- News bulletin -

Monitoring the effectiveness of wildlife passages for medium-sized and small mammals along HW 175

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Increasing concern about impacts of roads on wildlife populations

Many studies have shown that roads increase wildlife mortality for many species. Roads are also barriers to animal movement and reduce the amount and quality of available habitat. There is increasing concern about the reduction in connectivity for wildlife across roads. Connectivity is important for many ecological processes such as access of animals to resources on both sides of the roads, migration of animals between their summer and winter habitats, gene flow across the road for genetic exchange, dispersal of young to find a territory for themselves when they leave their parents, the balancing between growing and declining populations, and relationships between predators and their prey. If efforts are not made to reduce these effects there could be severe consequences for ecological processes and wildlife populations. Some of these include higher mortality, higher vulnerability of the populations, increased predation, unbalanced sex ratios, lower reproduction rates, reduced gene flow, loss of species, reduced biodiversity, and shifts in community composition. However, the size of these effects are difficult to predict in most cases, because long-term monitoring would be required. Also many effects have a response delay, i.e., they become visible only after some time (several years or several decades). Mitigation measures are measures taken to alleviate, at least to some degree, these negative impacts. An example is the combination of wildlife passages and fencing along roads. Such mitigation measures serve three general objectives:

A. To reduce the risk of traffic mortality of wildlife and to increase traffic safety for drivers,

B. To improve the permeability of the highway, i.e. to increase access between habitats on either side of the highway for animals of all species,

C. To maintain connectivity of ecological processes across the road and provide for the long-term persistence of wildlife populations in the area.

For over 20 years passages such as the ones newly added to Quebec's HWY 175 have been implemented in many countries such as France, Germany, Switzerland, and the Netherlands. It is essential, for both scientific research and road management, that the degree to which these measures help reduce a highways ecological effects be studied.

Enlargement of Highway 175 from 2 to 4 lanes

The widening of HWY 175 between Québec City and Saguenay from two to four lanes began in 2006 and is now close to completion. This is currently the largest ongoing road expansion project in Canada. Reasons for enlarging the HWY include the issues of traffic safety and increasing traffic volumes. Currently, about 5600 vehicles use the road per day, of which 19% are heavy trucks, and the numbers are increasing. The total length of the widened road section is 174 km (between km 53 and km 227). This region is a large natural territory and provides important habitat for many wildlife species. 133 km of HWY 175 run through the Réserve faunique des Laurentides, and a large section of the road is directly adjacent to the Parc national de la Jacques-Cartier. The new road is approximately 3 times larger than before, growing from 30-35m to 90-100m wide. This expansion greatly increases the fragmentation of the habitat, separating the forest on either side of the highway by distances that may be difficult or impossible for small and medium mammals to safely cross. For example, among other species, a large number of porcupines are killed by vehicles on HWY 175 when they attempt to cross the HWY. Various measures to minimize the environmental impacts of the highway expansion have been constructed with the goal of increasing the connectivity between the two sides of the road. This includes measures to reduce negative impacts on wildlife populations and to increase traffic safety by reducing wildlife-vehicle collisions. Highway 175 will have 33 new wildlife passages designated for medium-sized and small fauna, of which 19 are already in place. With the exception of one passageway along Boulevard Robert-Bourassa in Quebec City, these are the first designated wildlife passageways built in Quebec. In addition, three wildlife passages for large fauna are in place between km 60 and km 144. Three additional crossing structures for large fauna are located further north, at km 178, km 190 and km 210. Therefore, this highway reconstruction project provides a unique opportunity to investigate the positive effects of wildlife passages in Québec.

Mitigation measures for medium-sized and small mammals

A suite of mitigation measures have been installed along HWY 175:

(a) Fences and passages for large fauna: Fences prevent species such as moose, caribou, and wolves from entering the right of way. Bears, however, are able to climb up the fence. The fences guide the animals to the under-passages for large fauna. Today, 67 km of the highway have been fenced. These fences are 2,4 m high and have meshes size of 30 cm x 18 cm. Thus, they are permeable for most medium-sized and all small species, i.e., these species can pass through this fence. For this reason, an additional fence with smaller mesh size (5 cm by 5 cm) was added on either side of the wildlife passages for small and medium mammals. Downed logs and stumps were added around the passageway entrances and in the passages to encourage the movement of small mammals.

