Herpetofauna and Roads Workshop

*Is there light at the end of the tunnel?*

Vancouver Island University
Nanaimo, BC
Feb. 22-23, 2011
Herpetofauna and Roads Workshop

Is there light at the end of the tunnel?

The main objective of this workshop is to bring scientists, environmental managers, biological and environmental consultants, engineers, and non-governmental organizations together to recognize the impacts of roads on herpetofauna, and to discuss mitigative measures that can be taken to reduce those impacts. We hope that the oral and poster presentations will provide a sample of current Herpetofauna and Roads issues in B.C. and the potential options for mitigation that have been tried in B.C. and beyond. We hope the discussion and insights from the workshop will eventually lead to development of decision support tools and guidelines. We consider this workshop a first step to better management of impacts of roads on herpetofauna.

The organizers would like to thank the following partners and sponsors:

Organizing committee and volunteers

Elke Wind
Barbara Beasley
Greg Czernik
Darcy Pickard
Joe Materi
Alan Garcia
Sarah Schwarz
Jenny Balke

Purnima Govindarajulu
Angela Buckingham
Leonard Sielecki
Eric Demers
Jalene Littlejohn
Wendy Simms
Hitomi Kimura
Mandi Baxter
# Herpetofauna and Roads Workshop

*Is there light at the end of the tunnel?*

## Day 1 – Feb 22\textsuperscript{nd}, 2011

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<thead>
<tr>
<th>Time</th>
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<th>Speakers</th>
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<tr>
<td>7:45 AM</td>
<td>Registration opens and morning coffee</td>
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<tr>
<td>8:30 AM</td>
<td>Introductions and Announcements</td>
<td>Elke Wind - Consultant</td>
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### Session I - Ecology of Herps and Roads

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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>8:35 AM</td>
<td>Welcome</td>
<td>Alec Dale - MoE</td>
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<tr>
<td>8:40 AM</td>
<td>Do Roads Affect Herpetofauna in BC?</td>
<td>Purnima Govindarajulu - MoE</td>
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<tr>
<td>9:00 AM</td>
<td>Road Development &amp; Maintenance in BC</td>
<td>Leonard Sielecki - MoTI</td>
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<tr>
<td>9:20 AM</td>
<td>Roads &amp; Herpetofauna: The Learning Curve</td>
<td>Barb Beasley - Consultant</td>
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### Session II - Modeling as Tool

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<tr>
<th>Time</th>
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<th>Speakers</th>
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<tbody>
<tr>
<td>9:45 AM</td>
<td>Risks of Roads for Snakes Using Modeling &amp; Telemetry</td>
<td>Bruce Kingsbury - Indiana-Purdue University</td>
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<tr>
<td>10:00 AM</td>
<td>Modeling Herpetofauna Movements in Ontario</td>
<td>Kari Gunson - Eco-Kare International (ON)</td>
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<tr>
<td>10:15 AM</td>
<td>Coffee Break #1</td>
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<tr>
<td>10:45 AM</td>
<td><strong>Plenary Speaker #1 - The European Experience</strong></td>
<td>Miklós Puky - Hungary</td>
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<tr>
<td>11:45 AM</td>
<td>questions/discussion</td>
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<td>12:00 PM</td>
<td>Lunch</td>
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### Session III - Case Studies

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<thead>
<tr>
<th>Time</th>
<th>Case study 1 - Sea to Sky - amphibians</th>
<th>Josh Malt - MNRO</th>
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<tbody>
<tr>
<td>1:00 PM</td>
<td>questions/discussion</td>
<td></td>
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<tr>
<td>2:00 PM</td>
<td><strong>Case study 2 - Summit Lake &amp; others - amphibians &amp; reptiles</strong></td>
<td>Jacob Dulisse &amp; John Krebs (BC Hydro)</td>
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<tr>
<td>2:30 PM</td>
<td>questions/discussion</td>
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<tr>
<td>3:00 PM</td>
<td>Coffee Break #2</td>
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<tr>
<td>3:30 PM</td>
<td>Scenarios - Group exercise</td>
<td>Facilitator: Darcy Pickard</td>
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<td>5:00 PM</td>
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### 6:00 PM - Poster Session & Social (ACME Food Co.-14 Commercial St.)

<table>
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<tr>
<th>Time</th>
<th>Movie - Division Street</th>
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Herpetofauna and Roads Workshop
Is there light at the end of the tunnel?

Day 2 – Feb 23\textsuperscript{rd}, 2011

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<th>Time</th>
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<th>Speakers</th>
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<tbody>
<tr>
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<td>Morning coffee</td>
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<tr>
<td>8:25 AM</td>
<td>Announcements</td>
<td>Elke Wind - Consultant</td>
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<tr>
<td>8:30 AM</td>
<td>\textit{Plenary Speaker #2 - Integrating Policy with Road Ecology}</td>
<td>Kari Gunson - Eco-Kare International (ON)</td>
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<tr>
<td>9:30 AM</td>
<td>questions/discussion</td>
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<tr>
<td>9:45 AM</td>
<td>Coffee Break #1</td>
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\textbf{Session III - Case Studies continued}

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<tr>
<td>10:00 AM</td>
<td>\textit{Case study 3 - Oliver / Hwy 97 - amphibians &amp; reptiles}</td>
<td>Brent Persello (MoTi) &amp; Jonquil Crosby (UWaterloo)</td>
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<td>10:30 AM</td>
<td>questions/discussion</td>
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<tr>
<td>11:00 AM</td>
<td>\textit{Case study 4 - Hwy 4-PRNPR - frogs &amp; salamanders}</td>
<td>Barb Beasley - Consultant</td>
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<tr>
<td>11:30 PM</td>
<td>questions/discussion</td>
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<td>12:00 PM</td>
<td>Lunch</td>
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\textbf{Session IV - Where do we go from here?}

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<tr>
<th>Time</th>
<th>Task</th>
<th>Facilitators: Barb Beasley and Purnima Govindarajulu</th>
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<tbody>
<tr>
<td>1:00 PM – 2:30 PM</td>
<td>\textit{summary, lessons learned, tasks, where to go from here}</td>
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<tr>
<td>3:00 PM – 5:00 PM</td>
<td>\textit{Field Trip - travel to road herpetofauna mitigation site}</td>
<td>Lead: Joe Materi</td>
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<tr>
<td>5:30 PM</td>
<td>\textit{Travel back from field trip}</td>
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<tr>
<td>6:30 PM</td>
<td>end of day</td>
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Long-toed salamanders stopped by curb, Photo by Barh Johnston
Abstracts
Oral Presentations
DO ROADS AFFECT HERPETOFANA IN B.C.?

Purnima.Govindarajulu@gov.bc.ca

The primary objective of this presentation is to provide workshop participants with a baseline understanding of the biology of the herpetofauna in B.C. as it relates to the presence of roads in the landscape. To achieve this, the talk is presented in three parts that build on each other: 1) What are herpetofauna and are there reasons to consider threats to these taxonomic groups in particular? 2) What are some of the mechanisms by which roads can affect herpetofauna? and 3) What are some current herpetofauna and road issues in B.C. and where do they occur?

Herpetofauna are an evolutionarily diverse and paraphyletic (multiple evolutionarily distinct lines) group of vertebrates that are most easily described as amniote vertebrates that are not mammals or birds. Herpetofauna includes all groups that have traditionally been called amphibians and reptiles, although some now consider only lizards and snakes are reptiles, placing other taxa such as turtles and crocodiles in separate phylogenetic groupings. Herpetofauna are represented in B.C. by 11 species of anurans (frogs, toads), 9 species of salamanders, 2 species of lizards, 1 extant freshwater turtle (2 marine turtles), and 9 species of snakes.

The global conservation status of amphibians was assessed in 2004, and found that one third (32%) of the 5,743 amphibian species worldwide are threatened compared to just 12% of birds and 23% of the mammals. The situation in B.C. seems even more worrying as 33% of the salamanders and 64% of the anurans are listed to be species of conservation concern either provincially or federally or both. The global assessment of reptiles was launched in 2004 and is still underway. The North American reptile assessment was released in 2007 and was heralded as good news. Only 12% of the snakes and lizards in Canada, United States, and Mexico were considered to be of conservation concern. Most reptiles reach the northern limit of their distribution in B.C., and here 50% of the lizards and 66% of the snakes are listed as species of conservation concern. The only extant freshwater turtle in B.C. is listed as a species of conservation concern.

Due to the high proportion of listed species, standardized threat assessments have been completed for a number of herpetofauna species in B.C. Transportation corridors, and in particular roads, are documented as a threat for almost all the herpetofaunal species assessed to date. Most amphibians have a biphasic life-history that requires travel between aquatic breeding sites and terrestrial foraging sites. Just based on probability, one would expect that there will be mortality if a road intersects these travel routes especially when roads bisect wetlands or run along watercourses or wetlands. It is possible that the amphibians actually stop or slow down their travel when they encounter a road because road surfaces may be warmer than the surrounding habitats and hence present preferred thermal environments. I have also observed spadefoot emerging to rehydrate in the puddles that form on road surfaces soon after small rain events, even when the surrounding habitat remains dry as the precipitation is quickly absorbed by the parched soil.

Roads are often assessed as a high impact threat for snakes because many snakes have shown wide ranging movement patterns from their overwintering dens to foraging sites. Data from various sites indicates that mortality rates are higher than expected by simple
probability even when traffic volumes are low and this is probably because snakes are actually attracted to road surfaces as favourable habitats for basking.

Adult turtles are most vulnerable to roads during the nesting season when female turtles leave the wetlands and may have to cross roads while seeking suitable nesting areas. In addition to direct mortality, the shoulder of roads are attractive nesting areas because of suitable exposure, soil characteristics and the lack of vegetation due to regular brushing activities as part of road maintenance (natural nesting areas may be grown over by invasive plants and no longer be suitable nesting habitats). The hatchlings are vulnerable to direct mortality again in spring when they emerge from their nests and migrate to ponds. In addition to population declines, roads have been shown to skew the sex ratio and age structure of turtle populations.

In addition to direct mortality, roads can have other impacts on herpetofauna. Roads and road noise has been shown to disrupt breeding choruses in amphibians. Road construction and maintenance can lead to habitat loss and degradation. De-icing chemicals, salt, dust suppression chemical are detrimental to amphibian health and cause mortality. Wetlands that are constructed next to roads for sediment and run-off control can present attractive breeding habitats but may become sink habitats as there is little successful recruitment into the population from these habitats.

