once again, commenting and voicing concerns about these projects at this earlier stage will give transportation agencies the chance to alter or drop projects that are likely to have significant environmental impact. At this point, very few resources are committed to individual projects and there is no guarantee that any specific project will move forward. Commenting during the short-range planning provides a better opportunity for making changes than waiting until the project is officially selected and further site level planning goes forward.

Project Selection and Development

Despite the millions of dollars and countless hours of labor that go into creating the long and short-range plans, the final list of projects selected for implementation is heavily influenced by politics, budget constraints, earmarks, and other non-science based influences. Thus the final list of projects for implementation may differ significantly from the STIP list. However, there are often avenues for public input during the project selection stage. An even better option is to get a joint transportation/natural resource employee on staff who can participate consistently in the project scoping and selection process.

Project development occurs after a project is selected, potential funding is identified and further site level planning is completed. Transportation agencies generally open the process up to public and environmental review at this late stage. This is also the time when environmental groups traditionally get involved. At this stage, it is difficult for transportation agencies to make significant changes and often the only avenue for influencing the process is through litigation

under the National Environmental Policy Act (NEPA). Litigation is costly for all sides, exacerbates animosity and still may not result in significant changes to the project. By creating good faith partnerships between transportation and wildlife agencies, both sides have the opportunity to find workable solutions without litigation. At the very least, getting involved with the entire planning process demonstrates a willingness to work collaboratively and proactively rather than relying solely on reactive legal recourse.

Effective Mitigation

Mitigation is intended to compensate for any *unavoidable* environmental impacts associated with a given project and can take many forms including land protection, habitat restoration, and terrestrial or aquatic wildlife crossing installation. Traditionally, regulatory agencies determine a project's environmental impacts and required mitigation action as one of the last stages in project planning. At this late stage, not only is it nearly impossible to alter the project to avoid or minimize impacts, but also transportation agencies must choose mitigation sites quickly, to expedite project approval, and usually with minimal knowledge of the land's ecological value. This approach means that mitigation areas rarely contribute to larger conservation planning goals.

Furthermore, addressing environmental impacts at the end of a project limits the transportation agency's ability to avoid and minimize rather than mitigate impacts. Recognizing these shortfalls, eight federal agencies (BLM, EPA, FHWA, NOAA, NPS, USACE, USDA FS, and USFWS) recently collaborated to create: *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects*. This report encourages integrating plans across agency boundaries and endorses ecosystem-based mitigation. For more information on Eco-Logical, go to http://www.environment.fhwa.dot.gov/ecological/eco_index.asp

References to Integrating the Action Plans and Transportation Planning

Arkansas: “The goal of the roads/right of way (ROW) multi-site strategy is to prevent stresses caused by road/ROW construction by reducing road/ROW construction in targeted areas, and ensure roads/ROWs that are built and maintained in targeted areas are done so with the least impact possible.

Road Construction/ROW Action Items:

- Develop federal partnerships—esp. SENRLG
- Develop TNC’s information lobbying capacity at the division and state level to all relevant partners. Develop MOUs for early preventative planning.
- Share PCAs with state heritage and DOTs” (pp. 1929-1930).

California: “Transportation planning should give high priority to preserving large core habitat areas, and, when possible, locate future highway or rail construction along existing transportation corridors. Current transportation proposals include several proposed roads that would bisect the Mount Hamilton area and a high-speed rail line that would bisect a number of regional State Park lands. If implemented, these proposals would fragment wildlands and important wildlife habitat areas” (Ch 10, pp. 198-199).

Florida:

- “Support multi-agency review and coordination of the planning and permitting process for roads, bridges, and causeways, i.e., the Florida Department of Transportation’s Efficient Transportation Decision Making (ETDM) process (<http://etdmpub.flactat.org/website/PublicInfo/help/ETDM.pdf>)
- Multi-agency and partner adoption of the “Cooperative Conservation Blueprint” process (see Chapter Florida’s Strategic Vision) that can be used for transportation planning
- State-sanctioned approach for identification of areas where new roads may or may not be constructed and development of criteria for best protecting wildlife and supporting smart growth where road expansion is likely” (pp. 459 – 460).

New Hampshire: “Contact with state and federal agencies will be made to integrate the priorities and strategies of the WAP into their plans and operations. Agencies and their existing plans include but are not limited to: NHDOT, including the Long Range Statewide Transportation Plan due to be completed Spring 2006” (pp. 7-2).

Oregon: “Oregon Department of Transportation (ODOT) shares staff and consults with Oregon Department of Fish and Wildlife regarding the effects of road construction on habitat, particularly fish passage. ODOT is increasingly addressing habitat connectivity and exploring opportunities to incorporate wildlife passage into road and highway plans. A statewide bridge reconstruction project launched in 2002 has served as a means to streamline planning and work in concert with fish and wildlife programs” (pp. a:23).

Vermont: “For the past several years, the Vermont Agency of Transportation has had several important initiatives related to road ecology. This work is a collaborative partnership with the Vermont Fish and Wildlife Department and includes a Wildlife Crossing Steering Committee, chaired by VTrans’ Director of Program Development. Initiatives include:

- The effects of new transportation projects on habitat and consideration of animal and fisheries passage are considered early in the project planning process. These effects are also considered in the maintenance and upgrading of the existing transportation infrastructure. One recent and very successful example of the former is agreement reached among the regulatory agencies regarding a major expansion of Route 78 through the Missisquoi National Wildlife refuge” (pp. 2-29 - 2-31).

The section 6001 consultation provides an opportunity for wildlife agencies to inform the transportation planning process and emphasize that avoiding and minimizing impacts is more ecologically and economically effective. For *unavoidable* impacts, the Action Plans can help align mitigation projects with the conservation goals and priorities of each state. Wildlife and transportation agencies can work together to develop a set of potential mitigation projects for a given landscape that will contribute to protecting and maintaining a functional ecological network. Rather than planning mitigation for each project in isolation, transportation agencies can then “bundle” mitigation from multiple projects and even direct that mitigation off-site to the most ecologically important areas. The state wildlife agencies will benefit by using mitigation to fund necessary conservation projects and actions identified in their Action Plans. A recent Federal Highway Administration Report found that on average 2-12% of total transportation project costs are spent on environmental compliance. Given the high cost of many transportation projects, even this small percentage can result in states spending up to \$300 or \$400 million each year on environmental compliance (Bureau of National Affairs, Inc. 2006). Those are significant dollars compared to the average \$1 million going to each state under the State Wildlife Grants Program. Approaching mitigation with a comprehensive strategic plan will help transportation agencies move projects through environmental review faster while also ensuring more effective benefits for wildlife.

Best Management Practices

The term “Best management practice,” or BMP, describes a design standard or operational procedure that will minimize environmental impacts. Many states suggested developing or implementing BMPs in order to reduce pollution or sediment run-off, better manage roadside vegetation, minimize barriers

for aquatic species, and/or facilitate wildlife crossings for both large (ungulates and predators) and small (reptiles and amphibians) species.

Terrestrial wildlife crossings

Almost all animal and plant species need to migrate or disperse from one place to another at some point in their lives to find new territory, food or mates. Migration and dispersal of individuals is critical to maintaining genetic variation in the larger population and to repopulating open habitat patches. Because many species are either unable or unwilling to cross agricultural fields or urban areas, scientists recommend maintaining linear strips of natural habitat between larger protected areas. Habitat connectivity or linkage analyses identify these important migration and dispersal corridors. The results of these analyses can inform transportation planning by identifying locations either to avoid developing roads or, for existing roads, to install wildlife crossings.