Round concrete culverts, can have a diameter of either 60 cm or 90 cm.

Box culverts with a prefabricated shelf in concrete.

Box culverts with a wooden shelf built on as an addition.

Concrete walkway.

Landscaped stream bed.

Fig. 1: The five types of wildlife passages used along HWY 175.

(b) Fences and passages for medium-sized and small fauna: 19 wildlife passages out of a target total of 33 have already been constructed for medium-sized and small species and are subject to monitoring this year. These animals can also use the large passages mentioned above. The term “medium-sized and small fauna” includes all species that are size of or smaller than a wolf. The following species are expected to use the wildlife passages on HWY 175: American marten, porcupine, beaver, skunk, weasel, ermine, red fox, raccoon, mink, red squirrel, snowshoe hare, river otter, musk rat, lynx, fisher, as well as various species of shrew, vole and mouse.

(c) Almost all passages were placed at locations where water is flowing under the highway and a culvert was needed to accommodate the water flow in any case (Fig. 1). The different types of passageways were modeled after previous trials conducted in France.

These passages were combined with fences that extend 100 m on either side of each passage to help guide the animals towards the passage and to discourage them from entering the roadway. These fences are 80 cm high and have meshes size of 5 cm x 5 cm (Fig. 2).

Fig. 2: The meshes of the fences for large and medium-sized fauna differ: 30 cm x 18 cm for large fauna (2.4 m high) and 5 cm x 5 cm for small fauna (80 cm high).

Why is this research project needed

The area affected by Highway 175 has been identified as an important connectivity zone for wildlife populations in the region, linking natural and semi-natural habitats east and west of the highway. As this is the first time that designated wildlife passages for small and medium-sized fauna have been constructed in Québec, there is an urgent need to evaluate their ability to improve connectivity for wildlife. This information is important for helping future road management implement wildlife passages along new highways and existing highways in Québec, in particular in the more fragmented southern forests of Québec. This research project will assess whether the wildlife passageways are effective in reducing the environmental impacts of the highway on medium-sized and small mammals. It will evaluate how well the performance objectives of the fences and passageways have been met and whether adaptive management is needed. Many studies from Europe, North America, and Australia have shown that a number of species use wildlife passages successfully. However, most research has been focused on large mammals, while more research is still needed for small and medium-sized mammals. Medium-sized mammals can also pose a serious risk for drivers, e.g., when drivers try to avoid the animals and move their car into another lane or lose control of their vehicle.

The findings from this project will help identify options for improvements to road mitigation and determine how successful the five designs of passages for medium-sized and small mammals in the study area are. This project has a duration of at least 4 years and the information gained will be indispensable for adaptive management which requires ongoing monitoring to identify the need for improvements. The effectiveness of the mitigation measures for large mammals is being studied in a separate project.

Objectives of the research project

This research project has three main objectives:

(1) To characterize the locations and rates of vehicle collisions with medium-sized and small mammals and to evaluate the changes in the frequency of highway-related mortality due to the mitigation measures;
(2) To determine the performance of the 5 types of wildlife passages for medium-sized and small mammals;
(3) To assess how well the mitigation measures provide for the permeability of the highway for individuals and for gene flow across the road, with a focus on the American marten.

The specific research questions that will be answered by this project are :

Objective 1:
(a) What species are affected by collisions, where do the collisions occur and how frequently?
(b) Where are the locations of unusually high and low road mortality ("blackspots" and "whitespots")?
(c) What spatial factors that can explain why these locations are "blackspots" and "whitespots"? Examples are the characteristics of the road, the height of the surrounding vegetation, and the distance to the forest.
(d) How does the risk of traffic mortality for the various species depend on the time of the year, the meteorological conditions, and the traffic volume?
(e) Is the mortality rate significantly less on mitigated sections of highway compared to unmitigated sections?
(f) How do the different types of wildlife passages compare?
(g) Are the small mammal fences effective in guiding the animals to the passageways? Or do animals work their way around the fences and cross the road regardless?