There are differences in the level of impact of roads on different species of herpetofauna in B.C. In B.C. Western Toads, ranid frogs with the exception of Oregon Spotted Frog, Spadefoots, Tiger Salamanders and Roughskinned Newts are some of the amphibians that are most affected by roads. All the snakes are very vulnerable to the effect of roads, as roads are attractive but deadly basking sites. The extent of road impacts on native lizards is not well understood. Roads are assessed to have a significant impact on Painted Turtle populations.

On the coast and the lower mainland, roads are assessed to have a significant impact primarily on amphibians and the Western Painted Turtle both due to the high density of roads and the diversity of species vulnerable to road impacts. This is exacerbated in the Okanagan and Thompson regions where in addition to effects on amphibians and turtles, roads have a significant negative impact on a number of listed snake species. In the Cariboo, the primary road issues arise from impacts on Great Basin Spadefoot, Western Painted Turtle and Western Toads. In the Kootenays, the issues surround Northern Leopard Frogs, Western Painted Turtle, and Western Toad. Western Toads dominate the herpetofauna and roads issues that arise in Northern B.C. The impact of roads on B. C. Lizard species remains to be assessed in the various regions.

In summary, a large proportion of B.C. herpetofauna are of conservation concern. Roads have been listed as a potential threat for many of these species. Understanding the impacts of roads on these populations and designing effective mitigation is a high priority for both governmental and non-governmental organizations involved in management and conservation of herpetofauna in B.C.
ON THE ROAD AHEAD: HERPTOFAUNA AND BRITISH COLUMBIA HIGHWAYS

Leonard E. Sielecki, British Columbia Ministry of Transportation and Infrastructure, Victoria, BC Canada V8W9T5

Introduction: Since the late 1950’s, the British Columbia Ministry of Transportation and Infrastructure has been involved in efforts to protect amphibians and reptiles. From a small number of staff-initiated rattlesnake underpasses in the Okanagan Valley, to one of the world’s largest single concentrations of underpasses for toads and other small animals on Vancouver Island designed by highway project biologists and engineers, the Ministry’s approach to mitigating the impacts of highway development on herpetofauna is becoming more comprehensive. Consequently, the Ministry increasingly seeks expertise from other external sources for its herpetofauna protection initiatives.

Methods and Results: The British Columbia Ministry of Transportation and Infrastructure draws heavily upon the expertise of the British Columbia Ministry of Environment specialists and leading local, national, and international experts when dealing with herpetofauna issues.

In 2007, the Ministry successfully managed an unexpected mass migration of Western Toads across a major highway on Vancouver Island following advice from leading Canadian and Hungarian amphibian specialists. After the migration event, the Ministry developed a migration response protocol to prepare staff and contractors should similar events occur again in the province. In 2008, when a mass migration of toads re-occurred near the 2007 migration site, the protocol was successfully implemented.

In 2010, the Ministry published a field guide to assist staff and contractors in identifying amphibians and reptiles classified by the British Columbia Ministry of Environment as “Red” or “Blue” listed. The guide was made possible only by the contributions of local, national, and international herpetofauna experts and advice from specialists from the British Columbia Ministry of Environment.

In 2010, the Ministry developed amphibian wall designs to protect Red-Legged Frogs along highway right-of-ways in the Lower Mainland of British Columbia. The designs required extensive collaboration and discussions with Ministry engineers, species experts, material suppliers and fabricators, and British Columbia Ministry of Environment biologists.

Discussion: The success of Ministry of Transportation and Infrastructure efforts to protect herpetofauna along provincial highways in British Columbia is a direct result of advice obtained from leading local, national, and international experts and collaboration with specialists from other government ministries and agencies. Herpetofauna habitats are extremely complex ecosystems. Consequently, initiatives to protect herpetofauna require a collaborative, multi-disciplinary approach, utilizing expertise from numerous fields, including biology, ecology, hydrology, land use planning, and engineering. As the body of scientific knowledge about herpetofauna grows, there will be a greater need for dialogue between the Ministry, other government ministries and agencies, and external researchers to ensure Ministry efforts to protect herpetofauna achieve their full potential.
Literature Cited

.Painted Turtle Crossing, Photo Christian Engelstoft
ROADS AND HERPETOFAUNA: THE LEARNING CURVE
Barbara A. Beasley, Association of Wetland Stewards for Clayoquot and Barkley Sounds, Ucluelet, B.C., Canada V0R 3A0

When an individual or a non-profit group feels compelled to take action to deal with the mortality of herpetofauna on roads, what should they do? When I started 10 years ago, I did not imagine all the things I would need to learn along the way to finding a solution. The purpose of this talk is to introduce approaches for (1) understanding a site-specific problem with roads and herpetofauna, (2) identifying options to avoid or mitigate mortality, (3) implementing a solution, and (4) monitoring the effectiveness of the solution.

It is well accepted that roads have direct and indirect effects on herpetofauna. To understand these at a particular site level, there are all sorts of questions that need to be answered. Many are relatively easy, such as “Which species are (going to be) affected by the road or proposed road?“ Other questions are much more difficult, such as, “Will road mortality cause a population decline?” A sampling approach that links traffic volume and weather conditions to the amount of “roadkill” by species, age, and sex will provide data that can also be used to model the direct effect of roads on population dynamics. Landscape analyses can assess whether the placement of a proposed road will interfere with movement patterns.

The government document Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in B.C. proposes culverts as appropriate mitigation to reduce mortality. However very little work has been done to test whether tunnels are used by most of the species occurring in B.C. It is important to realize we are still at an experimental stage. Options that have the highest probability of success should be our first choice until we prove other options can work. In the case of new road building, this means pro-active planning to avoid important habitats, such as wetlands and surrounding areas, rather than assuming that culverts will suffice as connectors.

Implementing solutions requires combining expertise in herpetology and road engineering. People from different fields need to work together. Acquiring sufficient resources and motivating decision-makers to take action can be challenging. Workshops that allow for networking across disciplines and other forms of communication are helpful ways of bringing people together.

At this point in our provincial learning curve, it is valuable to monitor how well mitigation works. Evaluating levels of road mortality and road permeability, i.e., “can animals move through an installed culvert?” are equally important. It is also necessary to ask whether the mitigation creates any other issues: e.g., does a tunnel become a predator trap or does it concentrate individuals and cause increased probability of disease spread?

This workshop brings together many experts to share ideas about these and other types of approaches. I look forward to advancing up the learning curve together over the next two days.
THE BENEFITS AND LIMITATIONS OF TELEMETRY DATA AND MODELING TO EXPLORE ROAD PERMEABILITY FOR SNAKES

Bruce A. Kingsbury, Department of Biology, Indiana-Purdue University Fort Wayne, Fort Wayne, IN U.S.A. 46805.

Introduction: Many means of locating herps are heavily biased, such that discoveries occur where the animals are most obvious (e.g., crossing a road, basking) or where the observer is more likely to be (trail or road versus thicket). Telemetry offers the opportunity to find an animal at the time of the researcher’s choosing, and allows following the actions of secretive individuals not likely to otherwise ever be seen again. With respect to roads, it is thus possible to watch how an animal responds to a road, or for that matter, how it acts when no road is present. I discuss here some of my group’s findings with respect to snake movements and roads. I also discuss the pros and cons of a modeling approach to assessing cost to road crossing based on telemetry data.

Methods and Results: Using telemetry data from the federally threatened Copper-bellied Watersnake (Nerodia erythrogaster neglecta) and the ubiquitous Northern Watersnake (N. sipedon sipedon), and road densities in select areas of Indiana, we modeled the risk of road crossing to individual snakes (Roe et al. 2006). The findings of this model illustrated the relative risk to the snakes and the potential impacts to their respective populations (Fig. 1).

![Figure 1](image)

Figure 1. Differential consequences of roads in the landscape for two species of snake. A) The projected number of road crossings depending upon road density, and B) The relative risk of doing so. Figures derived from Roe et al. 2006.

Telemetry data of snakes near and far from roads paints a different picture. Telemetry observations may “stack up” against roads, such that snake movements near them are rather different from those further away. In some cases this pattern appears to result from a deflection of movements, while at other times snake locations might be inferred to be associated with the road. Ultimately we observe few efforts to cross roads, but also little evidence of road mortality.
Discussion: The modeling approach used does a reasonable job of projecting risk, and helps to explain why copperbellies tend not to be found in wetlands near roads during surveys. However, it is based on the behavior of snakes acting like the roads are not there. This may never truly be the case, and snakes certainly do respond in a species-specific manner to roads (Andrews and Gibbons 2005).

Indeed, the species we have studied tend to avoid crossing paved roads, or even wide gravel roads. They may also be attracted to the vicinity of roads. While the attraction based on the thermoregulatory opportunity of road surfaces may be overstated by some, road sides may offer thermoregulatory opportunities, and localized landscape features such as ditches and rip-rap may also be attractive.

Consequently, road avoidance means that the risk of mortality may be over-estimated by modeling. Nevertheless, the models capture elements of the differential risk between species. Such models also provide an opportunity for comparison with actual data around roads.

Regardless of how snakes respond to roads, either by not crossing them, or crossing them with some risk, the models can also help us understand fragmentation. Clark et al. (2010) showed very nicely that highways are fragmenting populations of Timber Rattlesnakes (*Crotalus horridus*) - no doubt this effect is pervasive across the landscape. This can come from either avoidance or mortality.

Future work in our lab will include efforts to quantify the extent of blockage/permeability to roads. I will discuss current challenges and goals, and seek feedback regarding approach, with modeling or otherwise.