Nineteen Action Plans advocated for installing terrestrial wildlife crossings to reduce vehicle related mortality. At a minimum, successful crossings must have exclusionary fencing to funnel animals to the crossing and secured habitat on either side (either publicly owned lands or under conservation easement). Other considerations include size, openness ratio, vegetation/cover and adequate light, air and water flow where appropriate (Donaldson 2005). Given that designing, building and maintaining wildlife crossings can be very expensive, it is crucial to site each one where it is needed most. A comprehensive habitat connectivity or linkage analysis is essential for prioritizing the most important locations (Barnum 2003).

In order to be most effective, we recommend that the linkage analysis be created in cooperation with the state’s transportation

Wildlife Action Plans and Habitat Linkages Analyses

Roads are recognized both in the Plans and in the conservation literature as a significant cause of habitat fragmentation (Trombulak and Frissell 2000). All the Action Plans recognized habitat fragmentation as a threat to wildlife and many emphasized fragmentation as among the most critical threats in their state. To varying degrees, the plans all encouraged reducing fragmentation and increasing connectivity. Twenty-seven Action Plans stressed minimizing fragmentation and maintaining habitat connectivity in the context of transportation planning. The following actions for doing so were the most common (in descending order):

- coordinate with transportation departments, other agencies, FHWA, and other groups
- use maps to identify places to avoid in transportation planning and/or to preserve
- integrate habitat and wildlife corridor features into the road design
- encourage the construction of overpasses, underpasses, and culverts
- identify frequent wildlife movement corridors

Several states plan to work with transportation planners to create a linkage analysis or to share their analysis with transportation planners.

California: “To address regional habitat fragmentation, federal, state, and local agencies, along with nongovernmental conservation organizations, should support the protection of the priority wildlands linkages identified by the South Coast Missing Linkages project” (Ch 9, pp. 165-166).

Michigan: “Incorporate identified linkage areas (between isolated patches of priority landscape features) into local, regional and statewide planning and management efforts” (Ch 1, pp. 49).

New Hampshire: “Map landscape connectivity using models to represent spatial processes, such as dispersal, migration, colonization, and foraging. Mapping connectivity and buffering critical wildlife areas can target lands that help retain ecological connectivity and sustain wildlife diversity... Initiatives are in place to secure funding to model landscape connectivity from transportation planning resources.” (pp. 5-8)

New Mexico: “A promising opportunity lies in cooperating and coordinating with the New Mexico Department of Transportation and Federal Highways Administration to identify important wildlife habitat linkages and wildlife movement corridors that have been fragmented by highways, roadways and other human travel corridors” (Ch 6, pp. 437).

Oregon: “Oregon Department of Transportation (ODOT) shares staff and consults with Oregon Department of Fish and Wildlife regarding the effects of road construction on habitat, particularly fish passage. ODOT is increasingly addressing habitat connectivity and exploring opportunities to incorporate wildlife passage into road and highway plans” (Appendices, pp. a:23).

Vermont: Transportation initiatives - “A statewide GIS habitat database for use as a predictive model for making transportation decisions related to habitat connectivity. The database utilizes data collected by VTrans Operations and Maintenance road crews as well as data from the Vermont Fish and Wildlife Department” (pp. 2-29 - 2-31).

agency and fully incorporated into the State's Wildlife Action Plan. Working with the state's transportation agency will help to ensure that the plan is accepted and used by transportation planners. Also, transportation agencies can contribute funding to help create the plan. Incorporating this linkage analysis into the State Wildlife Action Plan will ensure that it receives wide circulation and support. In addition, consolidating existing information into the Action Plan is essential in order to create a central information resource for conservation statewide. About 15 states have either completed or begun a linkage analysis, but only a fraction of these discussed this effort in their plans. During section 6001 consultations, both state and regional long-range transportation plans can be overlaid with the linkage map to identify and prioritize potential locations for wildlife crossings.

For more information on wildlife crossings, see <http://www.wildlifeandroads.org/> <http://www.wildlifecrossings.info>.

Aquatic wildlife crossings

Many states were concerned about the impacts of development on water quality and hydrologic regimes. Sixteen states specifically expressed concern over fish passage blockages that occur as a result of road crossing. Rather than spanning the width of the natural flow of rivers, streams and wetlands, roads are often built into the stream channel and a culvert is installed to allow for water flow. Many culverts are historically too small in diameter to allow adequate stream flow. As a result, these culverts can block fish passage and increase erosion up stream of the culvert itself. In Vermont, the Aquatic Organisms Steering Committee, made up of Vermont Transportation Agency, Vermont Fish & Wildlife and U.S. Forest Service, assessed the condition of over 200 large culverts in the Upper White River Watershed and found that one half block fish passage entirely and the

others block fish occasionally. These blockages can make miles of upstream habitat completely inaccessible for anadromous fish species, such as salmon. However, migration is important for many fish species in any watershed to maintain genetic mixing.

Given the inherent connectivity of aquatic systems, it is best to address aquatic threats comprehensively rather than on a project-by-project or species-specific basis. Identifying and ranking all aquatic barriers will allow state agencies to address them systematically as resources and work programs permit. Transportation agencies actively monitor bridge status and functionality, but usually only in terms of their ability to move vehicle traffic – not fish. The aquatic barrier inventory can be incorporated into the transportation agency's bridge improvement schedule to improve efficiency. However, the most critical barriers may need special priority, regardless of existing replacement schedules. Stream crossing structures should be designed to restore and maintain natural flow and hydrological regimes. Where possible, bridges should span the entire stream to accommodate the 100-year floodplain, riparian integrity and terrestrial movement.

Creating an organized task force or working group can coordinate partners from various agencies and help ensure progress. Oregon's Department of Fish and Wildlife created the Fish Passage Task Force (ODFW, Oregon Watershed Enhancement Board, Oregon Department of Transportation, U.S. Forest Service, U.S. Bureau of Land Management, and other partners) to inventory, prioritize and remove fish passage barriers. The Task Force is developing passage designs that are economical as well as practical for wildlife. New Hampshire formed the "Stream Team" to focus on developing stream crossing guidelines and restoration protocols (see NH SWAP, pp. 5-13).

Best Management Practice Actions

Alaska: “Today transportation and resource agencies work to minimize project impacts to habitats near roads, including blockages to fish passage. Alaska proactively addresses project-specific concerns by having BMPs that guide permitting of major access projects. These practices are designed to reduce impacts to fish and wildlife, and their habitats. A step-wise progression of mitigation is mandated for unavoidable effects, some of which are discussed below. Even with modern BMPs, however, risks to sensitive wildlife species compound as the density and scope of regional transportation systems expand.” (pp. 117).

Arkansas: “Develop and promote river-friendly road maintenance practices utilizing existing research data and/or new data for use throughout the Ouachitas. This strategy will be accomplished through a demonstration project and an associated focused educational program that uses specialized training and fact sheets for county officials and their road crews” (pp. 1886).

Arizona:

- “Remove unnecessary fences and barriers to wildlife movement.
- Encourage use of wildlife-friendly fences.
- Use exclusion fencing and other design features to funnel wildlife movement to existing underpasses, overpasses or culverts.
- Develop species-specific wildlife friendly fencing guidelines” (pp. 231).

New York: “Work with the US and state departments of transportation to incorporate SGCN-friendly components into road maintenance and renovation work. Specific examples include wildlife underpasses, median and right-of-way mowing, tree-cutting schedules and plantings, sand and salt use runoff reduction measures, and new road location planning” (pp. 83).

Oklahoma: “Support cooperative efforts between government agencies and research institutions to develop or update Best Management Practices and management recommendations to minimize the ecological footprint left by road, pipeline, and utility line construction, and the impacts of right-of-way maintenance practices” (pp. 226-227).