Objective 2:
(a) Do animals use the engineered wildlife passages?
(b) If so, which species, and how frequently?
(c) What are the attributes of small passages and the surrounding habitat that facilitate passage of medium-sized and small mammals?
(d) Do the wildlife passages allow for the reconnection of habitats and populations?

Objective 3:
(a) Are the passages used by different individuals, or only by a few individuals who use them often?
(b) Are subadults able to disperse across the highway?
(c) What proportion of highway crossings by American martens occurs at the passages?

Methods

In the first part of the project which started in summer 2012, three methods are being used:

Road mortality survey

To address objective 1, a survey of road mortality will help evaluate by how much the wildlife passageways (combined with fences) reduce the traffic mortality of medium-sized and small mammals (Fig. 3a and b). Sections of the highway with passageways will be compared to sections without passageways that have similar habitat conditions. This will help us investigate how mortality rates vary depending upon the presence of fences and passageways as well as the type of passageway present. In every 2-week session, the researchers are searching for road-killed or injured animals 3 days in the evenings (before sunset) and 6 days in the early mornings (just after sunrise) over 4 summers. Winter sampling will not be feasible because the carcasses are removed by snowplows. At the detection of a carcass, the researchers remove the carcass from the highway, (record species, gender and age (if possible), and obtain a geographic coordinate with a GPS unit (Fig. 3c and d).

Small mammals, such as this mouse, are also subject to road mortality although they are less noticeable to drivers.

This red fox is a more visible example of road mortality on HWY 175.

Two research assistants processing relevant information about the mortality of a porcupine.

Two research assitants entering the data about a marmot mortality into a GPS and field book.

Fig. 3: Road mortality survey.

Monitoring the use of wildlife passages using cameras

Actual use of wildlife passages is being observed continuously (night and day, year-round) using digital cameras (Reconyx; Fig. 4). Existing drainage culverts will also be monitored as control sites. The cameras equipped with infrared sensors, are triggered by heat and movement and record images of wildlife entering and exiting crossing structures.

Infrared camera with NIMH batteries.

Technician installing camera and security box.

Fig.4: Cameras used for the detection of animals using the wildlife passages.

Various species have already been observed in the passages (Fig. 5). The cameras also record the time of the photo taken and the temperature.

Fox using one of the round concrete culverts.

Marmot using a box culvert.

Mink using a round concrete culvert.

Porcupine using a box culvert.

Fig. 5: Examples of pictures taken by the cameras in the passages.

Estimation of the relative abundances of wildlife populations using track boxes

In order to accurately evaluate traffic mortality and use of the wildlife passages the researchers also need to estimate the relative abundance of each species in the forests adjacent to the highway. This is because the relative abundances will influence the frequencies of expected at-grade crossings and of passage use. To discover relative abundance of medium and small mammals, track boxes are installed in the forest. They are 120 cm long, 50 cm wide, and 60 cm high (Fig. 6). The animals are attracted by a scent lure into the boxes, where ink and paper are laid out and the animal tracks are recorded on the paper in the center of the box (Fig. 6c). The relative abundance data will be used to determine the passageway characteristics that could influence their usage.

Installing a track box in the forest and marking its location with a GPS.

The view through a track box in the forest.

An installed track box in operation

Animal tracks on brown craft paper.

Fig. 6: Setting up the track boxes in the boreal forest.

In the winter, 300-m-long transects will be established at both ends of each culvert perpendicular to the road. A transect is a path along which researchers record the occurrence of biological phenomena. Animal tracks visible in the snow will be observed and counted along these paths. The visibility of the tracks will depend on snow conditions. Additional methods will be used in later years of the project to address objective 3, for example, VHF radio-collars and genetic methods to identify individuals. These methods will be presented in future editions of this information bulletin.

Were you can find further information

You can find more information about the wildlife passages along HWY 175 here:

Bédard, Y., É. Alain, Y. Leblanc, M.-A. Poulin, M. Morin (2012) : Conception et suivi des passages à petite faune sous la route 175 dans la réserve faunique des Laurentides. Le Naturaliste Canadien 136(2): 66-71.

More information about the ecological effects of roads and various mitigation measures is given here:

Carsignol, J., V. Billon, D. Chevalier, F. Lamarque, M. Lansiart, M. Owaller, P. Joly, E. Cuenot, P. Thievent, P. Fournier (2005): Aménagements et measures pour la petite faune. Guide technique. Sétra (service d'études techniques des routes et autoroutes). Bagneux Cedex, France.

Fahrig, L., T. Rytwinski. 2009. Effects of roads on animal abundance: an empirical review and synthesis. *Ecology and Society* 14(1): 21. [online] URL: http://www.ecologyandsociety.org/vol14/iss1/art21/

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

Jaeger, J. A. G., J. Bowman, J. Brennan, L. Fahrig, D. Bert, J. Bouchard, N. Charbonneau, K. Frank, B. Gruber, and K. Tluk von Toschanowitz. 2005. Predicting when animal populations are at risk from roads: an interactive model of road avoidance behavior. *Ecological Modeling* 185: 329–348.

van der Ree, R., E. van der Grift, C. Mata, and F. Suarez. 2007. Overcoming the barrier effect of roads—how effective are mitigation strategies? An international review of the use and effectiveness of underpasses and overpasses designed to increase the permeability of roads for wildlife. Pages 423–431 *in* C. L. Irwin, D. Nelson, and K. P. McDermott, editors. *Proceedings of the 2007 International Conference on Ecology and Transportation.* Center for Transportation and Environment, North Carolina State University, Raleigh, North Carolina, USA.

Members of the project team and project partners

To put this project into place, the Quebec Ministry of Transport (MTQ) brought together a team of scientific researchers:

- Yves Bédard, Direction de la Capitale-Nationale of the MTQ. He is the responsible person (chargé du projet) at the Ministry of Transport.
- Dr. Jochen Jaeger, Concordia University, Montreal. He is the principal investigator of the project.
- Katrina Bélanger-Smith, MSc student at Concordia University
- Évan Hovington, MSc, field technician
- Mary-Helen Paspaliaris, Honours student at Concordia University
- Dr. Anthony P. Clevenger, Montana State University. He is a wildlife researcher who has more than 14 years of experience in monitoring the effectiveness of wildlife passages along the Trans-Canada Highway in Banff National Park, Alberta
- Dr. André Desrochers, Université Laval, Québec City
- Dr. Jeff Bowman, Ontario Ministry of Natural Resources and Trent University, Peterborough
- Dr. Paul J. Wilson, Trent University, Peterborough
- Yves Leblanc, AECOM, Quebec City

and several research assistants to help with the field work.

The researchers are supported by the members of the Enlarged Advisory Committee. This committee includes representatives of the main groups and organisations affected by the project (in alphabetical order):

- Éric Alain, Ministère des Transports de Québec
- Jean-Emmanuel Arsenault, Parc national de la Jacques-Cartier, Sépaq
- Héloise Bastien, Ministère des Ressouces naturelles et de la Faune
- Pierre Blanchette, Ministère des Ressouces naturelles et de la Faune
- Sylvain Boucher, Réserve faunique des Laurentides
- Mathieu Brunet, Parc national de la Jacques-Cartier, Sépaq
- Marianne Cheveau, Ministère des Ressouces naturelles et de la Faune
- Louis Desrosiers, Ville de Stoneham
- Martin Lafrance, Ministère des Transports de Québec
- Hugues Sansregret, Forêt Montmorency
- Audrey Turcotte, Ministère des Transports du Québec

The committee is informed about the progress of the project and takes care that the interests of various organisations are considered and no parts of the environmental monitoring program is omitted.

The organizations more or less closely involved in this project are (in alphabetical order):

• Forêt Montmorency
• Ministère du Développement durable, de l'Environnement et des Parcs
• Ministère des Ressouces naturelles et de la Faune
• Ministère des Transports du Québec
• Parc national de la Jacques-Cartier
• Société des établissements de plein-air du Québec – Réserve faunique des Laurentides
• Sureté du Québec
• Concordia University Montreal (Department of Geography, Planning and Environment and Department of Biology)
• Tecsult, AECOM Inc.
• Ville de Stoneham

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Dr. Anthony Clevenger: Western Transportation Institute, Montana State University (WTI-MSU).

Please contact Dr. J. Jaeger for obtaining future editions of this information bulletin. The PDFs of the bulletins are also available on this website: http://gpe.concordia.ca/faculty-and-staff/jjaeger/