Literature Cited


MODELLING TOOLS USED TO PRIORITIZE ROAD MITIGATION LOCATIONS FOR HERPETOFAUNA IN SOUTHERN ONTARIO

Kari E. Gunson, Eco-Kare International, 644 Bethune Street, Peterborough, Ontario, Canada K9H 4A3; David Ireland, Toronto Zoo, 361A Old Finch Avenue, Scarborough, Ontario, M1B 5K7; Noah Gaetz, Terrestrial Natural Heritage Ecology Division, Toronto and Region Conservation Authority

In Canada, the kilometres of roads per person exceeds that of any other country on earth and in southern Ontario the total length of major roads has increased fivefold between 1935 and 1995. Along with a dense road network, southern Ontario harbours the highest diversity of flora and fauna in Canada. As more and more natural habitat is encroached by anthropogenic land use, more and more species are classified as Species at Risk (SAR) with increased likelihood of extirpation from the region. Today, the negative impacts of roads are more commonly seen as a contributing factor leading to SAR designation and herpetofauna, amphibians and reptiles, are the leading taxa on the list (approximately 20 species). Turtles are most especially vulnerable with seven of Ontario’s eight turtle species listed as SAR and roads has been identified as one of the most significant threats for five of these species.

In 2007 a partnership of government, non-government, practitioners, and academic agencies was formed (the Ontario Road Ecology Group or OREG) to provide expert opinion on how to alleviate negative road impacts on Ontario’s wildlife populations. The initial task, stemming from a Species at Risk grant, was to prioritize where wetland-forest herpetofaunal species were most likely to be killed on Southern Ontario’s dense road network.

We selected wetland-forest semi-aquatic turtles and pond-breeding amphibians that make annual migrations to forested wetlands for breeding and over wintering. Pond-breeding amphibians include the: Spotted Salamander (Ambystoma maculatum), Wood Frog (Rana sylvatica), Gray Tree Frog (Hyla versicolor), Eastern American Toad, (Bufo a. americanus), Red-spotted Newt (Notophthalmus v. viridescens), Jefferson’s Salamander Complex (Ambystoma jeffersonianum), and semiaquatic freshwater turtles: Painted Turtle (Chrysemys picta), Snapping Turtle (Clemmys guttata), and Blanding’s Turtle (Emydoidea blandingii).

We used a landuse geospatial layer to assign a score of 100 to all wetland pixels (swamps, fens, bogs, marshes, and open water) a score of 50 to all forest pixels (forest, mixed-forest, deciduous forest, and plantations) and a score of 0 to all other land-use pixels (open, agriculture, and built-up). We then quantified a habitat suitability index (HSI) for each 15 x 15 m pixel in the landscape, by summing the pixels scores within a 200 m radius buffer. We selected 200 m radius buffers (12.6 hectares) as this has previously been defined as the ‘core terrestrial zone’ required by a local breeding population to maintain amphibian and reptilian diversity (Porej et al. 2004). The final HSI layer was added to the Ontario Road Network (ORN) layer to obtain an HSI score for each 15 by 15 m road pixel. The final HSI scores ranged from 0-55,000.

To validate our results we used an on-road presence (alive or dead on road) database for the selected wetland-forest amphibians and reptiles for eastern Ontario
from 1970 to 2005 (Bishop Mills Natural History Centre and OMNR Ontario Ministry of Natural Resources, unpublished data). We used Chi-Square statistics to determine that road pixels with scores > 30,000 had a significantly higher chance of having on-road herpetofaunal encounters than road pixels < 30,000.

This work has provided an effective tool that can be used to facilitate discussion between municipal and provincial level transportation planners for development of a regional transportation mitigation strategy. Ongoing work with municipal planners includes building on the above GIS model to provide species or taxa specific movement models that will locate significant wildlife-road conflicts. Furthermore, models will define habitat required to maintain viable populations, i.e., habitat that is in close proximity and accessible to maintain gene flow and recolonization in fluctuating climate conditions (Van der Grift and Pouwels, 2006). Road bisecting dispersal movements will be prioritized for mitigation to re-connect the landscape. Next steps include packaging the modeling process into a toolkit that can be easily presented to decision-makers and planners through various media, e.g., manuals, books, and workshops for integration into the transportation planning process.

Literature Cited
PLENARY SPEAKER – MIKLOS PUKY

Dr. Miklós Puky, senior research fellow at the Hungarian Danube Research Institute of the Hungarian Academy of Sciences, was born in Budapest in 1961. In 1986 he finished his university studies at University Eötvös, where he graduated as a biologist in 1986. In 1992 he defended his university doctorate titled *Heavy metal accumulation in Anura populations* and wrote his PhD in 2005 titled *Conservation of amphibians in Hungary*. He is the author of more than 100 articles. His work primarily focuses on the cognition and conservation of highly endangered animal groups, decapods, amphibians, and reptiles. Besides Hungary, he has also participated in foreign conservation work from Britain to Nepal and in the USA. His talks have generated considerable interest from Mexico and China to South-Africa and New Zealand. Conservation education at the national and international level is also important for Dr. Miklós Puky and he readily develops new approaches. He is the screenplay writer and a performer of Frog concerts, author of Ecotales and organiser of Carpathian Basin international children competitions. In his free time he readily enjoys the beauty of nature, music and sports and he is also a keen photographer. He is the founder and president of the Toad Action Group Association, head of IUCN SSC DAPTF Hungary. He has received several national and international prizes for his conservation and education activities such as the "Pro Natura" and the "For our Environment" Plaques, a winner of the Ten Outstanding Young People competition and the Ford European Conservation Award.

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HERPETOFAUNA AND ROADS, A EUROPEAN PERSPECTIVE: IMPORTANCE, SOLUTIONS, DESIGN, AND NEED FOR COMPARATIVE EFFICIENCY STUDIES.

*Miklós Puky*, Hungarian Danube Research Institute, Göd, Jávorka S. u. 14., 2131, Hungary

The abundance of vertebrate species in the world, based on assessed populations, fell by nearly a third on average between 1970 and 2006 and continues to fall globally. Amphibians face the greatest risk among the animal groups evaluated (Secretariat of the Convention on Biological Diversity, 2010). Given this, the need to lower the effect of roads on the herpetofauna is steadily increasing.

Among other direct effects of roads such as habitat loss, pollution, and disturbance, road kill is a key factor for amphibians. Roads affect amphibian distributions and can result in avoidance behaviour, unequal sex ratio, low density in the vicinity of sections
with high traffic, genetic isolation, and local extinction (e.g., see review by Puky 2005). Much less is known about the effect of roads on reptiles but they appear greater nearer to the Equator. Reptile populations near roads experience unequal sex ratios, and lower densities than populations further away from roads. Roads may also cause local declines. These effects are more severe as road density increases, as in the Georgia Depression region of British Columbia, where a road network comparable to the one in Japan exists.

Researchers have been aware of amphibian road kills for decades—the first paper on this topic appeared 75 years ago (Savage, 1935). Road kills are usually greatest near aquatic or other suitable habitats for amphibians, and in regional studies often along rural roads (see e.g., Orlowski 2007, Santos et al. 2007, Sillero 2008 for Bufo bufo in Spain and Poland). Mitigation measures to help herpetofauna move under or over roads in Europe have been in use for more than forty years—the first tunnels were built near Zurich, Switzerland in 1969. Several strategies have been applied at different sites including educational road signage, speed limits, temporary directive fencing, permanent technical solutions, closing or demolishing roads, and mitigation ponds. In the majority of cases, the permanent solutions consisted of tunnels or modified culverts with fencing erected to direct amphibians towards them. Many technical solutions have been developed, mainly as a result of engineering inventions. There is no standard solution, and the actual plans are influenced by several factors such as the spatial pattern of the migration, species composition, and local topography. The most favourable tunnels for amphibians have a large diameter (e.g., 1 m x 1 m; if the road is very wide 2 m x 2 m), moist microclimate (sometimes with a permanent or temporary stream), rectangular shape, natural soil in them, and a smooth tunnel - barrier wall connection (Schmidt and Zumbach 2008). Barrier walls or fences need to be erected in areas with high amphibian road mortality to prevent road kills, and to direct animals into the tunnels. Ideally, the walls or fencing have a zigzag configuration and if made from concrete, L-shape elements with an overhanging lip. Unlike fences, the barrier wall top should be level with the road surface to provide escape routes. Alternatively, escape ramps can be used to help amphibians leaving the road. Some systems are ineffective because of poor connections between different elements or a lack of maintenance. On the other hand, mitigation measures or viaducts designed for other wildlife or purposes may also be suitable for herpetofauna. Besides amphibians, reptiles including Natrix natrix and Lacerta agilis also cross roads using tunnels and fauna bridges.

Most mitigation measures in Europe were constructed to meet the requirements of large, common amphibian species with considerable migration distances, namely the Common Toad (Bufo bufo) and the Common Frog (Rana temporaria), which are abundant and play an important role in local ecosystems. However, at most road or railway sections several amphibian species cross together due to their similar habitat needs. In these cases, listed amphibian species should be given priority. The design should not only meet general standards but also consider the composition, relative abundance, and vulnerability of the local amphibian fauna in order to function as the most effective conservation corridor. Post-construction monitoring is greatly needed in Europe and elsewhere to determine whether the applied measures prevent road kills
and facilitate amphibian crossings. As well, monitoring would help determine what life stages utilize tunnels (adults, juveniles), seasonality of use, and how the mitigation measure affects the viability of neighbouring populations. In addition, more information is needed on the migration characteristics of several species, especially juvenile and adult newts (see e.g., Elzanowski et al. 2009), including more precise estimates of the percentage of the migrating population that needs to be protected from road kill to sustain their survival.

**Literature cited**


Road barrier with scuppers (passage below), Photo Terry Anderson
ASSESSING THE EFFECTIVENESS OF AMPHIBIAN MITIGATION ON THE SEA TO SKY HIGHWAY: PASSAGEWAY USE, ROADKILL MORTALITY, AND POPULATION-LEVEL EFFECTS

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Introduction: As part of the Sea to Sky Highway Improvement Project, a 1.9 km highway realignment was constructed through a wetland complex approximately 20 km south of Whistler. This option was proposed in response to concerns expressed by the communities of Pinecrest Estates and Black Tusk, and was constructed as an amendment to the original Environmental Assessment Certificate. Six aquatic-breeding amphibians occur here, including the Red-legged Frog (Rana aurora) and Western Toad (Anaxyrus boreas), both of which are federally-listed species at risk (“Of Special Concern”). Also present are the Northwestern Salamander (Ambystoma gracile), Long-toed Salamander (Ambystoma macrodactylum), Rough-skinned Newt (Taricha granulosa), and Pacific Chorus Frog (Pseudacris regilla). Construction resulted in the removal of approximately 4,160 m² of permanent and ephemeral wetlands, and salvage of 1037 amphibians, including 683 Red-legged Frogs.