Red Spotted Newt, J. Michalak

Vegetation Management

With 12 million acres of land contained within public rights-of-way, transportation agencies are effectively land managers on a grand scale. When highway construction began in the early 20th century, the objective of roadside vegetation management was to establish an inexpensive, attractive and fast-growing slope stabilizer. Transportation agencies often planted non-native species where native flora was too costly, grew too slowly, or was deemed unattractive. As a result, public rights of way became clogged with invasive species such as kudzu and grasses. Some of these invasives

spread beyond the right of way, onto adjoining private and public property, further degrading habitat and reducing biodiversity.

Sixteen Plans advocated for better roadside vegetation management to minimize invasive species proliferation or to enhance habitat for wildlife. The most frequently mentioned action in this group was to encourage or require transportation agencies to use native species in their landscaping. Some states were concerned with the types of herbicide used and their application process. Arizona offered additional suggestions for controlling invasives including using seed traps and seed free hay.

References to Vegetation Management Actions

Georgia: “Incompatible road and utility corridor management pose problems for some high priority plant species such as Cumberland rose gentian, royal catchfly, and prairie purple coneflower. For these species, use of herbicides and other vegetation management tools should be planned and implemented in a way that minimizes impacts to rare plant populations occurring in the road right-of-way or utility corridor” (South Appalachian/ridge and valley ecoregion, pp. 59).

Louisiana: “Partner with DOTD and federal agencies to promote the planting of native prairie species in rights-of-way areas where historic native prairies occurred” (Ch 4, pp. 109).

New Hampshire: “Areas surrounding airport runways and roadsides often are cleared of native vegetation and are maintained as homogenous mowed habitat, largely due to safety concerns (Forman et al. 2003). Because roads are extensive in the landscape, roadside habitat loss can be substantial. Mowing during critical times can have serious effects on local populations of plants or wildlife (e.g., Karner blue butterfly, frosted elfin butterfly, Persius duskywing skipper, and grasshopper sparrow). Karner blue butterflies are attracted to abundant non-native nectar plants along road edges (S. Fuller, NHFG, unpublished data)” (pp. 4-57 – 4-58).

New Mexico: “Counter habitat fragmentation by working with federal, state, and private land managers to modify management of roadside rights-of-way and fencerows to provide useful habitat and corridors that allow wildlife to travel between existing patches of prairie” (pp. 147).

Oklahoma: “**Crosstimbers Region** - Conservation Landscape: Tallgrass Prairie: Require roadside re-vegetation following construction to native species and improve management of roadsides” (pp. 178).

Virginia: “Remove roadside shrubs serving habitat or food for birds, Work with VDOT and localities to remove existing plantings of invasive, exotic plants and to prevent the future introduction of invasive plants” (pp. 10-23).

Develop a roadside vegetation management strategy

The wildlife agencies were not required to consider plant conservation in their Action Plans. Despite the restriction, many Action Plans do address habitat and vegetation related issues. Twenty-one Action Plans linked roads with the spread of invasive plant species. However, only 16 included actions to address vegetation management along roads.

Congress has also taken action to address the problem. SAFETEA-LU includes a provision on “Control of Noxious Weeds and Aquatic Noxious Weeds and Establishment of Native Species” (Section 6006). This provision makes transportation funds available to control noxious weeds and establish native vegetation as part of any transportation project. These funds can apply to right-of-way surveys, training, native plant establishment and control or elimination of non-native plants. Wildlife agencies, in partnership with their state transportation agency can take this opportunity to establish a roadside vegetation management strategy to further the goals of their Action Plan. First, each state should inventory roadsides and develop a database of vegetation occurring there. Once completed, this information can be used to protect remaining rare plant populations found in rights of way, prioritize the removal of invasives and reestablishment of native species. The database can then become central to the highway maintenance division practices and should be included in the next rendition of the Action Plan.

Continued maintenance of rights of way should then include best management practices such as altered mowing and spraying regimes, according to the needs identified in the Action Plan. Wildlife agencies can continue to monitor rights of way with conservation value, removing invasives, restoring native

populations and providing input on those species of fauna nesting or foraging within roadsides. In the case of new construction, a roadside vegetation management strategy can include procedures for salvage of rare plants, equipment cleaning to avoid inadvertent spreading of seeds and a list of appropriate and preferred species to be used in revegetation.

CAUTION: There are two schools of thought regarding the use of roadsides as wildlife habitat. One school of thought contends that roadsides are unsafe and unnatural habitat. Wildlife should be discouraged from foraging or nesting near roads where they can be hit by cars, poisoned by runoff or emissions and habituated to human disturbance. For instance, Virginia’s Action Plan includes “Remove roadside shrubs serving as habitat or food for birds” as a conservation action (pp. 10-3). However, in some severely developed regions, rights of way may be the only remnants of rare plant communities or habitat remaining. Due to extensive loss of prairie, New Mexico’s Action Plan suggests modifying “management of roadside rights-of-way and fencerows to provide useful habitat and corridors that allow wildlife to travel between existing patches of prairie” (pp. 147).

Partners in the Transportation Planning Community

The term “transportation planner” is about as specific as the term “biologist.” There are many different types of planners, some work at the system level (think long-range and comprehensive planning) and others work at the project level. Clearly, talking with a project planner about system level issues will not be especially productive. Frequently, conservationists and biologists are directed to *environmental* planners, a seemingly logical decision. However, environmental planners usually guide specific projects through the environmental review process. Currently, they have little to do with proactive planning at the system level. In addition to the numerous types of planners, transportation planning occurs at multiple governmental scales including state, metropolitan, regional, local, and county.

State Transportation Agencies (Departments of Transportation - DOTs)

State DOTs are perhaps the most well known transportation planning agencies and are a convenient central source for transportation resources within each state. As a result, DOTs are critical partners in wildlife conservation efforts. State transportation agencies are responsible for producing long-range transportation plans, short-term work programs and air quality implementation plans. The state transportation planning division works with metropolitan and regional planning organizations to initiate studies and conduct transportation planning for the entire state.

Many states also utilize transportation advisory committees (TAC). The relevant municipality or transportation agency will appoint members to this committee, which makes recommendations to regional development organizations and state transportation agencies regarding the development of plans, activities and projects, and influences transportation policy at the regional and state levels.

Metropolitan areas over 200,000 people

Large metropolitan areas with populations that exceed 200,000 are referred to as transportation management areas (TMAs) and are managed by metropolitan planning organizations (MPOs). Aside from the usual planning process, transportation management areas also identify actions and strategies as part of a congestion management system to reduce congestion and increase mobility.

Cities over 50,000 people

For metropolitan areas with more than 50,000 people, the Governor and representatives of the metropolitan area form an agreement to designate a metropolitan planning organization (MPO). Most MPOs are either “free standing” or housed within city or county organizations. These organizations plan and coordinate federal highway and transit investments within their jurisdiction. MPOs also create their own set of long-range transportation plans, short-range work programs and a plan of studies to determine transportation needs. Some MPOs coordinate with land use and can provide a regional perspective on development, something critical to effective landscape scale conservation.

Small communities and counties

At the local level, many small communities and counties with populations below 50,000 have their own transportation planners, which hopefully coordinate their planning with land use. Some of these rural areas may create regional planning organizations made up primarily of local elected officials. Others have more general regional development organizations, regional councils, planning commissions or councils of government that work on a range of community planning issues including economic development, emergency services, housing and transportation planning. More than 25 state transportation agencies contract with these regional development organizations rather than engaging themselves in rural transportation planning.

State DOT Involvement in Action Plan development

In establishing the State Wildlife Action Plans, Congress required that the states include eight essential elements, one of which was “plans for coordinating the development, implementation, review, and revision of the State Comprehensive Wildlife Conservation Plan with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats” (US FWS 2001). A handful of states involved their transportation agency in the actual development of the State Wildlife Action Plan. According to the Plans, 13 state transportation agencies either were invited to participate in the development of the Action Plan or were listed as partners. Of these 13, seven Plans indicated that wildlife agency staff had already met with their transportation agency to discuss implementation (AL, DE, IA, MI, MS, NM, and TN).

