NORTHEAST NATURAL HISTORY CONFERENCE IX

Direct and Indirect Effects of Roads on Amphibians and Reptiles

Friday, April 21, 2006, Meeting Room 1
Organized Symposium

Organizer: *Mary Beth Kolozsvary on behalf of the Northeast Partners in Amphibian and Reptile Conservation (NEPARC)*

Forecasting Public Roads in the Settled Landscapes of the Northern Appalachian/Acadian Ecoregion

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Existing roads in settled landscapes cause severe mortality in some populations of amphibians and reptiles and have numerous indirect effects on their habitats. Most of the Northern Appalachian/Acadian ecoregion is facing land use change in coming decades. Forecasts of the future road network under alternative population growth scenarios are useful surrogates for anticipating ecological effects of human settlement and will assist conservation organizations to guide protection efforts. We investigated growth of public roads in the State of Maine over a 17-year historical period, and then use the best-selected (AIC) logistic regression model to forecast spatial probability of future roads. Nearly 2,000 km of new roads were constructed in settled landscapes in Maine 1986–2003, influencing 37,000 ha within an ecological road effect zone of 200m. The majority (93.5%) of the new roads performed local functions and were short (<1/3 km in length), characterized as cul de sacs and dead ends; in other words, were residential roads typical of sprawl. The best selected logit model (dwelling density (+), elevation (-), distance to urban area (+), distance to existing primary/secondary highway (+)) captured 84% of reserved new road points in Maine and only 27% of random points at the >0.5 probability level. The model forecast nearly 0.5 million km of new, residential public roads in the Northern Appalachian/Acadian ecoregion for the next two decades, suggesting that cumulative effects of road network expansion are a serious region-scale threat to amphibians and reptiles.

Road Mortality Risk for Spotted and Blanding's Turtles in Maine: Progress Report

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Spotted and Blanding’s turtles share life-history traits that make their populations vulnerable to small increases in adult mortality. Their frequent overland trips to reach isolated wetlands, coupled with increased development in southern Maine, puts these turtles at risk through roadkill. In order to mitigate road mortality we need to know the characteristics of the turtles’ terrestrial movements. We have been radio-tracking and thread-tracking spotted and Blanding’s turtles to determine habitat selection, terrestrial movement timing, path and tortuosity. Terrestrial movements are not distributed equally over the turtles’ active season, but concentrated during peak periods. Most terrestrial movements for Blanding’s turtles occur from mid-April to early July. Spotted turtles show their first terrestrial movement peak with the nesting season in June, and a second peak in late summer. Spotted turtles have made, on average, 3.4 terrestrial movements per season (range: 0–9), and Blanding’s turtles, 8.5 movements per season (range: 0–18). Terrestrial movements were made following a relatively straight line. These data will be used to model movements, estimate road mortality, and compare the population viability under various conservation management scenarios.

Observations from 6 Years of Monitoring New York State's First Amphibian Tunnel

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In October 1999, Albany County incorporated a tunnel-barrier fence system into a roadway reconstruction project in an area previously demonstrating significantly high amphibian diversity and abundance and correspondingly high road mortality associated with movements between hibernating, breeding, and foraging sites. The project, which was the first of its kind to be implemented in New York, was designed to limit movements by amphibians and other non-target species onto the road surface while directing movements toward one of two tunnels under the highway. The system design included two concrete box culverts with a bottom surface of native soil traversing the full width of a two-lane county highway. The 0.5 m × 1.2 m tunnel openings are connected by 90± m of permanent, pressure-treated lumber barrier fencing on each side of the roadway. Post-construction monitoring of the project area showed that most amphibian movements had been successfully directed along the barrier fence while movements onto or over the road surface were all but precluded. In an adjacent control area approximately 40% of over 600 individuals observed were roadkill whereas in the tunnel area only 2% of almost 300 individuals observed were roadkills. Monitoring also showed individuals of nine amphibian species and three non-target species entering the tunnels. We will also discuss design, maintenance and other considerations of the project.