Methods and Results: Mitigation measures were originally outlined in the Environmental Assessment within the application for the Pinecrest amendment. The level of mitigation was substantially increased after initial salvage operations and reassessment by an amphibian specialist demonstrated the abundance of habitat and large R. aurora populations that occurred in the area, which was not documented within the original EA. Mitigation measures were developed based on the expert opinion of consultants, and extensive negotiation between the project (MOT and PKS) and government agencies (MOE and EC). The final mitigation measures included: 1) adjusting the alignment to avoid permanent and ephemeral wetlands; 2) adding retaining walls to limit encroachment where overlap was unavoidable; 3) installing 8 wildlife/amphibian culvert underpasses to facilitate population connectivity; 4) installing drift fences to funnel animals towards culverts; 5) decommissioning part of the old highway and restoring wetlands and talus habitat there; 6) drainage and storm water management to maintain quantity and quality of wetlands; 7) protection of similar habitat through a park addition north of Brandywine Falls; and 8) funding to MOE for inventory, restoration, and post construction monitoring.

Post-construction monitoring included: 1) roadkill surveys to assess quantity, distribution, and timing of mortality; 2) installation of remote cameras at culvert entrances to assess passageway use; and 3) a mark-recapture study to assess the impact of road mortality on the local population growth rate of Red-legged Frogs.

Remote cameras frequently captured small and medium-sized mammals, which used passageways relatively frequently (32% use). Herpetofauna were less frequently observed, and appeared hesitant to use passageways (13% use). Roadkill surveys, adjusted for detectability, documented that approximately 400-500 amphibians are killed annually on the new alignment. However, roadkill rates were reduced by >50% in areas with ≥ 50m of drift fencing compared to areas with no barriers (F₅,₇₇ = 2.83;  P =
0.03; Figure 1). Using closed capture models in Program MARK, and extrapolating based on suitable habitat within the study area, I estimated the local population size of *R. aurora* to be 1500 – 1800 individuals. Given this estimate, annual roadkill has the potential to reduce juvenile and adult survival by 18 - 32%. A deterministic population model, using published vital rates, indicates that this reduction in survival will cause the population growth rate to be below replacement (λ = 0.71 – 0.86).

![Figure 1](image_url)

**Figure 1.** Mean amphibian roadkill per 50m-segment (±SE), adjacent to concrete barriers, retaining walls, cliffs, drift fencing, no barriers, or partial barriers (<50 m).

In response to the roadkill counts observed in 2009, MOE recommended to MOT that additional fencing be installed to limit highway access at areas of high roadkill mortality. This was completed in late fall of 2010. The fencing was installed too late in the season to directly assess its’ influence on roadkill mortality. However, a comparison of observed vs. predicted roadkill (based on temperature, precipitation, and traffic) demonstrated that observed counts were lower than predicted counts after installation of the new fencing. Additional roadkill surveys in 2011 will determine if this continues to be the case. It is expected that this new fencing will reduce annual roadkill rates, and will hopefully improve the population viability of Red-legged Frogs at Pinecrest.

**Discussion:** While drift fencing appeared to be effective in reducing roadkill, it was not extensive enough to substantially reduce annual roadkill throughout the alignment. During the EA, roadkill was not considered as a major impact. While roadkill impacts were identified in assessments post-certification, fencing was only considered as a mechanism to direct animals, not as a mitigation measure to reduce mortality. Future EAs of similar projects need to explicitly detail potential impacts due to road mortality, which can have significant population impacts, as shown in this study. Proposed mitigation should consider fencing as a method of exclusion. However, EAs need to balance the positive effects of exclusion fencing with the potential negative impact of isolating populations on either side of the highway.

An additional issue at Pinecrest was that the original EA did not use sufficient methods or efforts to properly quantify amphibian habitat and populations. As a result, the projected impacts were underestimated. Future EAs of similar projects need to employ sufficient methods, effort and expertise such that mitigation can be proposed that fits the true level of impacts. This may justify the use of more challenging mitigation measures, such as elevated highways and grated passageways.

Remote cameras indicated that amphibians are hesitant to use the passageways at Pinecrest. Design elements that allow light penetration, air flow, and moisture movement may help to improve use, as hesitancy is thought to be related to differences in microclimate between culverts and adjacent habitat. Future EAs should consider the likelihood that animals will use the passageways when determining if this mitigation measure is sufficient to mitigate impacts.
ADDRESSING WILDLIFE MORTALITY ON HIGHWAYS IN SOUTHEASTERN BRITISH COLUMBIA - WESTERN TOADS AT SUMMIT LAKE: A CASE STUDY


Introduction: Construction of BC Hydro dams in the Columbia Basin has impacted a broad suite of species, especially those associated with low elevation wetlands and riparian habitats. The Fish and Wildlife Compensation Program (FWCP) was created to compensate for those impacts. For some species where road mortality limits recovery, the most effective compensation is to work with agencies to address these problems. Western Toad (Anaxyrus boreas), Western Painted Turtle (Chrysemys picta), Northern Leopard Frog (Lithobates pipiens), and American Badger (Taxidea taxus) have been subjects of FWCP-sponsored road mortality studies and actions. Our case study involves a Western Toad population at Summit Lake, near Nakusp, B.C. The Western Toad is listed as Near Threatened by The World Conservation Union (Hammerson et al. 2004) and as Special Concern by the Committee on the Status of Endangered Wildlife In Canada (COSEWIC 2002). Summit Lake hosts a regionally and provincially significant breeding population of Western Toad, estimated to involve millions of individuals. Tens of thousands of adults and juveniles are killed by vehicle traffic on Highway 6 as they migrate to and from the lake in three phases every year consisting of adults moving to the lake to breed, adults leaving the lake post-breeding and toadlets leaving the lake after transforming from tadpoles. Migration is sporadic, taking place during warm, wet nights for adult toads and during wet or humid days for toadlets. Investigation of the mortality problem began in 1997 and mitigation structures (metal and plastic culverts and drift fences) were installed in 2006 (Seaton 2006) and monitored for efficacy in 2007 (Seaton 2008). Despite these efforts, significant mortality is still occurring. The current project was initiated to fully assess this issue via rigorous survey efforts with the end goal of designing effective mitigation measures within 2-3 years. The specific objectives for the 2010 season were to determine: 1) breeding distribution and the location, timing, and severity of highway mortality; 2) efficacy of the mitigation structures installed in 2006.

Methods and Results: Field work was conducted from 22Apr-01Oct and consisted of nocturnal road surveys for adults, canoe surveys for breeding sites, time-lapse photography within underpass culverts, and permanent toadlet sampling transects. Adult Western Toads were observed on Highway 6 for the duration of our survey period and total observations consisted of 12 live and 42 dead adults. We identified six main breeding areas (defined by the presence of 1-16 pairs of adults in amplexus) in sheltered waters with emergent vegetation. Subsequent movements of tadpoles and toadlets indicate that toadlets may not always emerge from the lake at the breeding sites. Permanent toadlet sampling transect revealed several important migration areas. Time-lapse photography captured relatively few toadlets and no adults using the culverts.

Discussion: Understanding the year-to-year variation in breeding and migration distribution is central to our assessment. Mapping the main migration routes will enable us to better address location and design features of future mitigation structures.
So far, we have found that some breeding sites and migration routes appear to remain constant while others vary from year to year. Determining the significance of mortality at juvenile and adult life stages will require population estimates of adults and juveniles which are currently not available. Future work will include population monitoring to inform priorities for crossing structures and provide a baseline for tracking population trends.

Literature Cited:


Seaton, P. 2006. Supply and installation of ACO wildlife fence and environmental monitor services for Highway #6 toad project at Summit Lake. Report prepared by Ingersol Mountain Enterprises Ltd for Ministry of Environment, Nelson, B.C.


Figure 1. Summit Lake Western Toad project area showing locations of July 2000 tadpole aggregations (Ohanjanian and Beaucher 2000), May 2010 breeding sites, mitigation structures installed in 2006 (Seaton 2006) and year-round creeks.
PLEANARY SPEAKER – KARI GUNSON

Kari Gunson, holds a B.Sc. in Zoology and Ecology from the University of Calgary, and a M.Sc. degree in Conservation Biology from the University of Cape Town, South Africa. Her most recent degree is a M.Sc. in Geospatial Technologies from the school of Environmental Sciences and Forestry with the State University of New York. The combination of the three degrees from around the world gives her a unique blend of international, biological and technical expertise.

Kari has worked for the past twelve years as a contract geospatial road ecologist on road mitigation projects throughout North America, including Banff National Park, Montana, New York, Vermont, and Ontario. Through her various projects she has solved complex road-wildlife issues for a variety of species including grizzly bears, cougars, coyotes, moose, deer, snakes, frogs, salamanders, and turtles. Her work has led to eight co-authored, peer-reviewed published articles in the fields of road ecology and Geographic Information Science.

In 2006, she co-founded the Ontario Road Ecology Group, completely devoted to lessening the impact of roads on the environment in Ontario. Kari enjoys bridging the gap between transportation planners, ecologists, and computer scientists to advance new frontiers in road ecology.

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INTEGRATING POLICY WITH ROAD ECOLOGY TOOLS AND TECHNIQUES INTO TRANSPORTATION PLANNING IN ONTARIO

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Introduction: In southern Ontario the total length of major roads has increased fivefold between 1935 and 1995 and there is no point in the landscape, excluding large lakes and protected areas, that is more than 1.5 km from a road. By 2031 population growth is projected to increase 30 percent necessitating a strategic plan for transportation infrastructure that will transport goods and people while also preserving natural features such as wetlands. Roads pose a significant threat to many rare species of plants and animals in the region and it is not known at what threshold road density will drastically decrease the long-term viability of these populations.

Objective: Over the past thirty years road ecologists have been establishing several techniques and tools to restore natural ecological processes in a landscape inundated by roads. This presentation will discuss and present case studies where the current techniques and tools can be integrated into the transportation planning process in
Ontario. In addition, mechanisms for dissemination of information, e.g., manuals, books, and workshops, to land-use planners are discussed.