Alabama: “CWCS staff met with state agencies including Department of Transportation (ADOT) and Department of Environmental Management (ADEM) to outline specific programs and projects where CWCS should be incorporated. Follow-up exchange of information and updates established a new level of coordination between these agencies and partners. Each partner was informed of the CWCS targets, process, and schedule and was asked to incorporate the CWCS information in to their appropriate programs and plans” (Ch 6, p 244).

Tennessee: “In June 2005, the planning team invited an additional group of conservation partners and stakeholders to participate in the fourth steering committee meeting. The purpose of this meeting was to unveil results of identified priority habitat areas for CWCS focal species, and to build consensus on the need for coordinating conservation actions. Invited partners included: TN Department of Transportation, TN Division of Natural Heritage, and the Joint Venture Program coordinators for each of the four Bird Conservation Regions found in Tennessee” (pp. 25).

Interagency Coordination

Often, the wildlife agency might first become aware of a highway project when the EIS arrives on their desk. For transportation agencies, consulting with wildlife and resource agencies late in the planning process exposes their projects to expensive delays. A Federal Highway Administration (FHWA 2000) study found that eight percent of delayed transportation projects were held back by resource agency review. While this is a small percentage, coordinated planning between transportation and wildlife agencies can reduce these delays even further.

Congress intended the Action Plans to improve cooperation between and within government agencies and mandated that the

states discuss coordination in their Plans. While state wildlife agencies are leading the Action Plan effort, the aim is to create a statewide vision for wildlife conservation – not just a plan for the agency. Forty Action Plans mention increasing interagency coordination with their state transportation agencies and the Federal Highway Administration (FHWA). The majority of these references simply state the need to increase coordination, others go into more detail including actions such as sharing spatial data, offering technical planning assistance, entering into a Memorandum of Understanding (MOU), participating in the permitting process, hiring joint staff, or creating a working group. Unfortunately, only 13 states mentioned inviting or engaging DOT staff during Action Plan development.

Interagency Coordination Actions

Georgia: “Develop an MOU between DNR and GDOT to facilitate collaborative efforts to minimize impacts from road construction projects to high priority species and habitats. Share information on locations of rare species and significant natural communities and sites that are suitable for mitigation activities. Emphasize protection of sites that will conserve high priority species and habitats and expand public recreational opportunities” (pp. 32).

Kentucky: “Work with the KY Department of Transportation (DOT) and other agencies to incorporate wildlife friendly features (incorporate overpasses, signs, road barriers etc.) into construction and maintenance projects to decrease impacts to wildlife” (Appen. 3.8, pp. 47).

Montana: “Work with Montana Department of Transportation and Federal Highway Commission to effectively mitigate impacts of highway construction. Conserve contiguous tracks of habitat by working with state and federal agencies to manage for road construction and development” (pp. 402).

New Hampshire: “Promote a Transportation Working Group - A New Hampshire transportation-wildlife working group can proactively identify opportunities to maintain or improve the ecological integrity of landscapes impaired by existing or proposed roads. Improved planning and coordination among state (NHDES, NHFG) and federal regulatory (EPA, ACOE) and transportation agencies (NHDOT, FHWA), conservation groups, researchers, and local planners would have a statewide benefit to wildlife, as well as broad project support, increased permitting predictability, and improved highway safety. A multidisciplinary working group should include biologists, land-use planners, engineers, transportation project managers, and technical assistance specialists. Goals of a transportation working group may include prioritizing research needs, identifying funding opportunities, improving data sharing and coordination, and increasing education and technical assistance. Also, the products from the WAP should be integrated into NHDOT’s long-range project planning effort that is currently underway” (pp. 5-18 – 5-19).

New Jersey: “DFW to coordinate with the NJ Department of Transportation to reduce road mortality to reptiles and amphibians and large mammals and create wildlife under and overpasses on new roads and road upgrades” (pp. 274).

New Mexico: “To increase the ability of NMDGF and cooperators to implement wildlife passage enhancements and monitor important wildlife habitat linkages across human transportation corridors, the NMDGF will consider the feasibility of creating a cooperative joint position with NMDOT” (pp. 439).

Oregon: “Oregon Department of Transportation (ODOT) shares staff and consults with Oregon Department of Fish and Wildlife regarding the effects of road construction on habitat, particularly fish passage” (pp. a23).

Washington: “WDFW also works with the Washington Departments of Transportation and Ecology in developing and implementing mitigation measures for projects with potential adverse impacts on fish and wildlife” (pp. 41).

“Washington state agencies such as the Department of Ecology, Department of Transportation, Puget Sound Action Team, and the Office of the Superintendent of Public Instruction also have conservation and education responsibilities that may be effectively applied to the implementation of the CWCS” (pp. 253).

The Action Plans offer a prime opportunity to improve coordination between wildlife and transportation agencies. The first step is for Action Plan coordinators to meet with transportation planners in their state and walk them through their Plan. These meetings will be most effective if they include representatives from the environmental review and long range planning divisions, as well as members of the administration. The following are suggestions for how to improve coordination between wildlife and transportation agencies.

Become actively involved in Section 6001

Section 6001 provides an unprecedented opportunity for conservation planning to influence land use decisions. However, although section 6001 consultation is required by law, active participation from permitting agencies is essential to achieve success. The recent release of the Action Plans provides an excellent opportunity for the wildlife agency to meet with transportation planners, formally present the Action Plan, and plan for section 6001 consultation. These preliminary meetings can provide an opportunity to learn more about transportation planning, where Action Plan data could be used most effectively, and what information is most useful to transportation planners. Finally, these meetings can establish a section 6001 process and schedule, whereby each party has a clear understanding of expectations and outcomes.

Organize a transportation-wildlife work group

Transportation issues are complex and the solutions require a strategic and committed effort that involves all stakeholders. An effective transportation-wildlife work group should include biologists, planners, engineers and project managers from wildlife, resource, regulatory, and transportation agencies, as well as conservation organizations, land trusts and citizens. Together, the working group can identify proactive opportunities to restore landscapes impaired by existing roads and protect remaining quality habitat through comprehensive transportation planning.

The information and actions laid out in the State's Wildlife Action Plan can provide a platform for this more detailed strategic or operational plan. Scheduling regular (monthly, quarterly) meetings to discuss your progress will help the working group maintain coordination.

New Hampshire: "Promote a Transportation Working Group - Improved planning and coordination among state (NHDES, NHFG) and federal regulatory (EPA, ACOE) and transportation agencies (NHDOT, FHWA), conservation groups, researchers, and local planners would have a statewide benefit to wildlife, as well as broad project support, increased permitting predictability, and improved highway safety. A multidisciplinary working group should include biologists, land-use planners, engineers, transportation project managers, and technical assistance specialists. Goals of a transportation working group may include prioritizing research needs, identifying funding opportunities, improving data sharing and coordination, and increasing education and technical assistance. Also, the products from the WAP should be integrated into NHDOT's long-range project planning effort that is currently underway" (pp. 5-18 – 5-19).

Develop a Memorandum of Understanding/Agreement

A memorandum of understanding or agreement (MOU/MOA) is a non-binding legal document describing a bilateral or multilateral agreement among parties intending a common line of action. At a minimum, the MOU/MOA should be written and signed by the state wildlife and transportation agencies. If possible, ask the state representatives from your federal regulatory, resource and transportation agencies to sign on as well.

North Carolina: "The Ecosystem Enhancement Program, developed through a 2003 Memorandum of Agreement between the NC Department of Environment and Natural Resources, the NC Department of Transportation, and the US Army Corps of Engineers, also has huge potential to dictate future land acquisitions in North Carolina through a watershed approach to compensatory mitigation from unavoidable impacts to stream and wetlands associated with highway development projects" (pp. 61).

Connecting Transportation and Land Use Planning

The fragmented governing structure of current land use and transportation planning systems seriously hinders sustainable conservation efforts. Despite the logical connection between land use and transportation, decision-making about these related processes often occurs in isolation. Transportation planning occurs primarily at the state or regional level with significant funding coming from the federal government. In contrast, land use planning is governed mostly at the local level without significant external funding sources (Moore and Thorsnes 1994). Planning is further fragmented among the numerous counties, cities, and metropolitan jurisdictions that each conduct separate land use planning processes. In order to maintain ecological function, conservation planners must coordinate their efforts at a variety of scales ranging from landscapes to ecoregions to ecosystems.

Though ecologically critical, creating regional land use planning structures is challenging politically. However, transportation planners have long recognized the need for taking a regional approach and currently coordinate their actions through regional metropolitan planning organizations (MPOs). State wildlife agencies may find it easier initially to coordinate with transportation planners, as both agencies operate at the state and regional levels. However, advances in transportation planning will not result in long-term wildlife protection without similar progress in local land use planning. Improved coordination among land use planning jurisdictions and between transportation and land use planners would be a valuable ancillary benefit to coordinating a regional conservation strategy.

The states will need a wide variety of policy tools in order to deal with transportation and development threats comprehensively. Although the Plans themselves carry no regulatory restrictions, most states recognize that regulations are a necessary component of any successful conservation strategy. Forty-three Plans included language indicating that it will be necessary to apply regulatory land use measures in order to achieve sustainable development goals. Of these, 20 states expressed a need to alter existing or create new regulations to protect wildlife adequately. States were also supportive of using voluntary economic incentives to encourage private lands conservation. Forty-four states included some type of incentives as a means for addressing land use and development threats. The states linked the following incentives to addressing development threats: acquisition (37 states), tax deductions (15 states), technical assistance to landowners (13 states), cost sharing programs (8 states), special protection for working lands (18 states), and Farm Bill programs (12 states). Applying a suite of these policies will allow each jurisdiction to tailor their strategy to meet the needs of each community.



I-405 Corridor Courtesy of Washington State DOT

Linking Land Use and Transportation Actions

California: “As a complement to [Natural Community Conservation Planning], wildlife agencies should work with local governments to develop General Plans and zoning regulations that are compatible with conservation goals. In particular, local land-use plans should direct growth within established communities and along existing infrastructure and transportation corridors, restrict rural residential subdivision, and support those ranching and agricultural land uses that maintain habitat values and benefit environmental quality” (Ch 9, pp. 164).

North Carolina: “Administrative and Management Challenges - Fragmented Responsibility and Jurisdiction: What’s more, the impacts to species and habitats can include any number of human influences: agricultural practices, road construction, urban sprawl, industrial water demand, municipal sewage treatment, invasive species releases. While species and habitats may be affected by the sum of these impacts, we must manage their influence in piecemeal fashion, under the jurisdiction of multiple regulatory agencies and organizations” (pp. 39).

“Land use planning and zoning laws are needed to limit development, land clearing, and hydrology alterations within floodplains (e.g., route highways and other corridors that cross floodplains as closely as possible to existing corridors to avoid fragmenting an extensive corridor of forest)” (pp. 182).

New York: “Develop land protection strategies for large blocks of unfragmented forests by working with private land owners and public land managers, transportation planners, and local government to reduce planned fragmentation. Development of tax incentives and disincentives, easements, and cooperative management programs is crucial to the achievement of this task” (pp. 80).

Washington: “Transportation systems such as major highways and roads are also a major cause of habitat loss and fragmentation, as well as direct barriers to wildlife movement and causes of direct mortality from roadkill. When wildlife populations are low, roadkill mortality is significant, especially for slow-moving animals such as turtles and salamanders, as well as wide-ranging carnivores that have to cross many roads.

Washington will continue to experience significant population growth into the foreseeable future. This growth and development will result in continued loss, conversion and fragmentation of fish and wildlife habitat. Steps are being taken by WDFW, other state and federal agencies, local governments and many private conservation organizations to identify and conserve the most important and productive habitats. Many different nonregulatory and regulatory strategies and tools, as varied as habitat acquisition and administration of the Growth Management Act (GMA), are discussed at both statewide and ecoregional scales in the CWCS” (Sec 1, pp. 22).

RECOMMENDATIONS FOR STARTING A COOPERATIVE TRANSPORTATION PLANNING PROGRAM

The Action Plans clearly document that transportation infrastructure causes numerous and significant problems for wildlife. The continued loss and degradation of habitat associated with poor transportation and development planning detracts from the agency's on-going and proposed conservation efforts. Collectively, the Plans recognize the urgent need for wildlife agency staff to increase their coordination with transportation planners and involvement in the transportation planning process.

The quotes in this report highlight a small sample of the many excellent ideas, statements, actions and comments that are found throughout the Plans. However, each state addressed this issue with a varying degree of specificity. A number of states used vague language that will provide little to no guidance to transportation planners such as "Work with [state] Department of Transportation" or "Collaborate with transportation planners." This lack of specificity does not provide a useful picture of the wildlife agency's conservation strategy to the variety of public interest groups, small non-governmental organizations and private citizens that care about wildlife conservation in their state. We hope that viewing this synthesis of how the states collectively address this issue will help states that currently lack a strategy for dealing with transportation to develop one. If a state has more detailed ideas for addressing transportation issues than are reflected in the Plan, we hope to see those ideas in more detail in future iterations.

Examples of Vague Coordination Language

The following quotes were taken directly from the Action Plans. This type of statement was common. Most states went on to include additional actions or description. However, many states did not expand beyond these general types of statements.

Work with XX Department of Transportation, county transportation departments, and other partners to identify and address key areas of wildlife mortality on highways and consider animal movements when planning new roads.

Work with XX Department of Transportation and Federal Highway Commission to effectively mitigate impacts of highway construction.

Collaborate with transportation planners (e.g. XX Dept. of Roads, Federal Highway Administration) to minimize impacts to at-risk species and key habitats.

Conservation action: Coordinate with XXDOT re: road construction.

Learn the Transportation Planning Process

Transportation planning is a complicated process that involves scores of planners and occurs over long time frames. Understanding the various phases of this process and being familiar with the time frames and deadlines for transportation planning in your state will be essential in order to engage transportation planners effectively. This report offers a very general overview of transportation planning. There are many details specific to individual states, regions, or localities.

To learn more about transportation planning, talk with your state transportation agency and review the literature highlighted in Appendix A of this report. Organize a workshop and invite natural resource agencies and conservation groups to get together with transportation planners and identify informational needs and potential avenues for partnerships.

Provide Meaningful Technical Assistance

It is difficult for wildlife agency staff to fulfill their role as technical advisors if they cannot base their recommendations on credible data. Likewise, policy makers are wary of creating new laws or altering procedures without some valid assurance that their efforts create meaningful change on the ground. Many of the

states expressed concern about lack of data and research and called for increased research and monitoring, 30 and 10 Plans respectively, in their Action Plans. Twelve Plans called for more research into the stresses caused by roads. In general, road stresses are well documented and reviewed in Trombulak and Frissell (2000), and we recommend relying on this existing research unless additional data are necessary for making a specific policy decision.

Many Plans called for action-related research including developing effective transportation planning, designing best management practices, developing wildlife migration models to identify key crossings and barriers, identifying roadkill “hotspots,” and researching wildlife crossing design.

Research Actions

Kentucky: “Evaluate effectiveness of various types of barriers and underpasses in areas where priority reptile species are particularly vulnerable to highway mortality (e.g. KY 307 at Obion WMA, KY 268 at Sloughs WMA, etc.)” (Appen. 3.2).

New Hampshire: “Map landscape connectivity using models to represent spatial processes, such as dispersal, migration, colonization, and foraging. Mapping connectivity and buffering critical wildlife areas can target lands that help retain ecological connectivity and sustain wildlife diversity. Mapping landscape connectivity will be achieved through coordinated inter-agency and inter-organizational efforts, and NHFG is not likely to lead the effort. TNC and NHFG have completed a fragmentation model that will contribute to mapping of connectivity, and NHFG has contracted UNH to develop methodology for modeling movements of large carnivores. Initiatives are in place to secure funding to model landscape connectivity from transportation planning resources” (pp. 5-8).

New Jersey: “Identify and map (using a global positioning system) known areas where wildlife are repeatedly killed (e.g., amphibian breeding ponds close to roads, bobcat kill locations). These areas can be identified with data from Biotics, ENSP staff and the ENSP’s Herptile Atlas, Amphibian Crossing Survey and Vernal Pool volunteers” (pp. 34-35).

Oregon: “Fish and Wildlife Monitoring Team - The team should include representatives from federal, state, and local agencies; fish and wildlife user groups; tribes, conservation organizations; and forestry, agriculture, industry, and transportation interests. Their expertise and perspectives on monitoring would provide the groundwork for establishing and maintaining a database and data management system that can be used by a variety of data collectors and managers” (pp. 27).

Unfortunately, highway dollars often are earmarked for design, construction and operation only -- leaving little or no funds for assessment and monitoring. Many states and researchers nationwide have developed tools, models and methods for identifying wildlife migration corridors and key linkage areas. Researchers have also assessed the efficacy of various wildlife crossing structures. We encourage state wildlife agencies to look to their neighbors and to academia for answers to many of the questions regarding the impacts of roads, design of wildlife crossings, best management practices and methodologies for creating a wildlife linkage plan.

Target Education Strategically

Eight Plans included education as a strategy to address transportation threats. Especially for transportation issues, wildlife agencies can have a greater impact on transportation policy by coordinating with transportation planners rather than by educating the general public. However,

wildlife agencies can catalyze change by providing technical assistance and information about the impacts of transportation decisions on wildlife to planners and policy makers. Some states suggested training programs for transportation officials in best management practices, educating officials about transportation impacts, and ensuring that information about species and habitats is readily available.

In Vermont, the wildlife and transportation agencies have partnered to offer a habitat training program that takes transportation professionals into the field with wildlife experts from Keeping Track, Inc. and the Vermont Herp Atlas. In a series of field trips, the class learns some fundamentals of ecology and how to track various species. Most importantly, they gain an appreciation for the natural resources in their state and how their work as transportation professionals can reduce impacts and reconnect habitat for wildlife (pp. 2-29 - 2-31).

Targeted Education Actions

Iowa: “Coordinate habitat management policies and messages among all layers of government to promote goals of the plan. Educate other government land management and protection agencies on the [Action] Plan so it may be used in conjunction with their work activities (example: DOT)” (Part II, page 6).

Michigan:

- “Educate the public, land-use planners, transportation planners, planning commissioners and local government officials about the consequences of habitat fragmentation.
- Improve accessibility of information to local, regional and statewide land-use and transportation planners.
- Provide training and education in the means and methods of managing land-use change, transportation systems and community development at multiple scales” (Ch 1, pp. 49).

North Carolina: “Expand technical guidance to developers to promote site design techniques that minimize impacts and maximize benefits to wildlife and habitat (e.g., urban development projects, roads, wastewater treatment plants, stormwater treatment sites, utility stream crossings)” (pp. 45).

New Mexico: “Provide education regarding the value of riparian systems to specific types of landowners, managers, or federal lands lessees, such as [...] transportation agencies, developers, federal water management agencies, [...] state and county planners, counties, municipalities, and legislators” (pp. 244).

Increase Capacity

The Association of Fish and Wildlife Agencies issued a set of guiding principles for creating the Action Plans including to “ensure that the Plan-Strategy can be implemented, i.e. that it is administratively and politically feasible, and that there are sufficient resources (funding and staff) among the partners to accomplish significant gains at a large scale, and within an appropriate time frame, to preserve our Nation’s wildlife heritage” (AFWA 2002).

Lack of dedicated staff assigned to work with other agencies on key threats to wildlife is one of the greatest barriers to increasing interagency coordination. With such a limited workforce wildlife agencies can rarely go beyond the minimum requirements when it comes to working with their transportation agency.

Engaging more comprehensively in transportation planning will require additional staff time and agency resources. State Wildlife Grants funding averages about \$65 million each year, which is divided among all 50 states, DC, and the US territories. The states can use State Wildlife Grants money to fund joint projects with transportation agencies, but this small amount will not meet the needs outlined in the Plans. The wildlife agencies will need to look for creative funding sources and rely on partners to fully implement their Action Plans. However, only five states suggested specific funding sources that can help the agencies reach their needed capacity. California suggested motor vehicle and highway impact fees (gas and vehicle registration tax), the District of Columbia and Georgia recognized the Transportation Bill, Florida suggested their road mitigation budget, and Pennsylvania suggested a surcharge on speeding tickets.

Congress acknowledged the value of improved coordination among agencies by including enabling provisions in the 1998 and 2005 highway bills. Section 1309 of the Transportation Equity Act for the 21st Century

(TEA-21) allows state transportation agencies to provide highway funding to affected agencies to help expedite the review process while ensuring that environmental concerns are fully considered. In 2005, State transportation agencies funded 32 staff positions in state Department of Natural Resources/Wildlife Agencies for 10 states. Wisconsin’s DNR had 11 staff positions funded by their DOT (AASHTO 2005).

Unlike TEA-21 funding, which was primarily focused on the NEPA review process, SAFETEA-LU funds can be used for “transportation planning activities that precede the initiation of the environmental review process, dedicated staffing, training of agency personnel, information gathering and mapping, and development of programmatic agreements” (23 U.S.C. 6002(j)). In other words, SAFETEA-LU authorizes transportation agencies to spend money on coordination with conservation planners, planning and mapping, smart mitigation, invasive plant species control, and staff to serve as a liaison between transportation and wildlife agencies. This new transportation bill provides a total of \$265 billion in funding over four years (ending in 2009). Many states have taken advantage of these provisions to support full time staff in wildlife agencies, fully funded by highway dollars.

If you are not already taking advantage of this provision to improve interagency coordination in your state, go to <http://www.environment.fhwa.dot.gov/strmlng/igdocs/appa.asp> for more information on creating one.

Expand Capacity through Partnerships

In addition to cross agency staff, wildlife agencies will need to reach out to new and perhaps non-traditional partners.

Transportation issues in particular require concerted effort from partners in both the public and private sectors. Reach out to university researchers and students and encourage them to design their research to provide solid answers to real world policy and science questions. Encourage a more interdisciplinary approach that educates urban planners about ecology and ecologists about land use policies. Share the location of conservation priorities with local land trusts so that they can target ecologically significant areas for protection. Provide them with the technical assistance necessary to protect wildlife habitat effectively. Coordinate with non-governmental organizations for additional expertise, funding and advocacy capacity. Build the state's conservation plan off of pre-existing

work from the NGO community rather than duplicating effort.

Finally, create a citizen science program. Many states are utilizing citizen and NGO volunteers to collect wildlife data of different types. According to New Mexico's Action Plan, "Citizens are becoming more active statewide in monitoring wildlife/vehicle collisions on local highways, documenting wildlife corridors across highways and proposing that habitat connectivity be reestablished using technologies similar to those being implemented for Tijeras and Abo Canyons" (pp. 441). New Jersey plans to involve Citizen Scientists in protection projects such as fencing high road kill areas for northern diamondback terrapin (pp. 410).