Turtles in Sprawlville: Landscape Models for Strategic Conservation in Massachusetts

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Turtle populations are especially vulnerable in areas with high road densities and traffic rates. Due to their life history strategy, small increases in mortality of adult turtles can lead to serious population declines. Adult turtles of several species typically move long distances overland between wetlands, often crossing roads in the process, where they may be killed. Suburban sprawl in much of Massachusetts is thus likely driving a collapse of turtle populations. Traditional reactive conservation seeks to protect vulnerable species by restricting or modifying development projects near known species locations. We argue that this approach is insufficient, and must be combined with strategic conservation efforts, which seek to proactively protect large blocks of habitat where populations are potentially viable. To help identify conservation targets, we are building spatially-explicit models for three state-listed species: spotted turtles (*Clemmys guttata*), wood turtles (*Glyptemys insculpta*), and Blanding's turtles (*Emydoidea blandingii*) across Massachusetts. These models assess both potential habitat availability and likely sources of mortality. Models combine GIS data (e.g., wetlands, land use, road traffic) with habitat selection and movement patterns based on empirical data and expert opinion. Results of these models will be used by the Massachusetts Natural Heritage and Endangered Species Program to help drive surveys and inform proactive land protection.

Monitoring Amphibian Mortality during Migration: Tompkins County, NY

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It is well documented that amphibian populations are declining in the Ithaca region. In response to this query Dr. John Confer and a group of Ithaca College students set out to determine the impact road mortality was having on local amphibian populations. Thomas and Ellis Hollow Roads., in the nearby town of Caroline, host two large amphibian migrations each spring. This past spring we conducted a first year's survey to collect data and determine which species were crossing the roadway and hot spots where amphibians cross in high numbers with significantly lower migrations at the adjoining ends. Aside from our data collection and scientific analysis we also worked to raise community awareness and gain local support for our efforts. This spring we will again be monitoring the amphibian migrations and compiling data to assess possible culvert applications at these two sites. In conjunction with our community involvement in Caroline we are attempting to determine a source for funding for the possible road construction and culvert materials. This spring's data will serve to reinforce our beliefs as to the location of the migrations, and so that we may more accurately inform the town of Caroline.

Impacts of De-icing Salt on the Demography of Vernal Pool-breeding Amphibians

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De-icing agents, primarily road salt, are applied to roads in 26 states in the United States and in a number of European countries, yet the impacts of road salt on aquatic organisms remain largely unstudied. The issue is germane to amphibian conservation because both adult and larval amphibians are known to be particularly sensitive to changes in their osmolar environments. In a field study in the Adirondack Mountain Region of New York, road salt traveled at least 172 m from a highway into wetlands. Conductivity levels in roadside vernal pools in this relatively pristine environment were comparable to those in urban wetlands elsewhere in the region. Density of egg masses of spotted salamanders (*A. maculatum*) and wood frogs (*R. sylvatica*) was more than two times higher in forest pools than roadside pools, a pattern attributable directly to proximity to roads rather than water chemistry. Survival in embryonic and larval *A. maculatum* was reduced at moderate (500 µS) and high conductivity (3000 µS) levels, but those in *R. sylvatica* were affected only at the high level. A sensitivity analysis indicated that only at high conductivity would decreases in larval survival in *A. maculatum* and hatching success and larval survival in *R. sylvatica* be sufficient to strongly influence population dynamics of both species. Efforts to protect local populations of *A. maculatum* and *R. sylvatica* in roadside wetlands should, in part, be aimed at reducing application of road salt near wetlands with high conductivity levels.

Landscape Predictors of Hotspots of Herpetofauna Road Mortality along a Highway Network

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Road mortality is often spatially concentrated at 'hotspots', and there is a need for models that accurately and efficiently predict hotspots within a road network for mitigation. In July 2002, I surveyed 145 points distributed throughout the entire 353 km highway network in four towns of Northern New York State, USA (976 km^2) for road mortality of reptiles and amphibians. I analyzed the survey data in relation to habitat composition, wetland configuration, and road characteristics to identify landscape and road features that best predicted hotspots of road mortality for herpetofauna. Mortality hotspots were situated where the surrounding landscape was comprised of wetlands and forest, on highways that were heavily used and which were raised above the surrounding landscape. Land cover within 100 m of the road was more accurate than smaller or larger spatial scales at indicating road mortality hotspots. Overall, the best predictor of hotspots was the presence of a causeway configuration of wetlands: wetlands on both sides of the road within 100 m of it. Nearly 4% of the highway expanse within my study area was in a causeway configuration, and thus at risk of having elevated road mortality. These results indicate that accurate predictive models of hotspots of reptile and amphibian road mortality are possible, using publicly available data on land use, wetland features, and road characteristics. Such models have great potential for aiding policy makers and resource managers when planning new roads and selecting sites for barriers, passageways, and other methods of mitigation on preexisting roads.