**Discussion:** Ontario manages its land-use through the Provincial Policy Statement (PPS) developed and reviewed by the Ministry of Municipal Affairs and Housing (MMAH). Municipalities then devise their ‘Official Plans’ and ‘Master Transportation Plans’ outlining land-use and transportation needs within the policy guidelines. Within their ‘Official Plans’ municipalities use natural heritage systems, that connect significant wetlands, woodlands, and areas of natural and scientific interest. In addition, under the Endangered Species Act (ESA, 2007) municipalities are striving to map and protect habitat used by Species at Risk (SAR). These mapping techniques provide opportunities to find a sustainable balance between socio-economic land use needs and SAR and natural heritage protection. Road ecology techniques and tools, e.g., road-kill hotspot mapping can also be integrated within these processes to further refine conservation planning. Proactive planning can avoid building roads in significant areas with high connectivity and natural heritage values.

Flow chart, showing a general methodology for integrating landscape connectivity modeling into transportation planning.

However, typically, once a socio-economic need for a road is established it will be built. At this point planners will need to mitigate environmental impacts under the Environmental Assessment Act (EAA) in Ontario. There are several stages where best ‘road ecology’ management practices can be integrated into the process. For example, in the route planning stage algorithms can be developed to identify route alternatives that will lessen fragmentation impacts on natural heritage. Furthermore, in the preliminary design stage mitigation measures, e.g., crossing structures can be effectively placed and designed in an attempt to reconnect natural areas separated by a road.
AMPHIBIAN OCCURRENCE ON SOUTH OKANAGAN ROADWAYS, B.C.: REALISING MOVEMENT CORRIDORS AND IMPROVINC CONNECTIVITY

Brent Persello\textsuperscript{1*}; Jonquil E. Crosby\textsuperscript{2*}, Sara L. Ashpole\textsuperscript{3}, and Stephen Murphy\textsuperscript{2}

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Introduction: Increased traffic and road expansion along Highway 97, a main artery through British Columbia’s south Okanagan Valley, serves as a barrier to amphibian migration and dispersal events. Annual movements for the COSEWIC listed Blotted Tiger Salamander \textit{(Ambystoma mavortium melanostictum)} and Great Basin Spadefoot \textit{(Spea intermontana)} occur from upland overwintering habitat to lowland breeding areas, followed by travel to as-yet unspecified foraging grounds. The purpose of our study is to assess amphibian movement and population threats across a landscape bisected by a highway. The amphibian species data collected represents pre-construction road activity, acting as a baseline for further studies examining post-construction impact and evaluating the success of mitigation actions.

Methods & Results: From 15 April to 3 July 2010, 60 night-time road surveys (totaling 232 observation hours) recorded amphibian occurrence and traffic volume. Over 50 km of roadways were surveyed within the South Okanagan including Highway 97 from the U.S. border to north of Oliver B.C., as well as a scenic secondary roadway. Surveys were carried out utilising vehicles, bicycles, and on foot. Survey efforts were concentrated within a 3-km highway construction zone adjacent to a floodplain. This road section was surveyed on 46 nights, compared to three secondary routes that were surveyed on average 22 times each. Three species of amphibians were found on the roadways within the survey area: Great Basin Spadefoot \textit{(Spea intermontana)}, Pacific Chorus Frog \textit{(Pseudacris regilla)}, and Blotted Tiger Salamander \textit{(Ambystoma mavortium melanostictum)}. Nine Blotted Tiger Salamander mortalities were recorded with 1 live individual; 60 Pacific Treefrog mortalities as well as 25 living; 717 Great Basin Spadefoot adult mortalities and 459 living; and 199 Spadefoot metamorph mortalities with 152 live individuals (the latter were relocated off the road). We also estimated another 400 dead Spadefoot metamorphs during emigration by partial remains or smears. The majority of movements occurred during thirty wet, rainy nights over the thirteen week study period.

Discussion: Amphibian road use data and landscape variables from the 2010 field season have been included in plans for mitigating the effects of the highway expansion. Construction through 2010 to early 2011 will include strategic culvert placement and enhancement, combined with directive fencing to guide herpetofauna to the culverts. Eight corrugated steel pipe culverts (900-1200 mm) have been proposed for placement in areas of greatest recorded amphibian road occurrence. It is recommended that both a soil floor and refuge materials be put into the culverts for optimal amphibian use.
Continued research on post-construction roadway effects on amphibians, monitored use of culverts through camera traps (proposed), high priority wetland surveys, and greater movement data will commence in 2011 when the passing lane will be in use. Strengthening partnerships between adjacent private landowners and continued stewardship efforts through public presentations will continue in 2011. This project is a collaboration between the University of Waterloo, the British Columbia Ministry of Transportation and Infrastructure, the BC Ministry of Environment, and The Land Conservancy of BC.

Western Painted Turtle road kill, Photo Purnima Govindarajulu
THE SPLAT PROJECT ON HIGHWAY 4 – PACIFIC RIM NATIONAL PARK RESERVE

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Highway 4 crosses the Long Beach Unit of Pacific Rim National Park Reserve and fragments wetland and riparian habitats used by amphibians for breeding, foraging, and over-wintering. Each spring and autumn, amphibians move between habitats on rainy nights. Six species are killed while crossing the highway: the Northwestern Salamander (Ambystoma gracile), Pacific Treefrog (Pseudacris regilla), Red-legged Frog (Rana aurora), Rough-skinned Newt (Taricha granulosa), Western Red-backed Salamander (Plethodon vehiculum), and Wandering Salamander (Aneides vagrans). Of these, the Red-legged Frog is listed as a species at risk (“Special Concern”) in Canada.

From 2000 to 2006, community volunteers and Parks Canada staff assisted in surveying the 40-km highway between Ucluelet and Tofino for amphibian road-kill (“SPLATS”) to determine where to focus mitigation efforts. We counted a total of 978 dead amphibians (average 27±6.5 SE per survey, N=36 surveys) with a maximum of 224 individuals killed in one survey (Beasley 2006, Wildlife Afield 3:1 Supplement). The highest density of mortality occurred along a 2-km stretch of Highway 4 adjacent to Swan Lake, a wetland just southeast of Pacific Rim National Park Reserve.

In 2005, we installed three 90-m sections of temporary fence and pitfall traps on each side of the highway near Swan Lake. Since then, we have trapped amphibians at the fences and released them on the other side of the road, while continuing to count road-kill along unfenced sections of the highway. Most of our trapping occurs in the autumn when the highest numbers of amphibians, mainly juveniles, are moving across the highway. For example, in autumn 2010, we moved 762 amphibians across the highway (average 27±4 SE per night, N=28 nights) and approximately 73% were juvenile and immature individuals. The majority were Red-legged Frogs (55%) and Northwestern Salamanders (31%). We rarely catch Pacific Treefrogs (2%) even though they comprise a relatively high proportion of the road-kill in unfenced sections (~30%).

We obtained estimates of traffic volume from a traffic counter at the Tofino-Ucluelet Junction of Highway 4. Autumn traffic volume ranged from 120 vehicles/hour at dusk to a low of 2 vehicles/hour around midnight. The ratio of amphibians killed in unfenced sections to number caught at fences, indicates that 20 to 50% of the amphibians trying to cross the highway are killed. Low traffic volume accounts for the successful crossing of the rest.

In 2007, we began surveying breeding Red-legged Frogs and Northwestern Salamanders by counting egg masses in Swan Lake and wetlands close to Highway 4. Swan Lake had higher counts (884 egg masses in 2007; 895 egg masses in 2009) than those found in 96% of 132 water bodies inventoried by the B.C. Ministry of Environment throughout Vancouver Island from 2006 to 2008 (D. McConkey, personal communication). Thus, the area affected by Highway 4 appears to be a “hotspot” for Red-legged Frogs.

We are developing a population model to predict critical thresholds of road mortality that could cause a decline in the local population levels of Red-legged Frogs.
Data collected on the number of breeding females, traffic volume, weather conditions, seasonal movements, and road mortality of different age and sex classes will be incorporated into the model.

There are four drainage culverts under Highway 4 where peak mortality occurs in the vicinity of Swan Lake. Using minnow traps we monitored amphibian movements through these existing drainage culverts. We captured four Red-legged Frogs and eight adult Northwestern Salamanders (N=235 trap x nights). Only one of the four culverts had low enough water-flow to allow movement on a regular basis. In 2009-2010 we installed directional fencing to guide amphibians to the entrance and used an infrared camera to detect amphibian movements through the low-flow culvert. The camera has detected 15 amphibians, nine frogs and six Northwestern Salamanders, moving through the culvert on 15 nights (45 nights sampled). The rate of detection was very low - 21 frames out of 36,192 possible frames, or 0.05 %.

In 2007, we reviewed the literature for optimal tunnel design for families of concern on Highway 4 – Ranidae, Ambystomatidae, Salamandridae and Plethodontidae. We also visited tunnel installations on Vancouver Island and where available, post-construction effectiveness data. Very little success had been documented for Ranidae but, in successful cases, there were three critical features: large size, natural substrate, and directional fencing to lead animals to the tunnel entrance.

In 2010, the Ministry of Transportation (MoT) procured an elevation survey of the road and drainage ditches at the Highway 4 site. With MoT staff, we designed a tunnel based on (i) the size of the roadbed, (ii) features of tunnels known to work best for amphibians in other projects, (iii) affordable construction materials, and (iv) MoT’s specifications for safe road construction. We are currently in the process of obtaining a permit, ordering materials, and organizing contractors to do the installation of a pre-cast concrete culvert that will be imbedded in the highway. The finished opening size will be approximately 1.8 m wide x 0.5 m high. We expect the materials and installation to cost between $50,000 and $75,000. We will describe the installation process as it happens at www.splatfrogtunnel.blogspot.com.