Capacity Building Actions

California: "Motor-vehicle and highway impact fees—Vehicles and the highways affect wildlife in several significant ways. Road kills account for substantial mortality of many species, including deer, owls, and snakes. More deer are killed by collisions with vehicles than by hunting. Habitat is eliminated and fragmented by roads and highways. Oil and other chemicals from roads pollute aquatic ecosystems. And invasive species are often introduced along highways. Impact fees could be assessed as an increase in sales tax on vehicles sales, or a flat-rate surcharge could be attached to vehicle registration fees. Assessing an additional \$1 per vehicle registration would generate approximately \$26 million. Another option is a surtax on vehicle fuels. The California Constitution allows gasoline tax dollars to be used for environmental mitigation related to construction and operation of roads and highways" (Ch 6, pp. 91).

Pennsylvania: "Speeding Fines - In a 1995 survey conducted by researchers at Slippery Rock University, 57 percent of respondents said they would support a surcharge on speeding violations as a supplemental source of funding for non-game wildlife programs. Similarly, in the 1996 Commission survey, 63 percent of respondents reported they would support such a fee to support non-game wildlife management programs. Hundreds of thousands of birds, mammals, reptiles, and amphibians are killed on Pennsylvania highways annually. A successful program that uses a surcharge on speeding fines to finance fish and wildlife management efforts is in place in Florida. In 1992, the Florida legislature authorized a 25-cent-per-mile-over-the-speed-limit-fee be added to speeding violations to support non-game conservation. During its first three years, the program generated an average of \$2.6 million per year" (pp. 24-13).

CONCLUSIONS

The State Wildlife Action Plans agree that future wildlife conservation efforts will need to address transportation issues in order to be successful. Land use and development, which are tightly interwoven with transportation, were also prominent issues in the Plans. Many states clearly hold development and transportation threats as top priorities for conservation action. The vast majority of the Plans advocated for better integration of wildlife considerations and transportation planning and closer coordination between transportation and wildlife agencies. The Action Plans themselves contain a vast quantity of knowledge about each state's wildlife and conservation needs that will be essential to making informed transportation planning decisions. As these Plans develop and improve over the years, they can become even more complete repositories of wildlife and conservation information.

The completion of the Action Plans coincides fortuitously with the recent passage of the *Safe Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU). SAFETEA-LU provides both the political framework and funding capacity to make integration of wildlife and transportation planning possible. Section 6001 of SAFETEA-LU requires that transportation agencies consult with wildlife specialists and compare their long-range transportation plans to current available conservation plans. A strategic partnership between state wildlife agencies and transportation planners will benefit both parties: the State Wildlife Action Plans can help transportation planners fulfill their section 6001 obligations and, conversely, transportation planners will be integral to the

successful implementation of the Action Plans. Furthermore, transportation funding can be used to hire joint agency staff, build wildlife crossings, fix fish passage barriers, and address roadside vegetation, all of which were recommended in the Action Plans. It is critical that wildlife agencies take advantage of these opportunities by reaching out to transportation agencies.

The Wildlife Action Plans are clear about one thing: state wildlife agencies will need to engage with a wide range of traditional and non-traditional partners in order to protect wildlife adequately in the coming years. The Action Plans launch a proactive approach to conservation at the state level that, if implemented effectively, will help pre-empt endangered species listings and help us move toward more sustainable communities across the landscape. Rapid action on this issue is essential because the transportation decisions that are made today will have permanent repercussions for wildlife. Not only do roads themselves pose a threat to wildlife, they also significantly influence future development patterns, which in turn severely impact wildlife populations. Between the Action Plans and the requirements of SAFETEA-LU, wildlife agencies have the tools to make real progress in reducing transportation threats.

Literature Cited

- American Association of State Highway and Transportation Officials (AASHTO). 2005. DOT-Funded Positions and Other Support to Resource and Regulatory Agencies, Tribes, and Non-Governmental Organizations for Environmental Stewardship and Streamlining Initiatives. American Association of State Highway and Transportation Officials, Washington, DC. http://environment.transportation.org/pdf/dot_funded/dot_funded_positions_report.pdf (Accessed on April 25, 2007).
- Association of Fish and Wildlife Agencies. 2002. State Wildlife Conservation Strategies: Guiding Principles. Association of Fish and Wildlife Agencies, Washington, DC. <http://www.teaming.com/pdf/state%20strategies%20guiding%20principles.pdf> (Accessed on April 25, 2007).
- Association of Fish and Wildlife Agencies. 2007. State Wildlife Action Plans. www.wildlifeactionplans.org (Accessed on April 25, 2007).
- Barnum, S. 2003. Identifying the Best Locations Along Highways to Provide Safe Crossing Opportunities for Wildlife. Colorado Department of Transportation – Research, Denver, CO.
- Bureau of National Affairs, Inc. 2006. Transportation/Environment Alert: Environmental Costs for Road Projects, July 28, 2006. Environmental Technical Assistance Program and Bureau of National Affairs, Inc., Washington DC.
- Bryer, M.T., K. Maybury, J.S. Adams and D.H. Grossman. 2000. More than the Sum of the Parts: Diversity and Status of Ecological Systems. In B.A. Stein, L. S. Kutner, J. S. Adams (eds.) 2000. Precious Heritage: The Status of Biodiversity in the United States. Oxford University Press, New York. 399 pp.
- Council on Environmental Quality. 1974. The Fifth Annual Report of the Council on Environmental Quality. U.S. Government Printing Office, Washington, DC.
- Donaldson, B. 2005. Use of Highway Underpasses by Large Mammals and Other Wildlife in Virginia and Factors Influencing Their Effectiveness. Virginia Department of Transportation, Charlottesville, CA. http://www.virginiadot.org/vtrc/main/online_reports/pdf/06-r2.pdf (Accessed on April 25, 2007).
- Federal Highway Administration. 2005. SAFETEA-LU. <http://www.fhwa.dot.gov/safetealu/> (Accessed on April 25, 2007).
- Federal Highway Administration. 2000. Reasons for EIS Project Delays. September 2000.
- Forman, R. T. T. and D. Deblinger. 2000. The ecological road-effect zone of a Massachusetts (USA) suburban highway. *Conservation Biology* 14: 36-46.
- Forman, R. T. T. and D. Sperling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L. Farig, R. France, C. R. Goldman, K. Heanue, J. A. Jones, F. J. Swanson, T. Turrentine, and T. C. Winter. 2003. Road Ecology: Science and Solutions. Island Press, Washington, DC.
- Michalak, J. L. and J. Lerner. 2007. Linking Conservation and Land Use Planning: using the state wildlife action plans to protect wildlife from urbanization. Defenders of Wildlife, Washington DC.
- Moore, T., and P. Thorsnes. 1994. The Transportation/Land Use Connection. Planning Advisory Service Report 448/449. American Planning Association, Chicago, IL.
- Natural Resources Conservation Service. 2000. 1997 Natural Resources Inventory (revised). Washington, DC.
- NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: April 26, 2007).

- Trombulak, S.C., and C. Frissell. 2000. A review of the ecological effects of roads on terrestrial and aquatic ecosystems. *Conservation Biology* 14: 18-30.
- United States Fish and Wildlife Service (US FWS). 2001. State Wildlife Grants Program. *Federal Register* January 24, 2001. 66:7657-7660.
- United States Fish and Wildlife Service. 2006. USFWS Threatened and Endangered Species System. United States Fish and Wildlife Service, http://ecos.fws.gov/tess_public/SpeciesCountForm.do (Accessed on April 20, 2007).
- White, T. 2005. SAFETEA-LU: Conservation Priorities of Interest <http://www.defenders.org/habitat/highways/safetea/safetea.pdf> (Accessed on April 25, 2007)
- Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, E. Losos. 1998. Quantifying threats to imperiled species in the United States. *BioScience* 48: 607-615.

APPENDIX A: ANNOTATED BIBLIOGRAPHY OF RELEVANT TRANSPORTATION PLANNING RESOURCES

Barnum, S. 2003. Identifying the Best Locations Along Highways to Provide Safe Crossing Opportunities for Wildlife. Colorado Department of Transportation – Research, Denver, CO.

This publication provides transportation planners with guidance for creating effective wildlife crossings, which are critical to reducing highway mortality for both wildlife and humans. Mid- and large-sized mammals tend to cross roads at particular points based on landscape characteristics. Therefore, transportation planners need to think carefully about both the crossing's placement in the landscape as well as its design. Barnum recommends working closely with wildlife biologists and landscape ecologists familiar with the ecosystems and species at each site and use habitat suitability as the primary indicator of crossing activity. Barnum cautions that each location is different and will require a unique approach. However, she offers the following general guidelines based on the findings in this report:

- Consider how landscape structure interacts with habitat suitability to increase or decrease the level of use an area of suitable habitat receives by a particular species.

- Consider how highway design will interact with habitat suitability and landscape structure to influence crossing behavior.

- Synthesize this information by mapping the landscape and roadway features/conditions likely to be associated with crossing or that are attractive/repellant to the species present. Use these maps identify the most likely crossing locations.

Brown, J. 2006. Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects. Federal Highway Administration, Washington, DC.

Eco-Logical is the product of an interagency effort to provide guidance for achieving effective and wildlife-friendly environmental mitigation. The report details the environmental advantages of taking an ecosystem approach to transportation planning and mitigation. *Eco-Logical* presents a three stage approach to integrating ecology and transportation infrastructure: 1) integrating planning by increasing interagency cooperation and data sharing to identify priority natural resources and incorporate them into the planning process, 2) identifying mitigation options using solid ecological data, natural resource priorities, and taking an ecosystem view, and 3) performance measurement to ensure that mitigation fulfills its intended purpose. *Eco-Logical* provides step by step guidance for each stage of this process and provides examples to demonstrate real world applicability.

Clevenger, A. P. and N. Waltho. 2000. Factors Influencing the Effectiveness of Wildlife Underpasses in Banff National Park, Alberta, Canada. Conservation Biology 14 (1), 47–56.

Clevenger and Waltho monitored four large carnivore and three ungulate species in 11 underpass structures in Banff National Park, Alberta, Canada to determine which variables most strongly influence their willingness to use these structures. They identified 14 variables that influenced wildlife crossing including underpass structure, landscape features, and level of nearby human activity. Carnivores were more sensitive to human activity than ungulates and tended to avoid underpasses when humans had recently been in the area. Carnivores were more sensitive to landscape level variables when crossing through an underpass, while ungulates were more sensitive to structural variables such as openness ratio. The researchers conclude by suggesting that future underpasses need to take topography, habitat quality and location into consideration, but these wildlife crossings will ultimately not be successful unless human activity is managed as well.

Evink, G. 2002. National Cooperative Highway Research Program Synthesis 305: Interactions Between Roadways and Wildlife Ecology. Transportation Research Board, Washington, DC.

Given the wide-ranging, linear nature of roads and highways, transportation infrastructure impacts numerous habitats and ecosystems across the United States. The National Environmental Protection Act requires transportation agencies to assess environmental impacts, but this process often occurs at the end of the project cycle. There is evidence that considering environmental protection early on in the planning process results in better environmental protection as well as a more streamlined project planning process. Evink synthesizes existing knowledge about transportation planning, the different types and scales of road impacts, analytical tools, conservation measures and mitigation, maintenance programs, and funding sources. He ends with three case studies illustrating how transportation agencies can successfully reduce environmental impacts from transportation infrastructure.

Forman, R. T., D. Sperling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L. Fahrig, R. France, C. R. Goldman, K. Heanue, J. A. Jones, F. J. Swanson, T. Turrentine, T. C. Winter. 2003. Road Ecology: Science and Solutions. Island Press, Washington, D.C.

Road Ecology is the seminal compilation of existing knowledge and research about the interaction of transportation infrastructure and ecosystem elements and processes. The book brings together fourteen leading ecologists and transportation experts to articulate core road ecology principles. First, Road Ecology covers the basics of historic and recent trends in transportation infrastructure extent and design, transportation planning and project development, and the environmental review process. Second, the book brings together existing information concerning the interactions between roads and wildlife, vegetation, hydrologic regimes, water and air pollution. Finally, Road Ecology addresses the numerous connections between infrastructure placement and design and surrounding landscapes and land uses. The authors both document the numerous negative impacts roads have on ecosystems and provide insights into plans and designs that can reduce those impacts in the future.

Maguire, M., K. McCarty, and A. Canby. 2006. From the Margins to the Mainstream: A Guide to Transportation Opportunities in Your Community. Surface Transportation Policy Partnership, Washington, DC.

From the Margins to the Mainstream: A Guide to Transportation Opportunities in Your Community is a guide for citizens, elected officials, advocates, and many others designed to help them understand and engage in transportation planning and decision-making. The guide gives an overview of transportation planning, laws, policy, and key players, explains transportation planning tools and money flows, identifies potential funding sources for a variety of transportation related community needs, and finally provides advice for how citizens can be effective advocates for better transportation choices. The authors offer the following strategies for transportation coalitions: 1) assess the situation, 2) develop a transportation action agenda, 3) organize for local or regional action, 4) engage the media, 5) know the players, and 6) organize a statewide coalition.

Smith, D.J. 1999. Identification and Prioritization of Ecological Interface Zones on State Highways in Florida. In Proceedings of the Third International Conference on Wildlife Ecology and Transportation. pp. 209–230.

The fragmented nature of Florida's landscape currently hinders efforts to protect and enhance biodiversity. Vehicle collisions are the second most significant cause of mortality for the endangered Florida Panther. In response, the Florida Department of Transportation initiated a program to install underpasses or culverts to restore landscape connectivity across Florida. Given the high costs of building wildlife crossings, it was important to identify those locations where crossing would be the most beneficial. Smith used a rule-based GIS model that incorporated data for chronic road-kill sites, focal species hot spots, riparian corridors, greenway linkages, strategic habitat conservation areas, existing and proposed conservation lands, and known or predicted movement/migration routes to identify the highest priority locations. Comparing these priority locations with planned road updates, repairs, and projects will allow transportation planners to incorporate wildlife crossings into future road projects.

White, P. and M. Ernst. 2003. Second Nature: Improving Transportation Without Putting Nature Second. Defenders of Wildlife and Surface Transportation Policy Partnership, Washington, DC.

Where and how transportation infrastructure is built has significant implications for both human communities and our nation's natural resources. In addition to the environmental impacts of roads and highways themselves, transportation infrastructure often is a key driver of residential and commercial development patterns. This combination of impacts makes transportation planning a key point of influence for conservationists. Second Nature outlines how the transportation planning process can be used to help reduce the impacts of infrastructure development on wildlife. White and Ernst cover topics including: integrated planning, conservation banking, interagency cooperation, wildlife crossings, roads on public lands, and roadside vegetation. The authors conclude with the following recommendations:

1. Integrate conservation planning into transportation planning.
2. Use conservation banking in concert with large-scale conservation plans to mitigate unavoidable impacts of transportation.
3. Coordinate with resource agencies early, substantively and continuously throughout transportation planning and project development.
4. Build wildlife crossings where necessary to repair ecological damage and restore habitat connectivity.
5. Provide alternative transportation and maintain roads on public lands in a manner consistent with surrounding natural resources.
6. Use only native species in roadside vegetation management.