Amphibian Behavior in Response to Car Traffic

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Nocturnal car traffic often results in amphibian casualties, especially during rainy nights. The behavior of amphibians presumably influences their vulnerability to mortality on the road, but this hypothesis remains untested. We investigated the behavioral response of six species of amphibians on roads when confronted by an approaching vehicle. We first conducted a field study consisting of 50 night-driving surveys over 4 yr during which we recorded the behavior (i.e., moving or immobile) of frogs, toads, tree frogs, and salamanders encountered on a 20-km stretch of road. In an effort to tease apart the effects of headlights and the sound of motors on amphibian behavior, we carried out a field experiment on a test road where we exposed individuals to different car-associated stimuli. Based on the observations of the 2767 individuals in the field survey, immobility was the most common response to the approach of a car (probability of 0.82 of remaining immobile); the response differed across species but depended on the season of the survey. Similarly, the 91 individuals included in the field experiment were more likely to move

during the control treatment than during any of the car-associated treatments. The combined stimuli (headlights + sound of motor) elicited the strongest response, followed by the headlights-only and the motor-only treatments. Both the field survey and the experiment consistently indicated that amphibians tend to remain immobile at the approach of a vehicle. This behavior highlights the vulnerability of amphibians to traffic and should be considered in measures to mitigate road impacts.

Multi-scale Habitat Characteristics of Wood Frogs and Spotted Salamanders across an Urbanization Gradient

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Biologists are increasingly concerned with the impact of residential sprawl on species biodiversity. Pond-breeding amphibian populations are particularly vulnerable because of their metapopulation structure and complex life cycles. We conducted research in western Rhode Island, which is heavily fragmented by roads and residential development. Wood frogs (*Rana sylvatica*) and spotted salamanders (*Ambystoma maculatum*) oviposit egg masses that can be rapidly surveyed, providing an index of their annual breeding effort. During 2000 and 2001, we assessed the effect of within-pond habitat characteristics and landscape composition within six spatial scales adjacent to the breeding pond; 0–30 m, 0–00 m, 0–200 m, 0–500 m, 0–1000 m, and landscape patch on wood frog and spotted salamander breeding effort. Our models showed that populations of both species were affected by a combination of within-pond habitats and landscape-level habitats. Wood frog populations were positively influenced by the availability of suitable breeding ponds, and the availability forested wetlands and forest uplands within 1 km of breeding ponds, while spotted salamander populations were positively influenced by within-pond habitat characteristics and forested uplands in habitat patches around breeding ponds, and negatively influenced the available acreage of developed lands in habitat patches around breeding ponds. Only areas in western Rhode Island that have low road densities are likely to have large wood frog and spotted salamander populations. Effective conservation of amphibian species, including wood frogs and spotted salamanders, that are currently considered widespread and ubiquitous, must begin before environmental thresholds are exceeded and populations decline to unsustainable levels.

Herpetofauna Road Crossing Structures—Informing Design through Behavioral Analysis

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Seasonal movements are fundamental to the life cycles of many species of amphibians and reptiles. These patterns of migration are often compromised by the presence of roads. Roads negatively impact many amphibian and reptile populations in various ways, such as obstructing movement, fragmenting and degrading habitats and causing increased mortality through vehicular contact. Road crossing structures provide one possible way to mitigate the negative effects of roads and facilitate safe passage for these species. However, if crossing structures are to be effective, animals must be willing to use them. Through a series of behavioral choice experiments, we examined whether certain aspects of structural design might influence animal preferences for particular crossing structures. Using individuals from four species, Northern green frogs (*Rana clamitans*), Leopard frogs (*Rana pipiens)*, Painted turtles (*Chrysemys picta*), and Snapping turtles (*Chelydra serpentina*), we tested four qualities of possible under-road crossing structures, aperture size, substrate material, length, and light availability. Our analysis of the results indicates that particular variables, such as aperture size and substrate material, did influence patterns of choice. These studies have elucidated important design aspects for the creation of behaviorally palatable crossing structures.