We plan to monitor the effectiveness of the new tunnel post-construction by: 1) road searches for mortality, 2) photo-monitoring within both the new tunnel and existing culvert, and 3) mark-recapture of animals moving along directional fences. We have already installed a set of directional fences to lead amphibians to the proposed tunnel location. In autumn 2010, we assessed its effectiveness in three ways. First, we captured 242 frogs and salamanders along all the directional fences during 19 nights of trapping, indicating that the fences intercept a large number of amphibians. Second, we marked 83 Red-legged frogs caught along the directional fences leading to the proposed tunnel. We recaptured 16 (19%) of the marked Red-legged frogs in roadside traps where the tunnel will be installed. Third, we tallied the number of amphibians caught along the verge of the road during 22 nights of trapping. There were four times more amphibians per trap at the proposed tunnel location than anywhere else. Amphibians (total 131) were caught at the proposed entranceways indicating that the directional fencing was reasonably effective. Next autumn we will test whether amphibians move through the tunnel once they get there.
Abstracts
Poster Presentations
# Herpetofauna and Roads Workshop

*Is there light at the end of the tunnel?*

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Turtle nesting site on road shoulder Photo Purnima Govindarajulu
ASSESSING THE IMPACTS OF VEHICULAR MORTALITY OF MIGRATING AMPHIBIANS NEAR RYDER LAKE, BRITISH COLUMBIA

Steve M. Clegg, Fraser Valley Conservancy, Abbotsford, BC Canada V2T 3J6

Introduction: In the rural community of Ryder Lake BC, a wetland that supports a large breeding population of amphibians is bordered by roads on three sides. During their three annual migrations, many individuals from six different amphibian species are hit on the roads. The Fraser Valley Conservancy (FVC) and local landowners have been studying the situation for four years and have made advances in short term mitigation measures. In 2010, a more comprehensive study was undertaken to assess the timing and location of the amphibian road crossings to determine the most appropriate sites for migration tunnels under the roadways.

Methods and Results: A survey route was chosen to encompass the three roads that surround the wetland. The same route was followed each monitoring night by walking in one road lane heading out and the other road lane heading back in order to cover new area with each pass for a total of 5.6 km. This method of road survey was adapted from the Western Toad / Amphibian Monitoring Program Survey Protocol developed by the BC Ministry of Environment in 2009. For consistency, the same person completed all monitoring sessions individually or with volunteers depending on their availability. Data collection began on February 24, 2010 and continued intermittedly until June 9, 2010 for a total of 17 sessions. Monitoring nights were selected based on suitable weather conditions for amphibian movement such as rain, fog, or dense cloud cover. Surveys always began near dark and continued for one hour to four hours depending on the number of amphibians found. Each time an individual was encountered the following information was collected: species name, alive or dead, sex (if determinable), snout-to-vent length, GPS location, and likely cause of death (if dead). To avoid double counting, live amphibians were moved to the side of the road they were headed to when found and if dead they were moved off to the closest shoulder. During the monitoring sessions a total of 723 individuals were found from six different species. Of the 723 individuals, 307 (42%) were found alive while 416 (58%) were found dead (Table 1).

Table 1: The composition of all amphibians found either dead or alive during the 17 monitoring sessions near Ryder Lake BC in 2010.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Number</th>
<th>Alive %</th>
<th>Dead %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Pacific Treefrog</td>
<td><em>Pseudacris regilla</em></td>
<td>334</td>
<td>41%</td>
<td>59%</td>
</tr>
<tr>
<td>Western Toad</td>
<td><em>Anaxyrus boreas</em></td>
<td>266</td>
<td>52%</td>
<td>48%</td>
</tr>
<tr>
<td>Northern Red-legged Frog</td>
<td><em>Rana aura</em></td>
<td>115</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>Rough-skinned Newt</td>
<td><em>Taricha granulosa</em></td>
<td>5</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Northwestern Salamander</td>
<td><em>Ambystoma gracile</em></td>
<td>2</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Western Red-backed Salamander</td>
<td><em>Plethodon vehiculum</em></td>
<td>1</td>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>

The minimum number of individuals found on a single monitoring session was two while the median number of individuals derived from all 17 monitoring sessions was 31. A maximum of 175 individuals were found on April 20th 2010. This monitoring session marked the observed shift in amphibian migration to and from the breeding wetland. Before April 20th the directional
trend of amphibian movement was towards the wetland. In contrast, after April 20th the directional trend of amphibian movement was away from the wetland back to forested upland habitat. Amphibians were found traveling both to and from the breeding site along all areas of the monitoring route. However, by analyzing this study’s aggregate GPS data in the computer program Mapsource, four sections of the monitoring route were visually determined to be key migratory corridors as they showed dense or clustered amphibian crossings in both migratory directions. The general migratory directions were assessed by looking closer at the GPS points within the suggested four corridors and cross referencing the point numbers with the date the points were taken. One suggested corridor contained various points that were found in March, April, May, and June. This demonstrates that these corridors sustained concentrated amphibian movement in both migratory directions as aggregate migration before April 20th was towards the wetland while aggregate migration after April 20th was away from the wetland.

Discussion: Multiple temporary mitigation measures have been attempted by local residents, volunteers, and the FVC. The placement of temporary signage has been considered, but not implemented in this case because aside from generating public awareness the signs are known to be ineffective (Ovaska et al. 2004). The transport of amphibians from one side of the road to the other via volunteers has been determined to be safe and effective (Ovaska et al. 2004). Yet, the FVC used this method during the summer juvenile migration of 2008 and found that the amphibians’ directional orientation was compromised after being placed, and transported, in a bucket. Further, added stress to the toadlets, inadvertent mortality due to trampling by volunteers, and the possibility of disease transfer was too great a risk to continue this method of mitigation for the juveniles or adults alike. The FVC has also utilized temporary road closures to protect the short-duration mass-migration of juvenile Western Toads. However, due to the long migration period of the adult amphibians discussed in this report, intermittent road closures from February to June are not likely to be accepted by the community. To overcome the challenges of short term fixes and unsustainable levels of volunteer effort, permanent long-term solutions are sought. Tunnels are commonly used to permit the simultaneous operation of vehicles on the road surface while amphibians travel below the passing vehicles unharmed (Langton, 1989; Ovaska et al. 2004). Four such tunnel sites have been proposed in or near the key migratory corridors identified above. Further consideration was given to areas that were relatively vegetated on both sides of the road allowing amphibians to travel primarily under the protective cover of native vegetation. Three of the locations follow waterways such as ditches and streams, while the fourth is almost the shortest route between the breeding wetland and the next closest water body. All four proposed tunnel locations direct amphibians to and from the shallow northern end of the wetland where the adults naturally congregate to mate and the resulting offspring undergo metamorphosis. The four tunnel locations proposed above, within the key migratory corridors, are candidates for further multi-year study to ensure accurate placement.

Literature Cited
MITIGATING ROAD MORTALITY OF THE WESTERN PAINTED TURTLE IN THE MUNICIPALITY OF
SAANICH: ROAD SIGN INSTALLATION IN 2010
Christian Engelstoft, Kristiina Ovaska, Adam Taylor, and Darren Copley
Habitat Acquisition Trust, P.O. Box 8552, Victoria, BC, V8W 3S2; District of Saanich, 770 Vernon Avenue
Victoria, BC Canada V8X 2W7

This project is part of broader conservation effort aiming to mitigate threats to endangered
Pacific Coast populations of Western Painted Turtle (Chrysemys picta bellii) on Vancouver
Island. In an attempt to mitigate road mortality, the District of Saanich in collaboration with
Habitat Acquisition Trust, erected two “turtle crossing” signs in an area where mortality had
been observed in 2008 and 2009 on Beaver Lake Road. Signs were installed in late March and
removed in mid-September 2010. One of the signs had to be replaced because it disappeared
soon after its installation. The road and road shoulders between the signs were surveyed for
turtles 117 times from March to July 2010, when hatchlings emerge from their nests and
females lay their eggs. A traffic counter was installed for a 5-day period both before and after
the signs were erected. Before sign installation, 1584 vehicles passed the site going an average
speed of 34 km/h; the speed of 85% of the vehicles was less than 42 km/h. After sign
installation, 2089 vehicles passed the site going an average speed of 33 km/h; the speed of 85%
of the vehicles was less than 40 km/h. More than 69-75% of the traffic occurred between
10:00 to 16:00.

The slightly lower speed after the installation of the signs did not prevent five Western
Painted Turtle hatchlings from being run over on 31 March 2010. A desiccated Western Painted
Turtle hatchling was found on the side of the road on 26 April. A newly emerged nest on the
shoulder of the road adjacent to the road kill site was located on 31 March, and we assumed
that all six hatchlings emerged from this nest as it was the only nest found in the area. No adult
females were seen laying eggs and no other signs of nesting were observed along the road. We
did observe adult turtles crossing adjacent gravel roads in June and July 2010.

Considering the small size of newly hatched Western Painted Turtles, it is not surprising that
motorists did not see the juveniles on the road. A more effective measure for protecting
hatchling turtles would be to install a low fence around the nest sites. The enclosure should be
monitored daily for hatchlings and, if found, they should be carried to the nearest pond.

The intention of the signs was to prevent adult mortality, and we documented that the
majority of the traffic occurred during the day. Generally, Western Painted Turtle females lay
their eggs at dusk and dawn, so traffic at this time of day is the greatest threat to them. Drivers
that regularly pass the signs would have been alerted to the possibility of encountering turtles
on the road and hopefully would have been prepared to avoid a collision. The signs also
functioned as outreach tools, informing drivers of the presence of turtles in the area and their
vulnerability to road mortality.

We recommend that the signs be reinstalled for the March – July hatching and breeding
period in 2011, that motorists be surveyed to find out whether they saw the signs and how it
affected their behaviour. We also recommend that the road be monitored for mortality, turtle
nests, and if emerging nests are found, that they be protected with an enclosure and hatchlings
be carried to the nearby pond.
CREATION OF WESTERN PAINTED TURTLE NESTING HABITAT REDUCES ROAD MORTALITY ON THE SOUTH COAST OF B.C.

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Introduction: Habitat loss and degradation is extensive on the south coast of British Columbia, and wetland habitat, in particular, has been significantly affected by unsustainable development practices. In the Lower Mainland/ Fraser River Valley, 87% of wetlands were lost between the 1820s and 1990s to urban development and agriculture (Boyle et al., 1997), and habitat loss still continues in many areas of the coast. On the Sunshine Coast, remaining wetlands are particularly vulnerable to destruction and degradation as this region is now the third fastest-growing area in B.C.

Most species of herpetofauna require both aquatic and terrestrial habitat to complete their life cycles (Semlitsch and Bodie, 2003), and are particularly vulnerable to road-related mortality as they move overland between habitats (Bowne et al., 2006). Approximately one-third of reptile and amphibian species inhabiting the south coast of B.C. are threatened or endangered. The only native freshwater turtle in B.C, the coastal population of Western Painted Turtle (Chrysemys picta bellii), is both provincially red-listed and federally endangered.

The Sunshine Coast currently supports the greatest number of Western Painted Turtle populations, but road mortality is a significant threat to their persistence. Several main roadways, including the Sunshine Coast Highway, run parallel to or bisect many lowland water bodies occupied by Painted Turtles. During the nesting season, female turtles are often killed as they travel overland seeking nesting areas. Moreover, roadways often attract nesting turtles due to their loose soil and gravel composition. Despite this attractiveness, road shoulder substrates are often unsuitable (e.g., do not maintain adequate temperature and moisture) and cannot support the survival of eggs through to hatching. Suitable alternative nesting habitat is limited and/or lacking at many occupied sites on the Sunshine Coast, leaving turtles with no choice but to nest along roadways. The goal of our project was to reduce the impacts of road mortality by addressing the lack of suitable nesting habitat.

Methods and Results: During the 2008 nesting season, 17 turtles (most likely nesting females) were killed in a 50 m section of highway that bisects Ruby Lake and Ruby Lake Lagoon. To determine the scope of this problem and to initiate mitigation measures, in 2009 project leaders conducted monitoring and concurrent salvage. It appeared that most turtles were crossing the highway from the lagoon side.

Painted Turtles are known to prefer nesting locations that are south-facing, open-canopy areas, on flat or gently sloping ground with little vegetation, and generally within 50 m of the water’s edge (Marchand and Litvaitis 2004). Because the highway was within meters of the lagoon edge and ran the length of the south-facing area adjacent to the lagoon, there were few alternatives with respect to where nesting habitat could be created. In cooperation with the private landowner, we identified an area frequently traversed by turtles that was adjacent to the lagoon and between the water’s edge and the roadside on a south-facing slope. By creating
new nesting habitat at this site, we hoped to intercept turtles moving from the water body to the roadside.

In December 2009, we sourced a combination of sand, silt, and clay from the local quarry, and mixed it on site by hand to mimic loam soil. Loam soils (40% sand, 40% silt, and 20% clay) promote highest hatching success because they maintain high soil temperatures and moisture while at the same time remaining well-drained (Costanzo et al., 2000). We first had to remove dense vegetation before laying the substrate. To prevent erosion, we did not remove the vegetation immediately along the shoreline. After clearing, the substrate was distributed by hand and raked into place. The nesting area is about 60 m² and at least 40 cm deep and used roughly 20 m³ of material. Prior to the nesting season in May 2010, the landowner erected signage and fencing to prevent human disturbance. Monitoring began in late May 2010 and continued through to early July. We documented eight turtle nests in the new nesting beach and only one confirmed case of road-related mortality. None of the nests were depredated. Discussion: Road mortality declined dramatically following creation of suitable nesting habitat at this site. We documented high use of the new nesting habitat by resident female turtles. These results suggest that our mitigation should be considered as a potential method in other regions where there is high road mortality due to lack of suitable nesting habitat.

We initially had concerns that creating nesting habitat adjacent to the road would exacerbate the problem. However, based on population assessments conducted in 2009, we suspected that over 50% of female turtles from this population had been killed in a single year. Immediate mitigation was clearly critical and taking no action appeared to be the riskier option.

Project success will be evaluated during spring 2011 monitoring for hatchling recruitment. Ongoing annual monitoring of nesting turtles and subsequent recruitment, assessing road mortality, and evaluating potential hazards such as increased predation will be required. Adaptive management is essential for continued success of this project. The nesting area will require continued vegetation removal, and we may need to install predator-proof fencing or nest cages, erecting fencing and/or installing tunnels to permit wildlife passage.

Literature Cited
ASSESSMENT OF AMPHIBIAN MOVEMENT AND TERRESTRIAL HABITAT USAGE IN A FRAGMENTED URBAN WATERSHED

R. Jalene Littlejohn*, Catherine de Rivera, Environmental Science and Management Department, School of the Environment, Portland State University, Portland, Oregon, USA, 97207. *rjlittle@pdx.edu.

Introduction: Urbanization can have detrimental effects on amphibian populations through habitat loss and fragmentation. In addition to other consequences of fragmentation, mortality risk for amphibians increases due to crossing roads and other barriers. Management for amphibians has largely focused on wetlands but such efforts do not address many of the problems from habitat loss and fragmentation that more terrestrial frogs may face when dispersing and as adults. For example, city and regional governments in and around Portland and Gresham, Oregon have been collecting data about pond-breeding amphibian species for a number of years through egg mass monitoring programs but little is known about the movement and terrestrial habitat use by the dispersing and adult amphibians.

Proposed Methods: The goal of this project is to collect data about amphibian movement from known breeding ponds into surrounding terrestrial habitat, with emphasis on urban barriers and their effect on movement patterns. Particularly, this study will focus on the habitat needs and movement of the Northern Red-legged Frog (Rana aurora). To achieve this goal, three to five sites will be selected in one urban watershed. Trapping grids of drift fences and pitfall traps will be positioned around breeding and upland habitat at each site and habitat assessments will be conducted. Mark-recapture will be used to collect data about the resident amphibians including movement to and from critical terrestrial habitat and patterns associated with surrounding barriers and connected green space. Coloured elastomer markings will be used to identify individuals based on site location of capture and direction of travel. Additional biological information will be recorded at the time of capture. A sub-sample of Northern Red-legged Frogs adults will be tracked using radio tags attached with adjustable bands. In partnership with local agencies, data collection will begin in spring, 2011 and continue through Fall, 2012. This study will help inform watershed managers about amphibian habitat needs for more effective conservation of habitat, especially in urban areas.

Literature cited:
SNakes on a lane

Mike Sarell, Ophiuchus Consulting, Oliver, B. C. and Darcy Pickard, Essa Technologies, Vancouver, BC, V6J 5C6

Road mortality of snakes was observed for a 25 kilometre rural road segment in Southern British Columbia for most years from 1988 through 2008. The data were collected with varying degrees of effort ranging from one road cruise every three weeks to six road cruises per week from April to October each year. This study is a retrospective analysis to determine: population declines of listed species, the key periods of road mortality, key habitat factors influencing road mortality, the potential use of road mortality data as an index of abundance, and to provide recommendations to improve future data collection.

Four species of listed snakes were observed over the course of the study: Racer (Coluber constrictor), Great Basin Gopher Snake (Pituophis catenifer deserticola), Rubber Boa (Charina bottae), and Western Rattlesnake (Crotalus oreganos). Gopher Snakes (45%) and Western Rattlesnakes (31%) comprised the majority of the observations. 33% of the observations occur during September, the period when the snakes are returning to their dens. We found that the dominant habitat type, and distance to the closest den influenced the frequency of observations for Gopher Snakes, Rattlesnakes, and Racers. The distance to the nearest gully was also important for Gopher Snakes and Rattlesnakes, while the presence of water within a segment was only important for Rattlesnakes. We hope that understanding the relationship between landscape predictors and frequency of road observations will provide useful for mitigation efforts. The high frequency of Gopher Snake observations on the road combined with low frequency of Gopher Snake observations at den sites, led us to explore the possibility of using road mortality as an index of abundance for this species. Given limiting funding levels and the difficulty of finding Gopher Snakes using other methods such as: den counts, live-trapping, and cover boards, road mortality may provide a reasonable long-term index of abundance for local populations in areas with roads. This approach may also be useful for Racers.

Despite some limitations encountered with the dataset during this retrospective analysis, road mortality observations are a relatively low cost method for obtaining a wide variety of data and with a few adjustments (e.g. formalizing effort measurements) they could be useful on a wider scale in temperate climates.
TOADLET TSUNAMI STRIKES VANCOURVER ISLAND HIGHWAY

Leonard E. Sielecki, British Columbia Ministry of Transportation and Infrastructure, Victoria, BC Canada, V8W 9T5.

Introduction: In August, 2007, the British Columbia Ministry of Transportation and Infrastructure (BCMoT) experienced an unpredicted and unexpected, large scale migration of Western toads (Bufo boreas) occurring across the Vancouver Island Inland Highway (Highway 19). Although extensive wildlife assessments conducted prior to the design and construction of the highway did not identify the potential for Western toads, an estimated one million toadlets were discovered converging on the highway. The migration continued for over a 13 week period and was successfully managed by BCMoT staff, maintenance contractors, species specialists and volunteers. The migration event occurred without any motor vehicle collisions or human injuries or fatalities.

Methods and Results: Upon discovery of the toadlet migration, temporary amphibian fencing was immediately installed on the right-of-way for approximately 2 kilometres along Highway 19. A system of fencing and catch buckets was developed to safely direct and collect the toadlets. Over the course of 13 weeks, thousands of toadlets were successfully recovered and transported across the highway. As a result of the migration, BCMoT developed a wildlife migration response protocol and initiated Western Toad monitoring in the area.

Discussion: Similar migration events, with the same or other amphibian species, have the potential to occur at other highway locations in British Columbia. Due to the dynamic nature of amphibian migrations, wildlife assessments conducted prior to the design and construction of new highways may still miss identifying the potential for such events. The wildlife migration response protocol provides a framework for the safe and effective management of unexpected amphibian migration events.

Literature Cited


Toadlets at road barrier Photo Terry Anderson,
AMPHIBIAN MIGRATION ACROSS A NEW RESIDENTIAL ROAD
Joanne P. Schuett-Hames, Frithiof T. Waterstrat, Marc P. Hayes, Tiffany L. Hicks, Eric M. Lund, Aimee P. McIntyre, Dave E. Schuett-Hames, Julie A. Tyson. South Sound Herps Crossing Working Group. 5146 Blue Heron Lane, Olympia, WA, USA 98502.

Introduction: The Pacific Northwest is a challenging region in which to identify, plan, and mitigate for vehicle-caused road mortality on amphibians. This region, especially the Salish lowlands of the Puget Sound-Georgia Basin, is experiencing rapid human population growth, which increases habitat alteration and fragmentation in the form of new housing and associated infrastructure (White and Ernst 2003; Andrews et al. 2008). Roads built near wetlands can isolate breeding habitats and disrupt the migration routes of native amphibians (Ashley and Robinson, 1996). This region sustains months of wet conditions favorable for amphibian migration when migrating animals may risk mortality from vehicles.

Road mortality surveys conducted in 2006 and 2007 (JSH, unpubl. data) pinpointed concentration areas of amphibian mortality on a rural residential road within Thurston County, Washington, USA. Concurrent with this discovery was the planning of a new large-lot subdivision between one of the areas where high amphibian mortality had been observed and a large wetland complex. The new access road and the impending housing development presented a unique opportunity to proactively develop guidance for measures to allow amphibians to cross safely. It also enabled an overview of the migrating amphibian assemblage and their migration patterns across these new roads prior to residential development. In this study, our overarching goal was to develop a knowledge base of where and when amphibians might be crossing the new roads such that future efforts might refine this knowledge and provide guidance to thoughtfully implement safe crossing measures.

Methods and Results: The new development roads consisted of a main segment 1,260 m long and a 133 m spur. Roads had an asphalt surface ~6 m wide, with the exception of three circular asphalt areas ~20 m in diameter (two located along the main segment and one at the end of the spur). All roads were bounded by mown grass strips 6-20 m wide. A small ephemeral stream originating from the aforementioned wetland complex flowed under the road through a 1.8-m diameter culvert roughly midway along the main segment. The surrounding landscape is a mix of second-growth Douglas-fir (Pseudotsuga menziesii) forest and coniferous-deciduous forest dominated by Big-leaf Maple (Acer macrophyllum) with a secondary canopy of Douglas-fir and Western Red Cedar (Thuja plicata).

We surveyed once a month from October 2008 to February 2009 except for January. We selected dates conducive to amphibian movement (wet, relatively warm [minimum 8-10 °C] conditions). Each survey was conducted over 24 hours, starting at 16:00 h. During each of six sequential 4-h intervals within this period, one to five surveyors walked the entire length of road (main segment and spur), in one back-and-forth pass. Observers walked at a slow pace to minimize the likelihood of missing amphibians crossing the road. As a consequence, one back-and-forth pass averaged 147 min (range: 90-224 min). When we found an animal, we recorded its biological (species, size, and gender), spatial (location along the road), and directional (movement direction) data. Following data collection, we placed the animal off the road on the side of its direction of travel. The culvert was surveyed twice during each interval, once each on
the outgoing and return passes. Beginning with the November survey, we installed paired funnel traps at each end of the culvert during the first pass of each survey.

We observed seven native amphibian species on the new development roads. A total of 182 live animals were found, including two pond-breeding anurans: Pacific Treefrog (Pseudacris regilla; n=40), and Northern Red-legged Frog (Rana aurora; n=13); three pond-breeding salamander species: Rough-skinned Newt (Taricha granulosa; n=91), Northwestern Salamander (Ambystoma gracile; n=19), and Long-toed Salamander (Ambystoma macrodactylum; n=13); and two terrestrially breeding lungless salamander species: Oregon Ensatina (Ensatina eschscholtzii; n=4), and Western Red-backed Salamander (Plethodon vehiculum; n=2).

Amphibian mortality was encountered for four species (Northwestern Salamander [n=1], Long-toed Salamander [n=1], Pacific Treefrog [n=10], and Rough-skinned Newt [n=31]).

We observed a diffuse spatial pattern of amphibians crossing the new roads, and future analyses will clarify this result. Interestingly, 14% (n = 25) of our live amphibian encounters occurred within the culvert; whether this implies preference for its use merits investigation. We encountered most live amphibians (69%; n = 125) and all species except Rough-skinned Newts under dark conditions, based on civil twilight-defined boundaries. Using this definition, Rough-skinned Newts were observed roughly 1.6 times more frequently during the day than at night.

Discussion: Our preliminary results indicate amphibian movement patterns span the breadth of the road length; had we instead identified one or a few concise routes, this could have provided a basis for considering structural safe-crossing measures. For some species, we cannot exclude the latter possibility because our numbers were too few. Most species crossing during darkness except newts may justify measures that alert drivers to crossing events at that time. As we further analyze our data for movement timing, species, and age-class specific patterns we hope to clarify details useful for identifying priority migration needs, and future research necessary to adequately support recommendations for safe crossing measures. We are very fortunate to be working in conjunction with a developer that is willing to consider the implementation of safe-crossing measures. Because the spectrum of measures (e.g., signs to alert drivers, drift fences paired with underpasses, or culverts) that might be employed involves a substantial cost range our recommendations must be solidly backed-up and credible. To ensure the application of identified measures not only to the survey site, but also to assist with the development of protocols and acceptance for amphibian safe-crossing measures elsewhere in our region, we will need to ensure that implemented measures are effective over time.

Literature Cited:


ROAD VERSUS TOAD – ROAD IMPACTS ON HERPETOFAUNA NEAR A RESERVOIR

Krysia N. Tuttle and Virgil C. Hawkes, LGL Limited environmental research associates, 9768 Second Street, Sidney, BC Canada V8L3Y8, ktuttle@lgl.com vhawkes@lgl.com

Introduction: Road kills are a major cause of wildlife mortality especially in areas of high biodiversity (Hels et al. 2001). Amphibians and reptiles are thought to be particularly susceptible to high rates of road mortality, due to their small size, slow movement, and life histories that require movements between habitats during the year (Eigenbrod et al. 2009). High numbers of road kills are often observed in spring, as species are moving from their terrestrial hibernation sites to breeding ponds or foraging areas (Ashley and Robinson 1996).

Revelstoke Reach, at the north end of Arrow Lakes Reservoir, has large wetland areas along the edge of the drawdown zone (DDZ), which support nine species of amphibians and reptiles (Hawkes and Tuttle 2010). Unfortunately, these wetland ecosystems occur in an area that also experiences heavy human use, including an airport runway, ~10 km of road that parallels key wetland areas, and frequent use of the DDZ (including wetland areas) by recreational vehicles (e.g., All Terrain Vehicles, mud bogging). Reservoir influenced wetlands such as those in Revelstoke Reach create a new twist to the road versus herpetofauna issue of road mortality because: 1) large areas of the DDZ, interspersed with amphibian breeding ponds, are frequently used by vehicle traffic during the spring prior to inundation (despite the lack of roads); and 2) as reservoir levels increase throughout the summer, less habitat is available to amphibians and reptiles, forcing them to occupy habitats closer to the road at the edge of the reservoir. As part of a 10-year study funded by BC Hydro, LGL Limited is examining the life history and habitat use of amphibians and reptiles in Kinbasket and Arrow Lakes Reservoirs; a component of the study involves documenting key habitats and seasonal migration corridors used by herpetofauna, including roads and road-side habitats.

Methods and Results: Road surveys were used to document amphibians and reptiles migrating to and from the DDZ of Arrow Lakes Reservoir between 2008 and 2010. Surveys were completed along Airport Road and in nearby DDZ habitats (wetland complexes, large open sedge/grass habitats, willow-shrub complexes). Road surveys were conducted at night in April and May, and during the day in June and July. Roads and surrounding DDZ areas were driven or walked (terrain dependant), and amphibians and reptiles were counted as live or dead.

Three species of amphibians and three species of reptiles were documented both on and adjacent to Airport Road (Table 1). Of the ~150 adult animal observations on the road, 20 were road-kill (~13%). The key periods of road-based activity for amphibians were cool nights in early spring and warm summer days for snakes (June-July).

Western Toads are expected to be the species most affected by road traffic in Revelstoke Reach, both in the spring during adult migration and in the summer during metamorph migration. Large numbers (estimated to be in the hundreds) of road-killed metamorphs were documented at the exact same location in Cartier Bay in all three years of study. Other road-killed species (e.g., Common Garter Snake) were frequently encountered along Airport Road; snakes likely use the rocky/grassy sloped habitats near the roads for basking and cover (especially at high reservoir elevations). One live female turtle was documented on the road at Red Devil Hill nesting site; however, most observations of turtles at this nesting site were on the protected-side of the road barrier (n=13).
Table 1: Species of amphibians and reptiles (adults only) observed along Airport Road, near Arrow Lakes Reservoir from 2008–2010.

<table>
<thead>
<tr>
<th>Species</th>
<th>Key Period</th>
<th>Time of Day</th>
<th>Road Observations</th>
<th>Key Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Toad</td>
<td>Early Spring</td>
<td>22:00 – 24:00 h</td>
<td>91</td>
<td>Cartier Bay 9 mile</td>
</tr>
<tr>
<td>Pacific Chorus Frog</td>
<td>Early Spring</td>
<td>22:00 – 24:00 h</td>
<td>16</td>
<td>Airport Marsh</td>
</tr>
<tr>
<td>Long-toed Salamander</td>
<td>Early Spring</td>
<td>22:00 – 24:00 h</td>
<td>23-30</td>
<td>Cartier Bay 9 mile</td>
</tr>
<tr>
<td>Painted Turtle</td>
<td>Spring</td>
<td>16:00 – 22:00 h</td>
<td>1</td>
<td>Red Devil Hill</td>
</tr>
<tr>
<td>Common Garter Snake</td>
<td>Spring Summer</td>
<td>10:00 – 19:00 h</td>
<td>5</td>
<td>Airport Marsh to 12 mile</td>
</tr>
<tr>
<td>Western Terrestrial Garter Snake</td>
<td>Spring Summer</td>
<td>10:00 – 19:00 h</td>
<td>3</td>
<td>Airport Marsh to 12 mile</td>
</tr>
</tbody>
</table>

Discussion: Currently, there is little to no management of Airport Road to mitigate for vehicle-based herpetofauna mortality. The only implemented mitigation measure was the installation of road barriers and educational signs at the Red Devil Hill nesting site to draw attention to the use of the area by Painted Turtles. A variety of management strategies could be implemented to mitigate for the detrimental impacts of vehicle-based mortalities on amphibians and reptiles on Airport Road including posted signs or speed limit reductions, road underpasses (Lesbarreres et al. 2004), and/or public education about the effects of DDZ off-roading with no-go zone areas delineated. The most successful mitigation strategy appear to be a combined system of guiding fences and underpasses to funnel amphibians beneath frequently used sections of a road (Dodd et al. 2004); however the costs of such structures can be high. Additional intensive study is required to identify key migration areas and dates and mitigation plans should involve the combined efforts of BC Hydro, and Ministries of Environment and Transport.

Literature Cited: