A report on findings from the 2011 Heart Lake Road Ecology Monitoring Project.

Heart Lake Road Ecology Volunteer Monitoring Project

The Heart Lake Road Ecology Monitoring Project is a joint initiative delivered by Toronto & Region Conservation Authority in partnership with City of Brampton, Ontario Road Ecology Group, Fleming College and community volunteers.

TORONTO AND REGION Conservation for The Living City

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Acknowledgements

This study and report was made possible through the generosity of our volunteers, municipality and agency partners and Fleming College. The volunteers concern and commitment towards the protection of wildlife, this sensitive wetland area and efforts to maintain healthy ecosystems is evident by the results obtained. This enthusiastic group contributed a considerable amount of time and effort to this project completing training, making observations (some of which were upsetting due to the nature of the fatality), collecting data and this is undertaken throughout all weather conditions.

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Executive Summary

The Toronto and Region Conservation Authority (TRCA) partnered with the City of Brampton (CoB), Ontario Road Ecology Group (OREG) at the Toronto Zoo and local volunteers to deliver the Heart Lake Rd. Road Ecology Volunteer Monitoring Project (HLREMP). The objective of HLREMP was to better understand which species were being impacted by interactions with vehicles, how many interactions were occurring, and to suggest mitigation measures to protect local biodiversity in the wetland systems adjacent to Heart Lake Road between Sandalwood Parkway and Mayfield Road in Brampton, Ontario. This 2.5 km section of road is adjacent to Heart Lake Conservation Area (HLCA) and bisects a provincially significant wetland complex.

The HLREMP took place between May 9th, 2011 and October 31st, 2011. Data was collected by volunteers with the goal of observing and recording wildlife-vehicle collision sites (WVC's), any notable live wildlife along the road, species proximity to the road, alive/dead status and GPS co-ordinates.

A group of four students through the Sir Sandford Fleming College, Ecosystem Management Technology Program, Credit for Product Course, assisted TRCA with analyzing the data collected through the study to produce a report of the findings. The report provides an overview of the study and study area, outlines the number of monitoring sessions, number of volunteer hours, number of wildlife observed (dead and alive) and also provides recommendations for mitigation.

The wildlife observed over the course of the study period included various frogs, turtles, snakes and avian species. When analyzing the relative number of WVC's, amphibians ranked the highest followed by reptiles then mammals. It is also valuable to note that out of the total number of dead animals observed, there were several unidentified species due to the severity of the kill.

The report and the findings will be shared with TRCA, the Region of Peel, the CoB and the Credit for Product course faculty at Sir Sandford Fleming College in Lindsay, Ontario. It is our hope that the data and recommendations in this submission will be considered a valuable contribution toward implementing mitigation options on Heart Lake Road.

1 Introduction

Road ecology is an emerging field addressing the effects of roads on wildlife populations and the impacts on ecological processes (OREG, 2010). This report focuses on a citizen science study conducted along Heart Lake Road from Sandalwood Parkway travelling north to Mayfield Road, in Brampton Ontario, a distance of approximately 2.5 km. This particular section of road is level to the wetland, adjacent to HLCA and bisects a provincially significant wetland complex.

The wetlands located in and around the Heart Lake Conservation Area, are an example of a complex biodiversity. They contain several species of reptiles and amphibians, aquatic and terrestrial plants and a variety of wildlife, all of them intertwined to support life. The wetland itself acts as a filter for water, catching contaminants and nutrients, thus allowing the groundwater areas to be recharged providing access to clean drinking water. In the spring of 2010, several painted turtles were observed dead along this stretch of Heart Lake Road in a single day. These observations were brought to the attention of TRCA Ecology staff and OREG. Following this observation, TRCA collaborated with OREG and the CoB to create and implement HLREMP over a 25 week period from May to October 2011. The purpose of this project was to determine species being impacted by interactions with vehicles, the number of interactions occurring and suggest mitigation measures to protect biodiversity in the wetland systems of this study area.

Biodiversity encompasses all life and is defined as the variety and genetically different number of species present in each geographic area or habitat. Roads pose risks to wildlife and biodiversity by contributing to increased wildlife mortality and habitat loss, fragment the movement of wildlife from their breeding, feeding and hibernation areas and add increased contamination to the natural environment. The hydrological functions of wetlands include storage of surface water, recharge of groundwater supplies, reduction in peak floodwater flows and erosion prevention (Gabor *et al*., 2004). Wetlands are also important feeding, breeding, and drinking grounds for wildlife (Lillesand *et al*., 2004). Pollution from fertilizers, insecticide, de-icing agents, combustion engine emissions, vehicle debris, illegal dumping activity and motorist litter are all factors of wetland degradation. Noise pollution disrupts normal wildlife behaviours such as mating, migration, predation and nesting (Former & Alexander, 1998). Cutting vegetation as part of regular road maintenance where the road borders a wetland negatively affects the wetland ecosystem by eliminating wildlife habitat, attracting wildlife to the roadside, removing natural buffer zones and encouraging the growth and spread of invasive species (OREG, 2010). Direct mortality due to WVC's is the most common impact roads have on wildlife. These factors can lead to chronic stress on local wildlife, reduced individual fitness and population viability (OREG, 2010). This study will aid in the research of the effects of habitat fragmentation on wildlife behaviour and mortality.

The results outlined in this study attest to the importance of this type of research, as Southern Ontario's dense road networks and human population are expected to intensify each year. Over a period of 60 years (between 1940 and 2000) major roads in southern Ontario increased from 7,133 kilometres to 35,637 kilometres (Fenech et *al*., 2000) and today no area of land is more than 1.5 kilometres from a road (Gunson, 2010). The Ontario Ministry of Transportation reports that there is a vehicle/wildlife collision in Ontario every 38 minutes (MTO 2011)… this is a staggering statistic.

Ontario is blessed with abundant biodiversity but also challenged with having 190 species listed on the Species at Risk Act (Species at Risk Ontario, 2011). Many of these species are negatively affected by roads. Habitat loss and road fatalities are the two major causes of declines in wetland species. The loss of specie numbers is growing and at-risk species are of great concern. Not only are they at risk from accidental kills from vehicles, some studies indicate drivers will intentionally swerve their vehicle to run over reptiles and amphibians. (Ashley EP, Kosloski A, Petrie SA, 2007)This is expected to continue as the population of the Greater Gold Horseshoe area is estimated to increase by over 3 million residents over the next 20 years (Growth Plan for the Greater Golden Horseshoe, 2006).

Increased global population, development, industrialization, overconsumption, pollution and climate change have contributed to a dramatic loss of habitat and threats to species, the natural environment and humans. There is an increased awareness of these threats, and this has led to the United Nations to declare 2011-2020 as the International Decade of Biodiversity (Environment Canada, 2011). This report analyses the data collected through HLREMP, helps raise awareness of the impacts roads are having on biodiversity and provides recommendations for mitigating the impact this section of road is having on the wetland ecosystem.

2 Materials & Methods

2.1 Study Area

The study area lies within the Etobicoke Creek Watershed and focussed on a section of Heart Lake Road that bisects a provincially significant wetland complex in Brampton, Ontario. This section of road is approximately 2.5 km, bordered by Sandalwood Parkway and Mayfield Road. This section of Heart Lake road is a paved and shouldered two-lane road which is level to the wetland complex and adjacent to the HLCA (see Figure 1). Heavy vehicle traffic occurs in the summer months partly due to a garden center located on the east side and people visiting the HLCA.

Figure 1: Study Area

2.2 Volunteer Recruitment

In an effort to recruit volunteers, the project was promoted through local media and various networks of community and volunteer contacts. An article promoting HLREMP was published in the Brampton Guardian on March 23rd, 2011 (see Appendix H) and notices were posted at local community centres outlining the program and invited volunteers to attend an information session at Loafer's Lake Recreation Centre. Volunteers attending the public information session were invited to sign up to participate in the study.

2.3 Surveying and Methods

The study was completed over the course of a twenty-five week period, extending from May 9th, 2011 through to October 31st, 2011. All volunteers received training on the protocol and safety requirements prior to the initiation of the project (see Appendix B). Volunteers worked in pairs and they were scheduled based on their availability. Each monitoring session was approximately two hours in length and these sessions were staggered throughout daylight hours each week (Sunday to Saturday). Each pair was given the opportunity to select from four monitoring time-slots ensuring no two groups were monitoring at the same time but could choose an alternate time to monitor on the same day.

With each monitoring session a field data sheet was completed which included; date and time, volunteer names, length of session, weather conditions (temperature, humidity, precipitation, cloud, wind). When a sighting was observed, volunteers recorded the taxa (mammal, frog/toad, snake, turtle or avian), species (if able to identify), freshness of the kill (dead within the last 24 hours) and alive or dead status. The status could be alive on road (AOR), alive by road (ABR), dead on road (DOR) or dead by road (DBR). Information related to the sighting location was recorded using a GPS unit to obtain UTM coordinates. The proximity of the wildlife observed, in relation to the road, was also recorded (i.e. east side/white line, centre line, or west side/white line). Volunteers were encouraged to take images to provide some visual reference for the data analysis. Dead organisms were moved well off of the road to avoid being counted multiple times. The data sheets and pictures were collected weekly and data was transferred to an excel file.

Image 1: Group Safety Training at HLCA

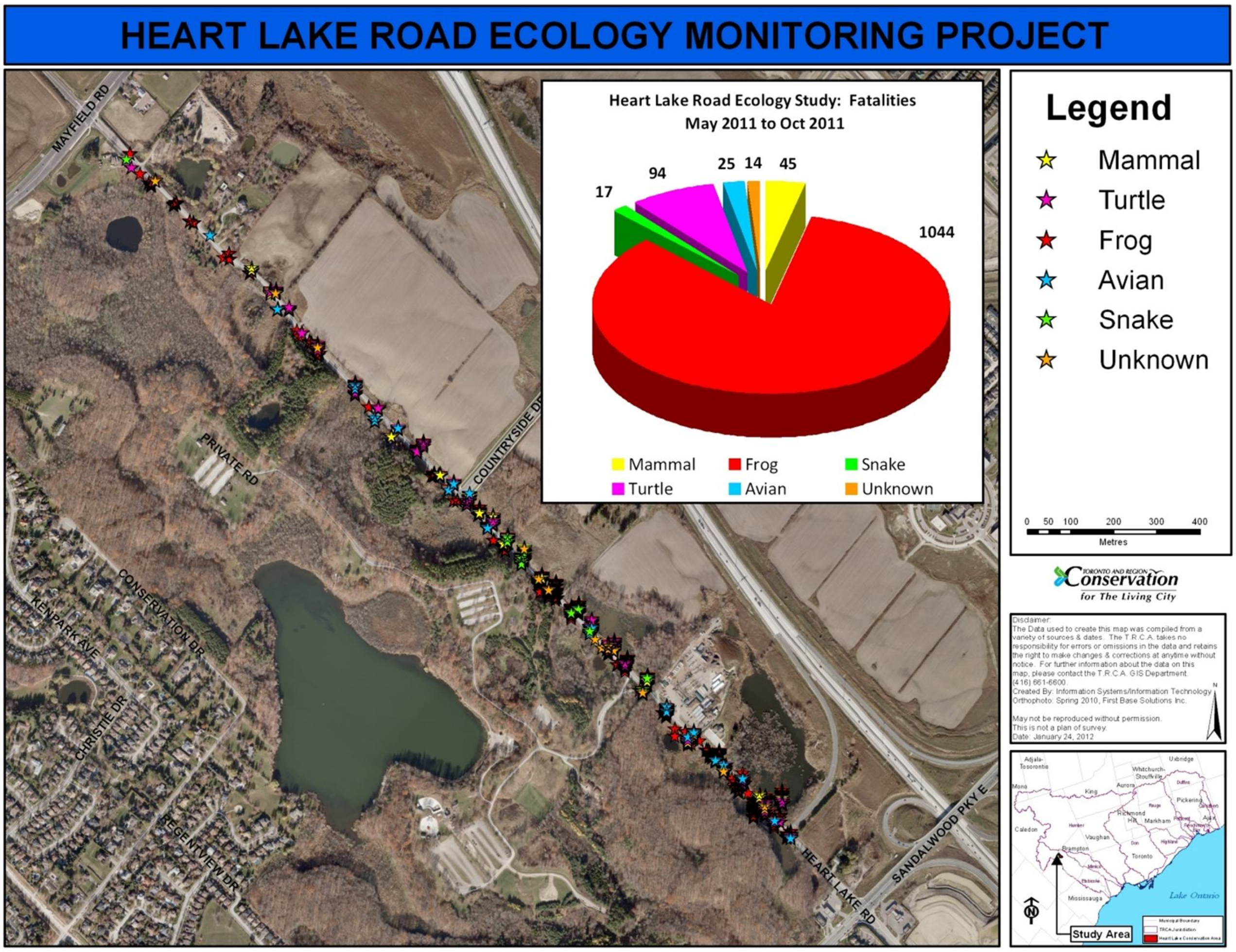
Image 2: Safety Signage

Image 3: Meiraid Mac Seain and Pauline Sutherland along Heart Lake Road

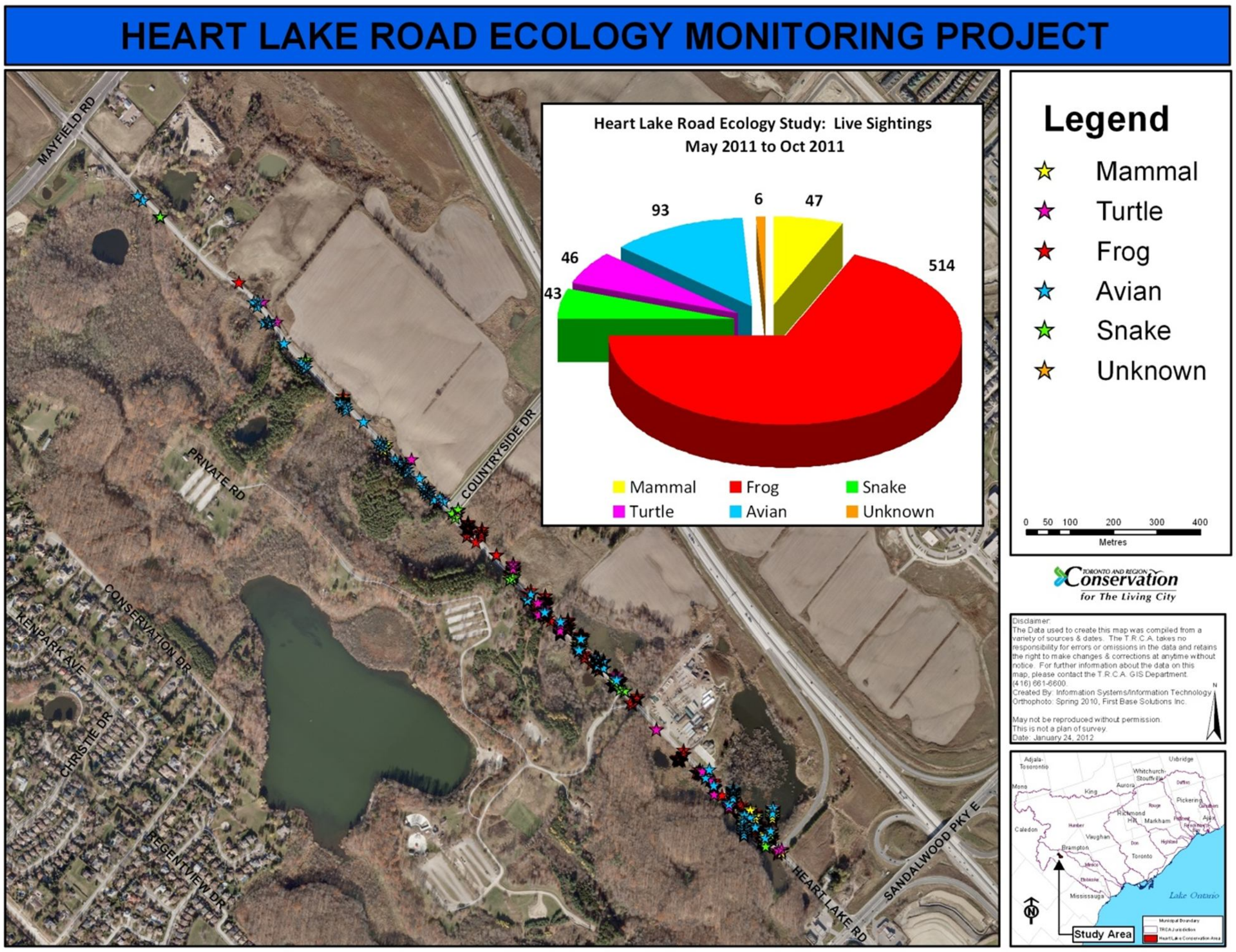
Image 4: Leo O'Brien and Shawn Patille monitoring along Heart Lake Road

2.4 Data Analysis

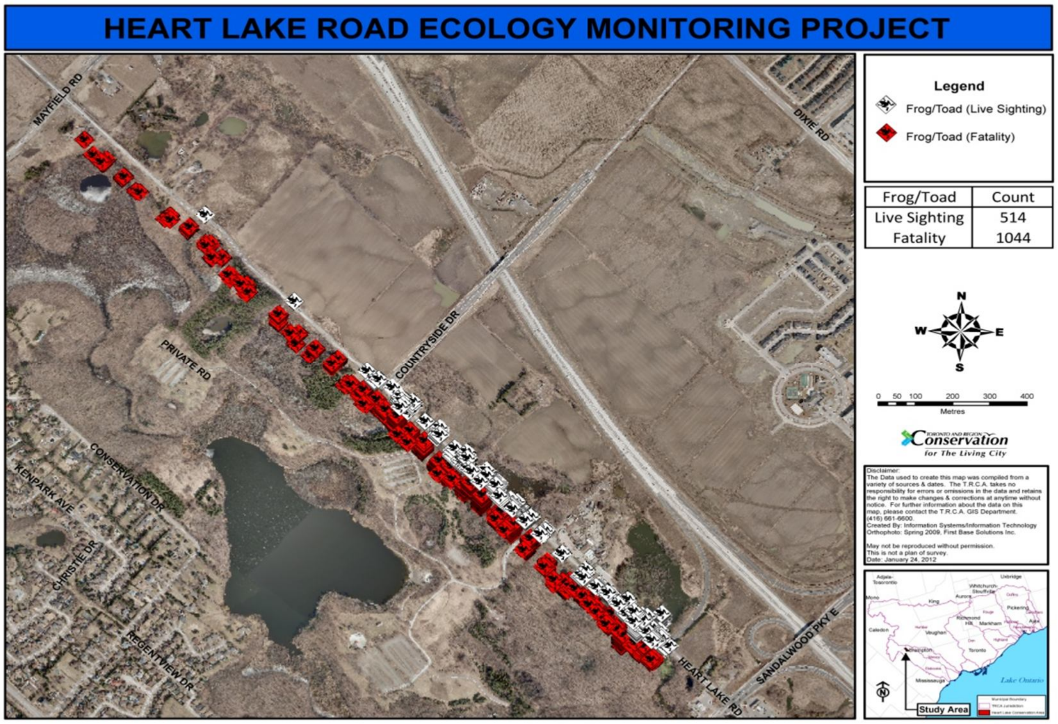
The data was analyzed to determine the number of monitoring sessions, number of volunteer hours and number and type of wildlife observed. The raw data was compiled to show a list of the observed wildlife by species, their status, the total number observed and using UTM coordinates, GIS maps were created to show these results (See Map 1 to 6).



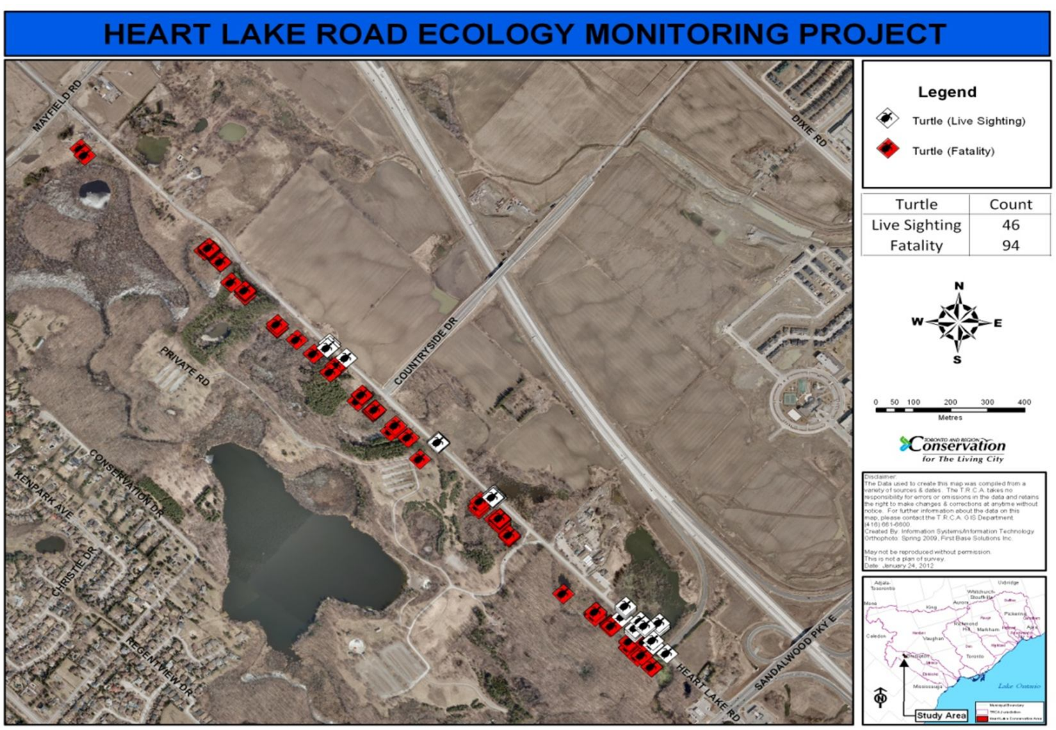
Map 1: Total Fatalities



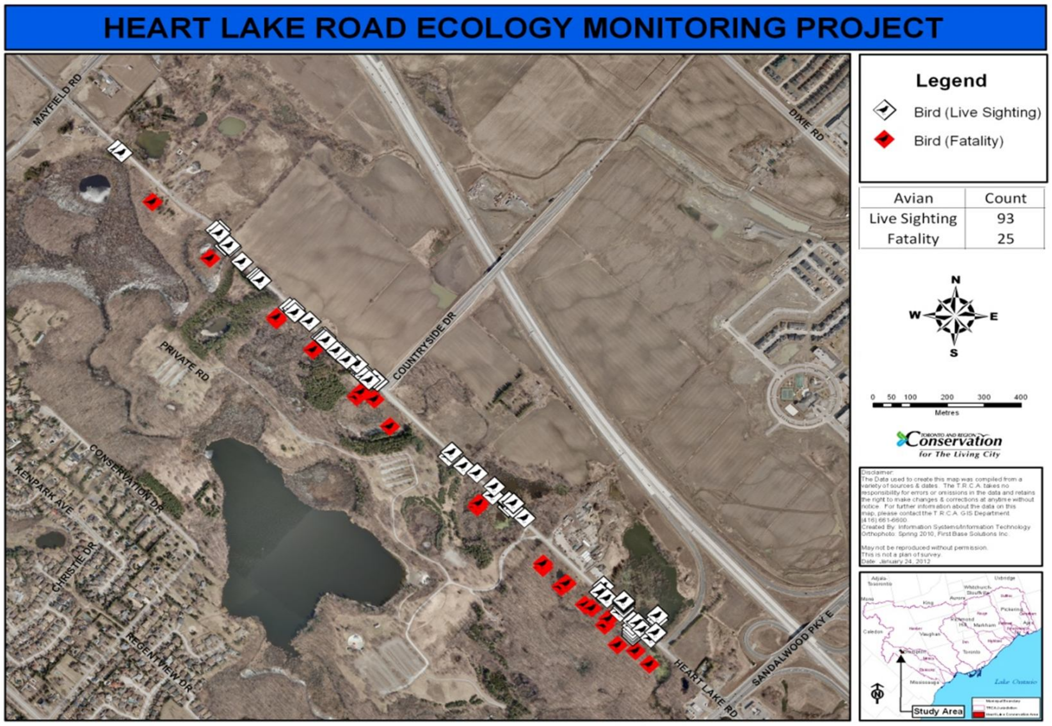
Map 2: Total Live Sightings



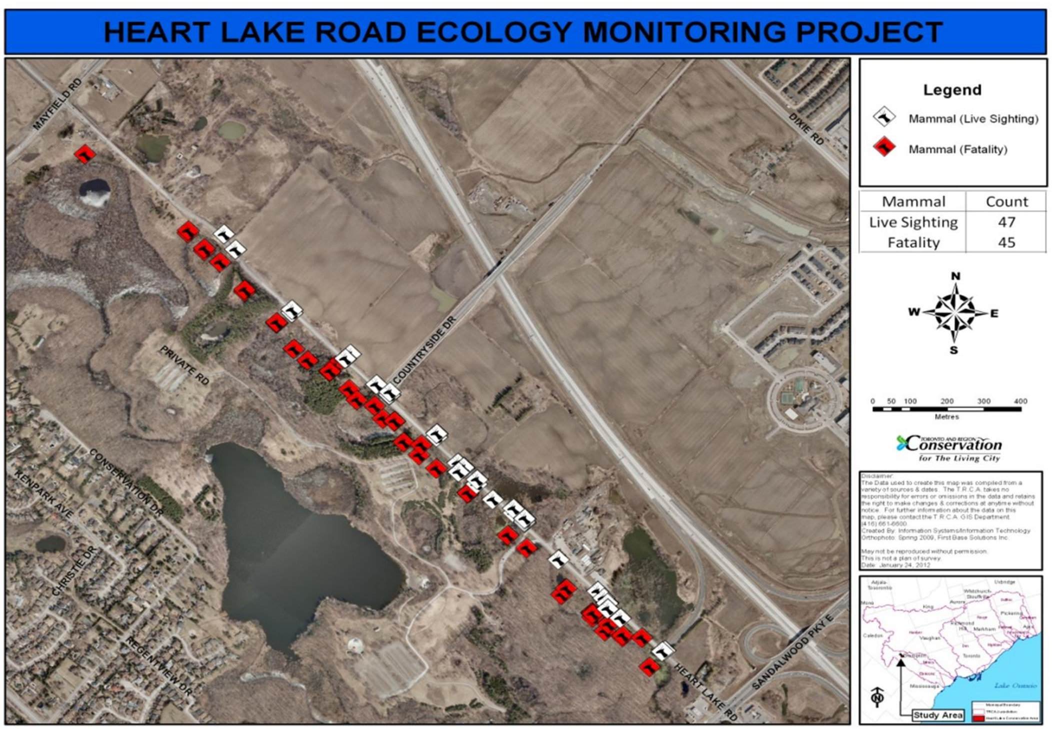
Map 3: Total Frog Sightings



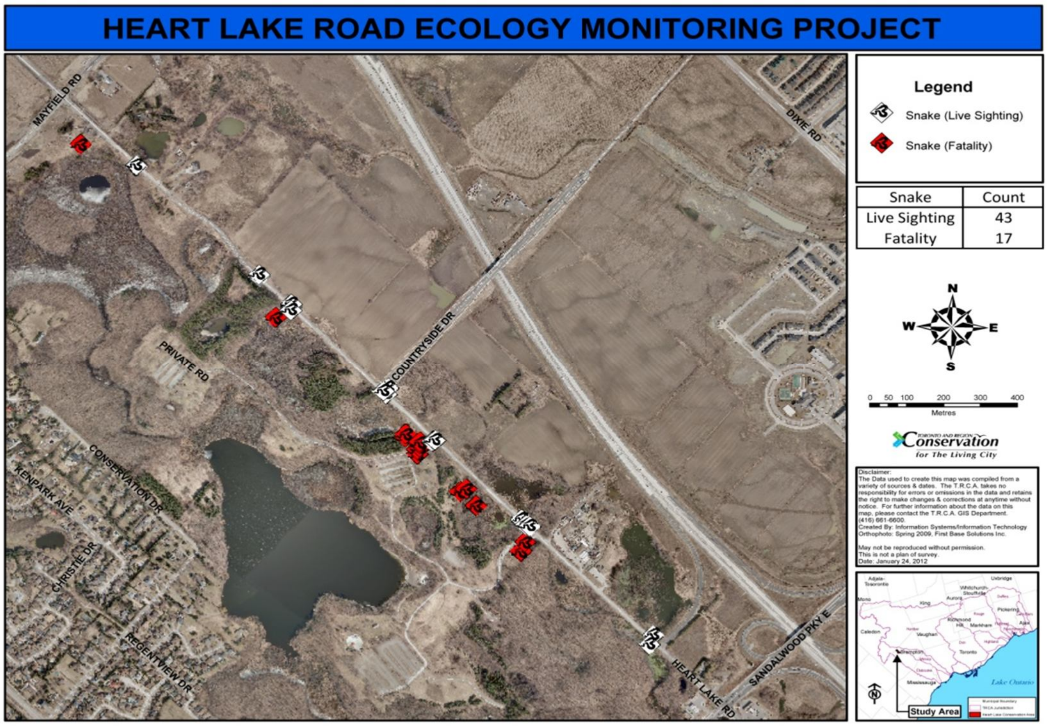
Map 4: Total Turtle Sightings



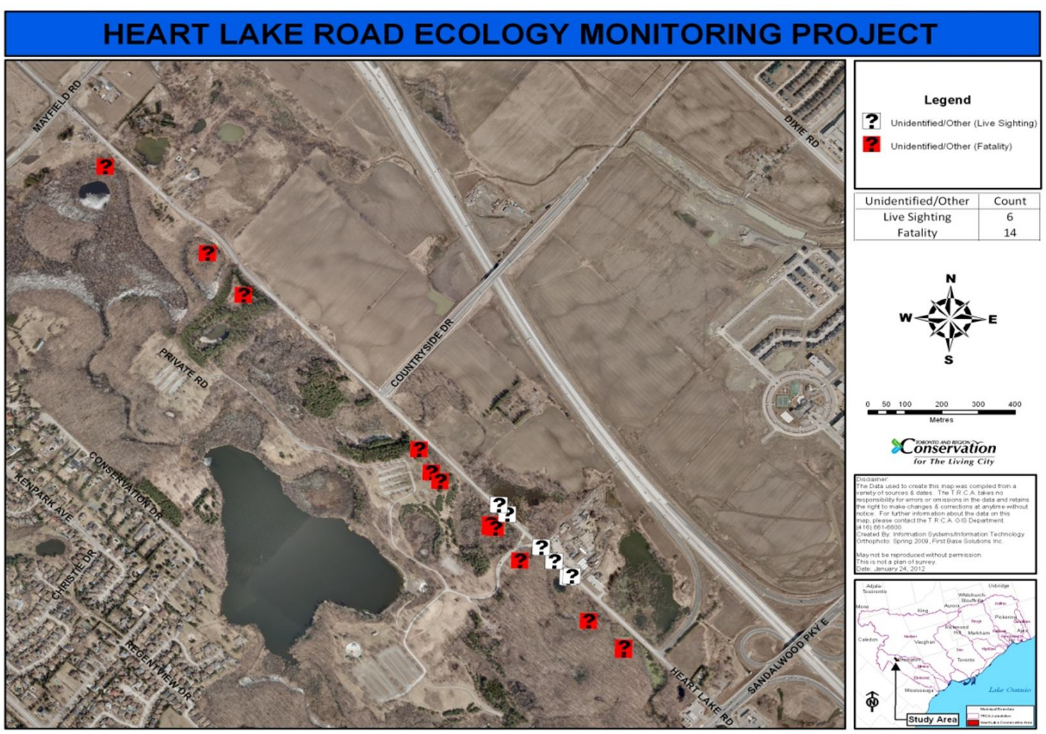
Map 5: Total Avian Sightings



Map 6: Total Mammal Sightings



Map 7: Total Snake Sightings



Map 8: Total Unknown Sightings

3 Results

Over the course of the project, a total of 1988 wildlife were observed. Of the total, 1239 were fatalities and 749 were live sightings. When analyzing the relative number of WVC's, frog/toad ranked the highest with 1044 individuals at 84.26%, followed by 94 turtles at 7.59%, 45 mammals at 3.63%, 25 avian at 2.02%, 17 snakes at 1.37% and 14 unknown at 1.13% (Figure 2 and 3).

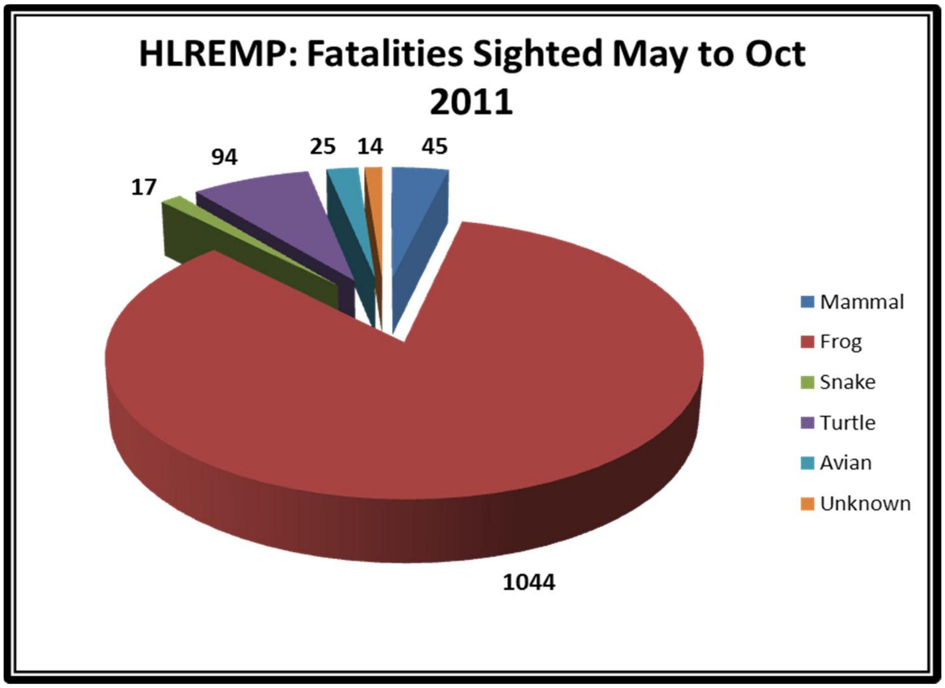


Figure 2: Pie chart showing breakdown of fatalities

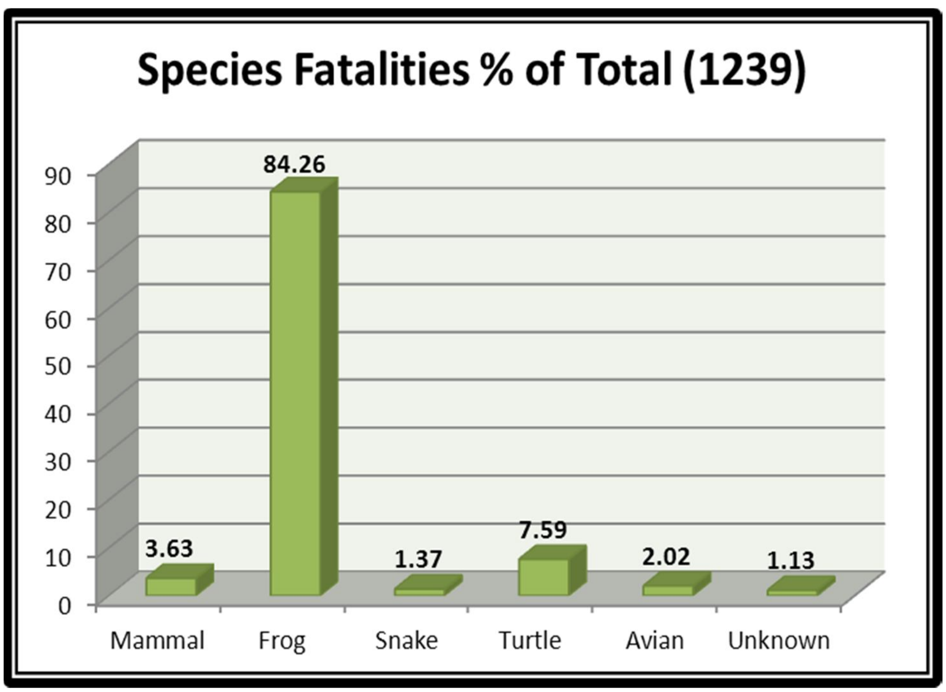


Figure 3: Bar chart showing % of fatalities from total

A total of 749 live wildlife were observed over the same time period with 514 frog/toads at 68.62%, followed by 93 avian at 12.42%, 47 mammals at 6.28%, 46 turtles at 6.14%, 43 snakes at 5.74%, and 6 unknown at 0.80% (Figure 4 and 5).

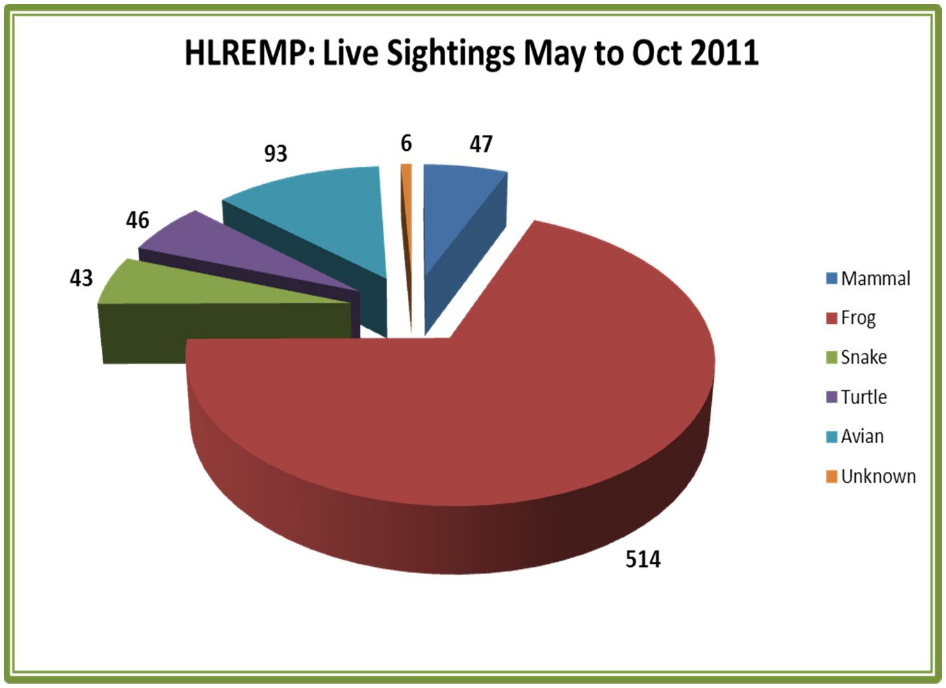


Figure 4: Pie chart showing breakdown of live sightings

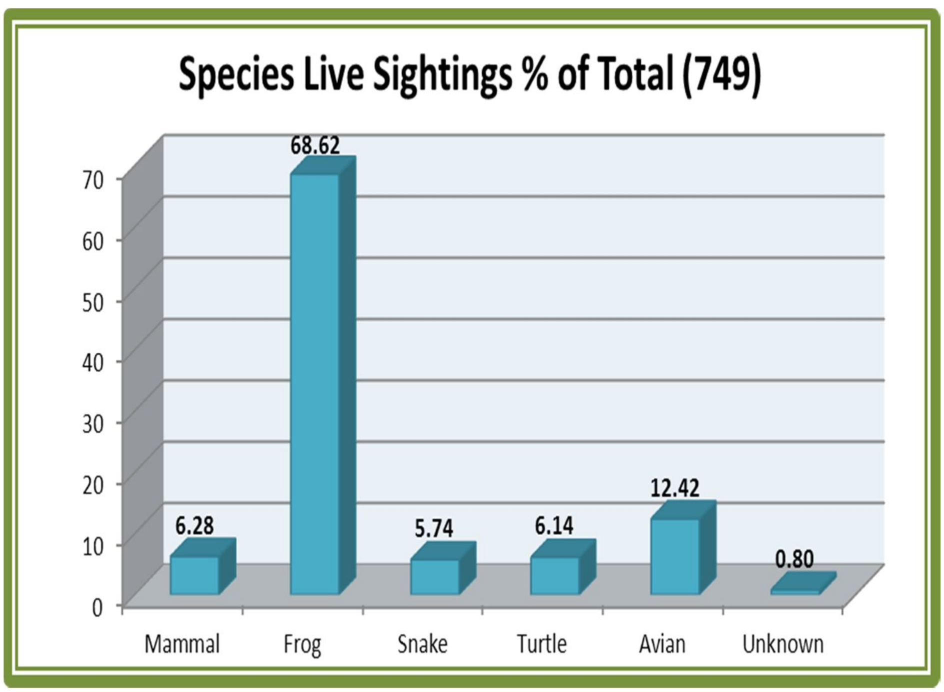


Figure 5: Bar chart showing % of total live sightings

Over the course of the 25 week study period from May 9, 2011 to October 31, 2011, over 40 community volunteers contributed more than 420 hrs to the monitoring project. The actual time spent monitoring only represent approximately 10% of the total available time for monitoring (daylight hours) over the study period. Since volunteers were not monitoring for approximately 90% of the available time and did not monitor after or before daylight, the number of WVC's during the study period is potentially higher than the study results indicate.

The study data indicates that volunteers recorded various uncommon and at-risk species of turtles and frogs. Many of these observations cannot be confirmed due to the lack of photo evidence and/or poor photo quality. Some of these observations, such as the snapping turtles have been confirmed with photos. Volunteers may have also incorrectly identified wildlife or may have been confused with observations of a non-native wildlife (Image 5), likely the result of pet dumping. In addition, there were wildlife observations which were unidentifiable due to the severity of WVC and as a result were placed in the unknown species category.

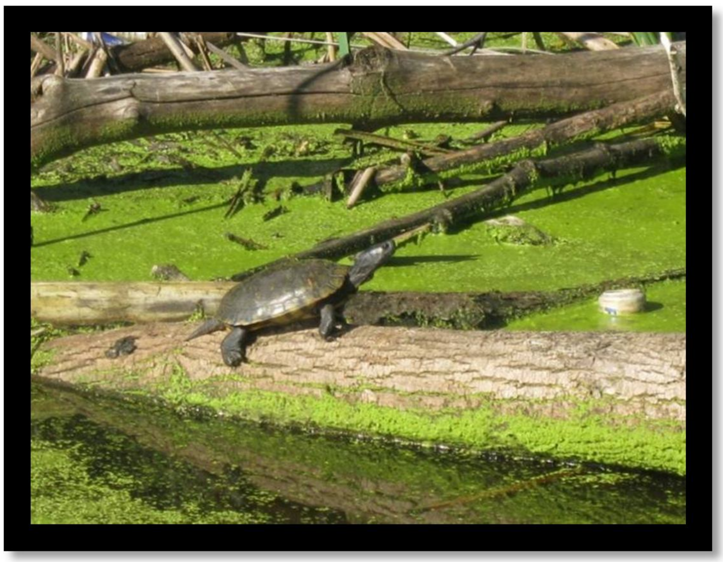


Image 5: Observation mistaken for native species

4 Discussion

4.1 Data Interpretation

The study area is located in a highly urbanized location but is fortunate to have a relatively high level of species diversity. As Brampton continues to grow the natural spaces and wildlife populations that inhabit them will be exposed to additional stresses. The study findings and observations show the study area has a relatively broad range of species inhabiting the surrounding ecosystem - Appendix B lists observed wildlife species, Appendix C lists avian species observed over the study period.

The majority of reported WVC's involve large wildlife (such as moose, deer etc.), while small wildlife WVC's generally go unreported. Smaller wildlife serves an important role in the ecosystem and some, due to their size and requirements, are confined to local habitat. The findings of this study show local frog, toad, turtle and snakes are the species significantly impacted along this section of road. The following are some facts regarding threats to these species biodiversity in Ontario.

Turtles:

Of the nine species of turtles in Ontario seven are listed on the Species at Risk List, a Regulation under the Endangered Species Act 2007. Depending on the species size, the age of maturity can range between 4 - 36 years (Wyneken, 2008). The number of eggs laid by an adult female varies and less than one percent of those eggs will reach sexual maturity. An adult female is a vital part of the continuation of the species and a loss of 1-2% each year in an area will lead to extirpation in a very short period of time. The habitat of these creatures is declining due to urban development and road extension. With their feeding and breeding grounds divided by roads and highways, it puts them at a higher risk of mortality as they cross over to reach areas to lay eggs and return to feed. As the eggs are dependent on the warmth of the sun to incubate, the female will place them in a non-vegetated area, which exposes them to predation (KTTC, 2011). The sandy-gravel located on the shoulder area of roads provides an ideal location for the turtle to lay her eggs putting her at risk of a WVC, leading to reduced populations and number of eggs laid each year (KTTC, 2011).

The illegal activity of pet trade is another growing concern. In Ontario, the collection and sale of the wood turtle have contributed to its present rating of Endangered on the Species at Risk List and this is verging on Extirpated (Ontario Nature, 2011).

Amphibians:

Nine species of frogs, salamanders and Ontario's only lizard are on the Species at Risk List. Loss of habitat, vehicle mortality from migration across roads and negative impacts caused by contaminants and pollution are all contributors to the decline of this species. Frogs are an essential component of wetlands being both a food source for other wildlife and they consume large amounts of insects and algae. Frogs and salamanders are known as indicator species which means simply by their presence or absence, they indicate the health of an area. They rely on their skin to breathe and transport electrolytes which makes them very sensitive to negative impacts such as pollutants and contaminants in water bodies. Scientists and researchers have discovered frog populations have decreased due to the infectious disease chytridiomycosis, a fungus which is attacking the species on a global scale. This fungus attaches itself to the skin, causes breathing impairment and prevents electrolytes to pass through the body, leading to cardiac arrest. There is global concern regarding the decline of frogs and many studies are currently being conducted to introduce control methods in order to protect these sensitive species (Reptile & Amphibian Ecology, 2011).

Snakes:

Ten of the seventeen species of snakes in Ontario are listed as Species at Risk. Again, snakes play an essential role in maintaining biodiversity of an ecosystem. They are both predator and prey, keeping the rodent population down but are also a food source to several predator species such as hawks. It is believed that human fear of these creatures contributes to their mortality. Many people are afraid of snakes and studies show human attempts to deliberately deplete this species.

The road ecology study has shown this area to be a significantly diverse wetland capable of supporting many varieties of life. There are an alarmingly high number of mortalities along this stretch of Heart Lake Road and the numbers indicate the need for mitigation methods to be put into effect in order to protect their continued existence and ensure a healthy biodiversity.

4.2 Mitigation Recommendations

Reptiles and amphibians are an important component to many ecosystems. Amphibians stay within close proximity of their breeding sites, and most juveniles stay within one kilometer. When a road bisects a seasonal habitat and a breeding site, high levels of amphibian traffic will occur over these roads during peak breeding seasons (Ovaska *et al*., 2005). Research has shown that when comparing mitigation options for reptiles and amphibians, tunnel and fencing systems, culverts, and relocations of breeding sites tend to work best (Ovaska *et al*., 2005). Studies have also found that small to mid-sized mammals will also take advantage of culverts and concrete box structures (Beier *et al*., 2008). For this study, options to decrease WVC's include installing permanent or temporary fencing, utilizing existing culverts, and/or re-construct areas of Heart Lake Road by building concrete-box structures with opening tops at potential crossing hotspots. Extensive research, years of data compilations and studies have proven under-road tunnels to be effective at conserving and sustaining amphibian and reptile populations (Jolivet *et al*., 2008).

Tunnel and fencing systems should be strategically placed at high traffic crossing areas and guidelines of installation and maintenance should be followed. There are a small number of pre-existing culverts along Heart Lake Road which could be modified for use as wildlife pathways. When using culverts for wildlife pathways, it is essential to incorporate as much of the natural habitat as possible by placing substrate on the culvert base versus uncovered steel or concrete (Ovaska et al., 2005). For the mitigation procedure to be effective it is essential that the culvert(s) be relatively close to crossing hotspots (*Bissonette & Cramer,* 2008). If culverts are not pre-existing at wildlife crossing hotspots, concrete box structures should be considered. The concrete box structures are larger, and with the use of overhead openings, it is brighter and therefore more inviting to reptiles, amphibians, and small mammals (McEachren, 2011). For both suggestions, fencing is essential to guiding wildlife to the crossing. Silt fencing can be used (Figure 7), however the fence must be buried a certain depth underground to prevent wildlife from crawling under. This type of barrier should be monitored and maintained on a regular basis. A more permanent solution is a concrete wall (Figure 8) that cannot be dug under, or easily destroyed (Lake Jackson Ecopassage Alliance Inc., 2011).

Image 6: Permanent Concrete Wall Directing Wildlife to Underpass

Image 7: Silt Fencing Mitigation Option

4.3 Prevention

The following recommendations should be considered in an effort to help prevent WVC's prior to construction of a road:

- Conduct monitoring projects prior to road development and expansion adjacent to natural spaces during which monitoring data related to wildlife movement (migration patterns, habitat requirements, species sensitivity, etc.) should be collected, reviewed and considered prior to providing approvals and construction permits.
- For projects related to improving and/or expanding existing roads or for the construction of new roads, wildlife movement data should be reviewed and incorporated into the project design. These types of projects may provide a great opportunity to install a permanent barrier to guide wildlife to the preferred crossing areas, replace undersized culverts, or install new culverts or tunnels at identified crossing hotspots.
- Co-operation between the government and conservation organizations (i.e. OREG, TRCA) to develop policy and legislation in areas of road ecology to aid transportation and planning agencies to design more ecologically-sustainable transportation networks.

4.4 Education and Awareness

The following recommendations should be considered to help raise education and awareness of road ecology:

- Community Level Education – government to work with conservation organizations (i.e. OREG, TRCA) to provide public outreach and education programs to raise awareness about the ecological effects of roads through. Community events, schools, local media, digital media, brochures, and road signage are examples of tools that can be used.
- Staff Level Education – transportation and planning agencies to train and educate staff about the ecological effects of roads and incorporate road ecology into the planning process.
- Construction and Building Community – Employ transportation and planning agencies to educate construction workers about Road ecology and develop certification programs for the installation of the various mitigation options.

5 Conclusion

The objective of HLREMP was to better understand which species were being impacted by interactions with vehicles, how many interactions were occurring, and to suggest mitigation measures to protect local biodiversity in the wetland systems adjacent to Heart Lake Road.

The data analysis from the HLREMP reveals that there is a high numbers of WVC's along this stretch of Heart Lake Road. This report recommends the following options to help mitigate the total number of WVC's including installation of permanent or temporary fencing and utilizing existing culverts, building concrete-box structures with open tops, and/or installing fencing on either side of the road at potential crossing hotspots. In the future, these mitigation options can be employed as prevention strategies to minimize the amount of WVC's that will occur after a road is constructed. The HLREMP will help to provide direction for future studies and stakeholder decisions regarding the construction of roads and development around the study area.

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APPENDIX

Appendix A: HLREMP Articles

BRAMPTON GUARDIAN

Print

Corpse counters needed

Pam Douglas
March 23, 2011

Death Valley. Bramptonians can help protect the many frogs, turtles and snakes that hop, crawl and slither across Heart Lake Road every spring— by documenting the ones that didn't make it. The Toronto Zoo is looking for volunteer "citizen scientists" in Brampton to help collect data this spring. *Submitted photo*

Bramptonians can help protect the many frogs, turtles and snakes that hop, crawl and slither across Heart Lake Road every spring— by documenting the ones that didn't make it.

The Toronto Zoo is looking for volunteer "citizen scientists" in Brampton to help collect data this spring.

A section of Heart Lake Road, between Mayfield Road and Sandalwood Parkway, has been tagged for this first-of-its-kind wildlife monitoring project, being organized by the Ontario Road Ecology Group (OREG) at the Toronto Zoo.

Residents interested in volunteering their time to scientifically collect data on how many frogs, turtles and snakes die on the marsh-flanked roadway are invited to an information meeting Wednesday, March 30, 7 to 9 p.m. at Loafer's Lake Recreation Centre, 30 Loafer's Lake Lane.

The information on just how many are killed and where they are trying to cross will be used to find local solutions, and can even be applied nationally or globally, according to Mandy Karch, OREG co-ordinator.

Because the road bisects conservation land and marshy areas, there is a large number of casualties along that stretch every year. Last spring, six painted turtles were found dead on Heart Lake just in one day, and that fact caught the attention of OREG.

The Toronto and Region Conservation Authority (TRCA) and City of Brampton will supply the equipment needed to do the monitoring, and will work with Karch to train the volunteers and share the collected data.

Karch said similar monitoring projects may be undertaken in other parts of the province if the local project is successful.

"We're hoping to expand this to other municipalities and other local groups," Karch said.

OREG is an organization comprised of government and non-governmental scientists, educators and transportation planners, who work together to raise awareness about the threats of roads to biodiversity in Ontario and to research and apply solutions.

The solutions don't have to be too elaborate, according to Karch.

"A culvert that's already in place for hydrology can be very easily and very inexpensively converted into a crossing for wildlife, so there are very simple solutions," she said.

Culverts under the road are also very easily incorporated into a road resurfacing project or road widening, but the information has to be available to justify a crossing.

"Collecting data is critical," she said.

The monitoring starts in spring when snakes, frogs and turtles start to wake up, and move from their overwintering site to their feeding and reproducing ground, Karch said.

"So that (May) is a real key movement time," Karch said. "For turtles, June again is a key movement time because the females start looking for nesting areas. Species like snapping turtles and blanding's, they'll walk up to 16 kilometres in search of an appropriate nesting site."

In the fall, they are on the move again, moving from their "active" wetlands to an overwintering site.

"Particularly for snakes, October is a very critical movement period when we see a lot of mortality, unfortunately," Karch said.

She said the group is focusing on the species that are becoming extinct because of "road mortality".

With declining habitat availability and climate change, I think globally there's a decline in amphibians, so I think Canada is very lucky to have our population so we should really invest in their protection preemptively before they (are on the endangered species list)," she said.

For more on road ecology, visit the OREG's website is at www.torontozoo.com/conservation/RoadEcologyGroup.asp.

BRAMPTON GUARDIAN

Print

Residents wild about survey

By PAM DOUGLAS
April 16, 2011

Survey area. Beginning this spring, a section of Heart Lake Road, between Mayfield Road and Sandalwood Parkway, will be monitored in a first-of-its-kind wildlife mortality monitoring project unique to Brampton. *File photo*

Sebastian Attard saw a chance to help some of Brampton's frogs— and he jumped at it.

"Mom, we have to do this. It's our duty," the nine-year-old told his mother, Suzy, when he saw a story in The Guardian about a wildlife monitoring program unique to Brampton that is looking for volunteers.

Sebastian and his mother were just two of the more than 60 residents who attended a meeting recently to find out how they can help protect the many turtles, frogs and snakes that dodge traffic to cross Heart Lake Road every year.

Sebastian is "into any creature and anything to do with science," according to his mom, and she saw the monitoring program as a chance for them to do something together for a great cause.

No special expertise or knowledge is needed, just an interest in helping out. Everything else will be provided by the organizers— the Ontario Road Ecology Group (OREG) at the Toronto Zoo.

The turnout at a recent information meeting exceeded expectations, with a wide range of ages and backgrounds, and that has organizers excited about the interest for the project in Brampton.

A section of Heart Lake Road, between Mayfield Road and Sandalwood Parkway, will be monitored for this first-of-its-kind wildlife monitoring project.

"Citizen scientists" have been asked to volunteer their time to scientifically collect data on how many frogs, turtles and snakes die on the marsh-flanked roadway. The study area is a one kilometre stretch and would take approximately 1 1/2 to two hours to complete a monitoring session. The study will begin in May and run through October.

The information will be used to find local solutions, and can even be applied nationally or globally, according to Mandy Karch, OREG co-ordinator.

The volunteers, who will work in partners, will meet again April 27 for an on-site training session to review safety, data collection methods, and ask questions.

Because that section of road bisects conservation land and marshy areas, there is a large number of wildlife casualties along that stretch every year. Last spring, six painted turtles were found dead on Heart Lake just in one day, and that fact caught the attention of OREG.

The Toronto and Region Conservation Authority (TRCA) and City of Brampton will supply the equipment needed to do the monitoring, and will work with Karch to train the volunteers and share the collected data. The Heart Lake Project Team first heard about the program one year ago, and many of the volunteers are members of the team.

Karch said similar monitoring projects may be undertaken in other parts of the province if the local project is successful.

"We're hoping to expand this to other municipalities and other local groups," Karch said.

More volunteers are welcome. The group would like to be able to monitor the road two to three times a week, twice a day (morning and evening).

Etobicoke & Mimico Watersheds

CreekTime e-newsletter

Heart Lake Road Wildlife Monitoring

Nature Up Close!!

Spotlight on Green Business

Conservation Tips

Community in Profile

Upcoming Events

Support Your Watersheds

Painted Turtle

photo provided by V. D'Elia

The Toronto and Region Conservation Authority (TRCA) is partnering with the City of Brampton, and the Ontario Road Ecology Group (OREG) at the Toronto Zoo to deliver the Heart Lake Rd. Road Ecology Monitoring Program (HLREMP). **Road Ecology** is the study of the interactions between road systems and the surrounding natural environment. Heart Lake Road, between Sandalwood Pkwy and Mayfield Road, runs through the middle of a wetland complex and over the years there have been numerous wildlife casualties but they have not been formally documented. The HLREM will engage local volunteers in collecting data on the number of wildlife casualties along this road in order to better understand what potential role roads play in the decrease in biodiversity. The data collected will support future actions to help reduce road side wildlife fatalities.

The project was developed after six painted turtles were found dead on the side of the road within the period of one day in the spring of 2010. The months of May and June are very active times for frogs, snakes and turtles as they move from their winter homes to nesting areas in active wetlands. The fall also becomes a critical time for these animals as they move back to their overwintering sites.

The monitoring program began on May 8th, 2011 and will run until October 31st, 2011. Through the interest and support of local residents, the HLREM will depend almost entirely on volunteer commitments and the contributions from partners and sponsors.

If you are interested in volunteering for this project, contact Leo O'Brien at friendsofheartlake@rogers.com. All interested volunteers are required to work in pairs and participate in a mandatory safety training session. If you do not already have a partner in mind, the organizers will do their very best to connect you with another

Etobicoke & Mimico Watersheds

CreekTime e-newsletter

Heart Lake Road Monitoring - Update

Jan 16, 2012

Written by: Vince D'Elia, Project Manager, TRCA and Casey Cook, TRCA

The Toronto and Region Conservation Authority (TRCA), the City of Brampton and the Toronto Zoo's Ontario Road Ecology Group (OREG) with the help of local volunteers, recently completed the Heart Lake Road Ecology Monitoring Project (HLREMP), which was featured in the article entitled "Heart Lake Road Wildlife Monitoring" in the May edition of CreekTime.

The HLREMP monitored the wildlife vehicle interactions along a section of Heart Lake Road between Sandalwood Parkway and Mayfield Road which runs through the middle of a provincially significant wetland complex. There are significant wetlands on either side of Heart Lake Road which are essential in the process of water recharge and purification and provide habitat to a variety of wildlife including several frogs, turtles, snakes, mammals and avian species.

The HLREMP ran for a 25 week period from May 8th, 2011 to October 31st, 2011. During this time, approximately 40 dedicated local volunteers contributed more than 420 hours towards monitoring this stretch of road. The actual time spent monitoring represents approximately 10% of the total

available time for monitoring over the 25 week period, but the data collected was very valuable in allowing us to better understand the types and species of wildlife impacted by Heart Lake Rd., the number of interactions that occur on the road and the wildlife movement activity in this area.

TRCA enlisted a group of four Ecosystem Management Technology students from Sir Sandford Fleming College, School of Environmental and Natural Resource Sciences, to compile the information into a report of findings. These third year students are chosen from the Credit for Product Course which operates in cooperation with various environmental organizations to assist in research, data collection and environmental projects. With the limited funds and staff resources that the TRCA had available for this project, this partnership proved to be very worthwhile for both parties, enabling TRCA to move forward with data analysis and report on findings while providing the students with valuable hands-on experience. The student report also explored mitigation options and provided recommendations to alleviate the number of wildlife and vehicle interactions related to the project area.

The analysis of the data revealed a surprisingly high number of wildlife vehicle interactions along this very short stretch of road (2.5kms). A summary of these findings is represented in the figures below.

Figure 1

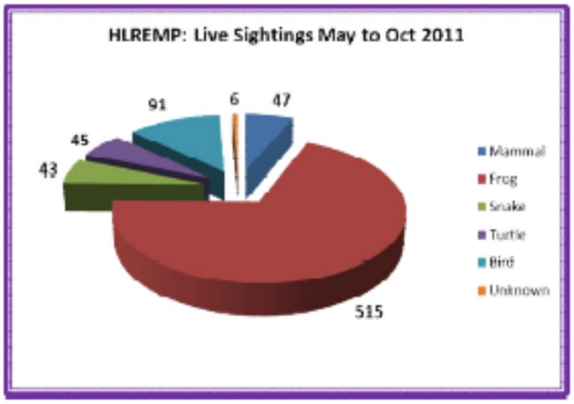
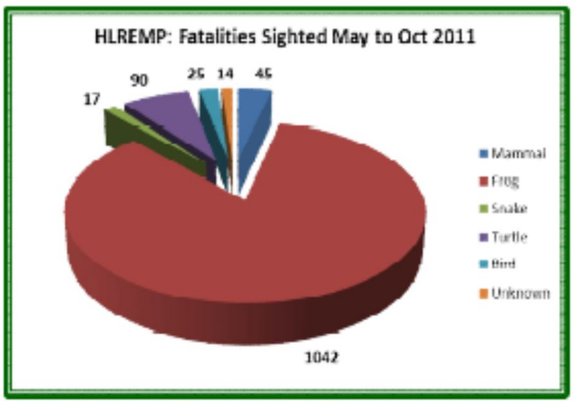


Figure 2



As noted in Figure 1, the number of fatalities is substantial and indicates mitigation is necessary in order to protect the health of both the wetlands and wildlife. These roads pose barriers to the movement of the creatures as they go through the breeding, feeding and hibernation process. Figure 2 represents live sightings, shows potential additional loss and depletion of these important members to a diverse system and are essential to a healthy sustainable ecosystem.

TRCA is in the process of finalizing the 2011 study and plans to share the report with partners and stakeholders in the hope that the report recommendations will be implemented to ensure a healthier, more sustainable future for this area.

Back to CreekTime E-Newsletter

BRAMPTON GUARDIAN

Print

1,000 dead frogs and counting

By PAM DOUGLAS
January 29, 2012

In danger. Volunteers monitored Heart Lake Road between May 8 and Oct. 31 (25 weeks) collecting data on the wildlife they found there— both alive and dead. What they found in the 420 hours they spent walking the shoulders of that relatively short section of road was a whole lot of dead frogs, turtles, snakes and birds.

The numbers are in and the picture is grim— traffic on Heart Lake Road is killing local wildlife by the hundreds.
A group of about 40 volunteer citizen scientists devoted their spare time last year to the Heart Lake Road Ecology Monitoring Project (HLREMP), recording the animal death toll along a 2.5 kilometre stretch of road in north Brampton that is level with an extensive marsh.
Between May 8 and Oct. 31 (25 weeks) they monitored Heart Lake Road, between Sandalwood Parkway and Mayfield Road, collecting data on the wildlife they found there— both alive and dead.
What they found in the 420 hours they spent walking the shoulders of that relatively short section of road was a whole lot of dead frogs, turtles, snakes and birds.
In all, 1,042 dead frogs were recorded, 90 turtles, 45 "mammals" of various types, 25 birds, 17 snakes, and 14 remains that were unidentifiable.
They also spotted plenty of live creatures— 515 frogs, 91 birds, 47 mammals, 45 turtles, 43 snakes and six unidentified animals.
The numbers show the wildlife and wetlands in the area are in need of protection, and ways of reducing the risk to local wildlife need to be found, organizers say.
The busy road is adjacent to Heart Lake Conservation Area, and it bisects a major wetland. Amphibians and reptiles cross to get to the other side frequently. HLREMP was launched to catalogue the impact of those crossings.
The Toronto and Region Conservation Authority (TRCA) teamed up with the City of Brampton and the Toronto Zoo's Ontario Road Ecology Group (OREG), putting together that passionate group of animal-loving volunteers who helped quantify just how deadly the road is for local wildlife.
But it wasn't just an exercise in counting. It is hoped something can be done to improve the deadly situation.
The information was handed over to a group of four Ecosystem Management Technology students from Sir Sandford Fleming College. They analyzed the data, compiled it in a report, and explored mitigation options, offering up recommendations.
That final report was presented to Brampton's Environmental and Planning Advisory Council last month by Vince D'Elia, project manager with the TRCA.
That advisory group has directed city staff to explore ways of reducing the death toll, including such measures as cleaning out the existing culverts and installing some type of fencing to guide wildlife to the culverts.
Also, TRCA planning and ecology staff will use the data when they are reviewing development applications for the area.
While the study was local, it can be seen as a reflection of what is happening all over the province, the report points out. Southern Ontario's road network is growing every year— from 7,133 kilometres in 1940 to 35,637 kilometres in 2000, and the Ontario Ministry of Transportation reports there is a vehicle/wildlife collision in this province every 38 minutes.
It is hoped that more such monitoring projects will be undertaken elsewhere, modelled after the pioneering HLREMP.
The dedicated volunteers were: Suzy Attard, Oliver Attard, Sebastian Attard, Leslie Bissegger, Mike Bissegger, Kelly Calovini, Nicole Calovini, Andy Calovini, Gillian Carson, Liz Ceci, Diana Christie, Bette-Anne Goldstein, Colin Grima, Teresa Grima, Janice Hessels, Susan Janhurst, Rosemary Keenan, Jim Laird, Rachel Luck, Sondra Luck, Debby McQuillen, Laura McQuillen, Leah MacSeáin, Mairéad MacSeáin, Damian MacSeáin, Chris McGlynn, Angela Mejury, Elizabeth Morin, Bob Noble, Jason Noro, Leo O'Brien, Shawn Patille, Marilyn Ross, Mike Solski, Cooper Solski, Sandhya Singh, Sonam Singh, Pauline Sutherland, Alana Ziobroski, Lyle Ziobroski.
To download a copy of the final report, click here.

Appendix B: Observed Wildlife

note: This table has been created using the raw data from the field data sheet. This data was collected by volunteers and analysis is based at the family level.

Taxa	Species	Dead	Alive	Total
Bird	Song bird	1	0	**1**
	Humming Bird	1	0	**1**
	Robin	1	0	**1**
	Chickadee	1	0	**1**
	Finch	2	4	**6**
	Canada Goose	2	51	**53**
	Swan	3	20	**23**
	Seagull	1	0	**1**
	Blue Heron	0	2	**2**
	Sharp Shinned Hawk	0	2	**2**
	Red-tailed Hawk	0	6	**6**
	Budge	1	0	**1**
	King Fisher	0	2	**2**
	Crow	1	0	**1**
	Turkey Vulture	0	1	**1**
	Turkey	0	1	**1**
	Mallard	0	2	**2**
	Duck	0	12	**12**
	Unknown	6	4	**10**
TOTAL		**20**	**107**	**127**
Frog/Toad	Leopard frog	226	78	**304**
	Bullfrog	3	4	**7**
	American Toad	2	0	**2**
	northern cricket	12	7	**19**
	Spring Peeper	1	0	**1**
	Western Chorus	5	1	**6**
	Tree Frog	1	0	**1**
	Toad	0	8	**8**
	Pickeral	1	0	**1**
	Green	25	9	**34**
	Grey tree frog	7	0	**7**
	Wood	1	1	**2**
	Unknown	736	93	**829**
TOTAL		**1020**	**201**	**1221**
Mammal	Cat	1	0	**1**
	Racoon	5	4	**9**
	Beaver	0	2	**2**
	Muskrat	3	4	**7**
	Rabbit	4	5	**9**
	Weasel	2	1	**3**

	Groundhog	0	7	**7**
	Mink	1	0	**1**
	Mouse	3	0	**3**
	Skunk	0	1	**1**
	Squirrel	3	6	**9**
	Chipmunk	2	1	**3**
	Rat	1	0	**1**
	Deer	3	9	**12**
	Unknown	4	2	**6**
TOTAL		**32**	**42**	**74**
Snake	Garter snake	10	11	**21**
	Northern Red Bellied	1	1	**2**
	Unknown	10	6	**16**
TOTAL		**21**	**18**	**39**
Turtle	Painted	28	5	**33**
	Wood	1	0	**1**
	Map	0	1	**1**
	Soft shell	2	0	**2**
	Snapping	10	3	**13**
	Unknown	42	39	**81**
TOTAL		**83**	**48**	**131**
Unknown	Unknown	287	9	**296**
TOTAL		**287**	**9**	**296**
Invertebrates	Unknown	1		**1**
TOTAL		**1**	**0**	**1**
OVERALL TOTAL OF INDIVIDUALS		**1233**	**747**	**1980**

Appendix C: List of Birds Identified, Bob Noble

note: This table represents birds observed in the study area by Volunteer Bob Noble over the course of the project.

HLREMP – Observed Bird Species

Row #	Species	Date First Seen
1	Canada Goose	29-May-11
2	Trumpeter Swan	5-Jun-11
3	Wood Duck	5-Jun-11
4	Mallard	29-May-11
5	Pied-billed Grebe	29-May-11
6	Great Blue Heron	29-May-11
7	Green Heron	5-Jun-11
8	Red-tailed Hawk	5-Jun-11
9	Killdeer	29-May-11
10	Ring-billed Gull	29-May-11
11	Rock Pigeon	5-Jun-11
12	Mourning Dove	29-May-11
13	Black-billed Cuckoo	5-Jun-11
14	Common Nighthawk	29-May-11
15	Ruby-throated Hummingbird	5-Jun-11
16	Belted Kingfisher	29-May-11
17	Downy Woodpecker	29-May-11
18	Hairy Woodpecker	29-May-11
19	Northern Flicker	29-May-11
20	Eastern Wood-Pewee	29-May-11
21	Alder Flycatcher	29-May-11
22	Willow Flycatcher	5-Jun-11
23	Eastern Phoebe	5-Jun-11
24	Great Crested Flycatcher	5-Jun-11
25	Eastern Kingbird	29-May-11
26	Warbling Vireo	29-May-11
27	Red-eyed Vireo	29-May-11
28	Blue Jay	29-May-11
29	American Crow	29-May-11
30	Tree Swallow	29-May-11
31	Bank Swallow	5-Jun-11
32	Barn Swallow	29-May-11
33	Black-capped Chickadee	29-May-11

34	White-breasted Nuthatch	5-Jun-11
35	House Wren	29-May-11
36	American Robin	29-May-11
37	Gray Catbird	29-May-11
38	European Starling	29-May-11
39	Cedar Waxwing	29-May-11
40	Yellow Warbler	29-May-11
41	Pine Warbler	29-May-11
42	Blackpoll Warbler	29-May-11
43	American Redstart	29-May-11
44	Common Yellowthroat	29-May-11
45	Chipping Sparrow	29-May-11
46	Savannah Sparrow	29-May-11
47	Song Sparrow	29-May-11
48	Swamp Sparrow	29-May-11
49	Northern Cardinal	29-May-11
50	Indigo Bunting	29-May-11
51	Red-winged Blackbird	29-May-11
52	Common Grackle	29-May-11
53	Brown-headed Cowbird	5-Jun-11
54	Baltimore Oriole	29-May-11
55	American Goldfinch	29-May-11
56	House Sparrow	29-May-11

Appendix D: Feedback from Volunteers and Other Recommendations

October 5th, 2011 Meeting in Brampton

Feedback Discussion from Volunteers

-Data sheet improvements

- Position category: how far from the paved line is the animal? Road boundaries need to be clearly defined.
- Include column indicating animal seen in wetland
- How dead is dead? Ie. turtle with a cracked shell versus flattened turtle. Solution: ensure that volunteers are aware and properly use the 'fresh' column.
- Referring to the LEGEND on the data sheet would help answer most of these questions. Perhaps make legend more visible/ stand out more so its draws attention.

-Photos collected with a measurement (scale) within photo. Create protocol of when to take pictures, and emphasize the importance of getting photos of animal types with small numbers such as turtles and snakes.

-Present to high schools on Road Ecology and recruit volunteers! This creates awareness and participation to a demographic just beginning to drive.

- Partner with Young Drivers of Canada and add Road Ecology to Driver's Manual.

-Inform customers at the Garden Centre. Ask to place a bristol board/ pamphlet with bullet point statistics about turtle mortality percentages, ie. 9% of animal mortality on Heart Lake Road are turtles and 1-2% is sustainable for turtle populations. Nesting females very important.

-Recommendations

- Road closures – generating awareness and notification of this happening prior to.
- Work with institution to find source populations and other significance of species and their interconnectedness. Ie. University studies and other co-op opportunities for university.

-Place all information regarding the project on a website

Other Recommendations

The following are suggestions and feedback given on October 5, 2011 by representatives from the City of Brampton, Peel Region, Toronto Region and Conservation and Associates, and volunteers to improve the HLREMP:

A) Data sheet and Volunteer Communications improvements

- Clearly define what the road boundaries are.
- Include a column for wildlife observed in Wetland.
- Ensure volunteers are properly trained/informed on how to fill in 'fresh' column.
- Improve location and visibility of legend on data sheets.
- Meetings on a bi-weekly basis should be held for both volunteers and community to ask questions.

B) Image Protocols

- Create protocol of when to take images.
- Emphasize the importance of getting images of animal types with small numbers such as turtles and snakes.
- Emphasize the importance of getting images of animals that are unknown.

C) Socio-Economic Recommendations

- Present to high schools on Road Ecology and recruit volunteers, and raise awareness of road ecology.
- Partner with Young Drivers of Canada and add Road Ecology to Driver's Manual.
- Ask the garden centre to place some signage/pamphlets of road ecology and statistics (including lowering speed on Heart Lake Road).
- Work with institutions to find source populations and other significances of species and their interconnectedness. Ie. University studies and other co-op opportunities for university.
- Make Heart Lake Road Ecology Monitoring Program information available to the public by placing information on a website.

D) Ecological Recommendations

- Road Closures are too costly and time consuming and are not a viable method to reduce mortality in this area, therefore it is recommended that future research be completed only during peak migration months. This method will save time, resources, and costs while providing relevant information that can be analyzed statistically to show correlations between time of year, species present, and peak migration times and can be compared against peak wildlife casualties.
- Migration routes for each species should be identified based on the hibernacula, feeding sites and nesting grounds for reptiles and amphibians before the study is carried out. This will provide an idea of the wildlife pathways already in place.
- Knowledge of the seasonal behaviour of the species present at the site will help determine the best times to conduct a study on migration routes and should be applied to future studies to increase the viability of the data and the efficiency with which the data is collected.

Appendix E: Safety and Monitoring Protocol

1. Must work with at least one other person so that one volunteer can complete the work, while the other volunteer can watch for traffic.
2. At least 1 person per monitoring session must have attended a training session.
3. Each volunteer must have signed and submitted a “Volunteer Waiver Form” and registered as a TRCA volunteer on the TRCA website: http://www.trca.on.ca/get-involved/volunteer/sign-in.dot
4. Walk the far edge of the shoulder of the road
5. Walk towards traffic
6. Do not wear ear buds for electronic devices
7. Individuals must wear proper Personal Protective Equipment that consists of safety boots, hard hat, and a safety vest.
8. That two “Road Works” signs be in placed on the side of the roadway prior to the commencement of work. One for northbound traffic just north of Sandalwood Parkway, and one for southbound traffic just south of Mayfield Road. When the work is done the signs must either be taken away or stored on the side of the road face down.
9. Removal of wildlife (dead or alive) from the road is to be done when there is a sufficient gap in traffic to do so as you will not be authorized to stop or direct traffic.
10. Dress weather appropriate
    - Sunscreen
    - Sunglasses
    - Sweater
    - Hat, etc.
11. Drink water
12. Carry a cell phone

I ________________________ have read and understand and agree to comply with the safety protocol.

Contact Information:

Phone: ______________________________

E-mail: ______________________________

Signature: _____________________

Study Site

Heart Lake Road between Sandalwood Pkwy E and Mayfield Rd. (approximately 2.5 km).

Important Contact Information:

Mandy Karch:

Office – (416)-393-6365

Cell - 416-726-9900

E-mail - mkarch@torontozoo.ca

Vince D'Elia:

Office – (416)-661-6600 Ext. 5667

Toronto Wildlife Centre:

Office – (416)-631-0662

Website - http://www.torontowildlifecentre.com

Local Peel Regional Police Station:

Office – (905)-453-3311

Survey Protocol

1. Set up Road Safety signs at Sandalwood Pkwy. & Heart Lake Rd (NE Corner) and at Mayfield Rd. and Heart Lake Rd (SW Corner). Carefully pull over to the shoulder of the road and set up the signs.
2. Park at Garden Centre Lakeside Garden Gallery or Heart Lake CA
3. Pick up field equipment box at Lakeside Garden Gallery – 10753 Heart Lake Rd.
4. Wear your personal safety equipment
5. Carry with you:
    - Clip board with
        - Data Cards
        - Species ID Guides
        - Emergency Contact #'s
    - GPS Unit – turn on unit and check battery power
    - Camera – turn on camera to check if battery is charged and that there is a memory card in the camera.
    - Cell Phone
    - Gloves
    - Dust pan/stick to remove wildlife remains from study area
6. Walk the far edge of the roadside shoulder towards traffic
7. Complete data sheet (name, date, weather conditions, etc.)

    PLEASE WRITE CLEARLY!!

8. GPS all signs of wildlife/road interactions (e.g. tracks, scat, remains)
9. Photograph unknown species or interesting findings
10. Discard wildlife/road interaction evidence to the side of the road (into the vegetation to avoid double counting a specimen)
11. Check over data cards to ensure all details are included
12. Return ALL equipment to the field box
13. Replace the field equipment box
14. Turn down Road Safety signs (leave them were you found them on the shoulder of the road) at Sandalwood Pkwy. & Heart Lake Rd and at Mayfield Rd. and Sandalwood Pkwy. Carefully pull over to the shoulder of the road and set up the signs.

Appendix F: Supplementary Information on Road Ecology

Ontario Road Ecology Group (OREG) & Toronto Zoo. (2010). A Guide to Road Ecology in Ontario, prepared for the Environment Canada Habitat Stewardship Program for Species at Risk. Scarborough, Ontario: Neo Communications. Retrievable from: *http://www.torontozoo.com/conservation/RoadEcologyGroup.asp*

Appendix G: Species Fact Sheet

List of Reptiles and Amphibians of Ontario – Status Under the Species At Risk in Ontario

Species at Risk in Ontario – Regulation under the Endangered Species Act 2007 (Ministry of Natural Resources, 2011)

Risk Classification

Extirpated	Native Species - Does not exist in Ontario, still exists in other parts of the world
Endangered	Native Species - Faces extirpation or extinction
Threatened	Native Species – At risk of being class as endangered
Special Concern	Native Species – sensitive to human activity, natural events, at risk of being endangered or threatened

Table 1 – Frogs of Ontario

Species Name	Category of Risk	Geographic Location	Facts
American Toad *(Anaxyrus americanus)*	N/A	Most of Ontario	5-9 cm – raised warts on body – kidney-shaped raised gland behind eyes
Blanchard's Cricket Frog *(Acris blanchardi)*	Endangered	Pelee Island [1]	Small, 2.5 cm – dark triangle-shape between eyes on top of head
Boreal Chorus Frog *(Pseudacris maculata)*	N/A	Northern Ontario	Very small, 25-30 mm – dark brown body, dark stripe-like spots – greyish-bronze underside
Bullfrog *(Lithobates catesbeiana)*	N/A	All areas southeast of Lake Superior [2]	Largest, 10-15 cm – green, olive, brown, male has large eardrum behind eye
Fowler's Toad *(Anaxyrus fowleri)*	Endangered	North shores of Lake Erie	50-80 mm – greyish-brown, 3-4 warts in brown areas on body – bony ridge behind eye
Grey Treefrog *(Hyla versacolor)*	N/A	East from Manitoba along shores of Lake Superior to southern Ontario	3-5 cm – Grey, brown or bright green – large toe-disks – inner part of thigh is bright yellow-orange – white squarish patch under eyes
Green Frog *(Lithobates clamitens)*	N/A	Southern Ontario to just north of Lake Superior	6-9 cm – Green with dark brown spots on back – bright green band on upper lip – black bands on hind legs – ridge runs down each side of body
Leopard Frog *(Lithobates pipiens)*	N/A	Most of Ontario	5-9 cm – green, light brown – dark spots lined with yellow on body/legs – white line on upper lip
Mink Frog *(Lithobates septentrionalis)*	N/A	All southern Ontario to just north of Lake Superior	5-7 cm – dark green to gray – dark circular areas on back – musky odour
Pickerel Frog *(Lithobates palustris)*	N/A	Southern Ontario north to Lake Huron	4-7 cm – cream to brown – 2 rows of square-like brown spot on body – 2 lighter ridges along sides of body
Western Chorus Frog *(Psuedacris triseriata)*	N/A	Southern Ontario, south of Sudbury	3 cm – light brown – 3 dark stripes on body, may be broken into splotches – white stripe on upper mouth area – one of 2 chorus frogs in Ontario
Spring Peeper *(Pseudacris crucifer)*	N/A	Most of Ontario	2-3 cm – tan to light brown – dark "X" shape on back – dark stripe between eyes on top of head – small disks on toes
Wood Frog *(Lithobates sylvatica)*	N/A	All of Ontario	3-4 cm – brown, tan or copperish – black triangle on face behind each eye – white line on upper area of mouth extending behind eye

[1] Confirmed sightings in 1970's, unconfirmed sightings 1990's – suspected not in Canada
[2] Research shows significant decline in recent years

Table 2 – Turtles of Ontario

Species Name	Category of Risk	Geographic Location	Facts
Blanding's Turtle *(Emydoidia blandingii)*	Threatened	Southern Ontario, north to Manitoulin Island	Up to 28 cm – black/grey-brown domed carapace with yellowish dots/streaks – eyes protrude - bright yellow chin and throat
Common Snapping Turtle *(Chelydra serpentina)*	Special Concern	Southern Ontario, north to Wawa , West along Lake Superior to Manitoba border	20-35 cm [3] - light brown, black carapace – yellowish plastron – long tail with triangle scales – large head
Midland Paint Turtle *(Chrysemys picta marginata)*	N/A	Southern Ontario north to Lake Superior	10-15 cm – olive to brownish smooth carapace, orange-red pattern along edge – yellow stripe behind eyes – yellow and red stripes on neck and legs
Northern Map Turtle *(Graptemys geographica)*	Special Concern	Southern Ontario	9-30 cm – olive to brown carapace with fine yellow lines and ridge down centre – head and legs may be lined - yellowish spot behind eyes
Spiny Soft-shelled Turtle *(Apalone spinifera)*	Threatened	South Western Ontario	12-43 cm – olive to brown flat leathery texture carapace, males have black outlined spots, females plain spots - long neck, 2 yellowish stripes outlined in black, distinct tube-like snout
Spotted Turtle *(Clemmys guttata)*	Endangered	Southern Ontario	9-13 cm – carapace smooth, black, yellow or orange dots – head black to grey with yellow marks, inside of legs orange-red
Eastern Musk, aka Stinkpot *(Sternotherus odoratus)*	Threatened	Southern Ontario	5-13 cm – smooth, rounded brown to black carapace – 2 lighter stripes on side of head – musky odour emitted when threatened
Western Painted Turtle *(Chrysemys picta bellii)*	N/A	West of Lake Superior to Manitoba Border	9-18 cm [4] - carapace olive to brown-grey carapace with lighter lines – distinct dark splotch on yellow plastron
Wood Turtle *(Glyptemys insculpta)*	Endangered	Southern Ontario	14-20 cm – carapace brown, sculptured with raised growth rings, may have keel – yellow plastron, black squares – black head, orange or yellow neck and legs

Table 3 - Salamander

Species Name	Category of Risk	Geographic Location	Facts
Mud Puppy *(Necturus maculosus)*	N/A	Southern Ontario	25-30 cm – reddish brown body, black spots – distinct red gills behind head, retained for life – 4 toes
Spotted Salamander *(Ambystoma maculatum)*	N/A	Southern Ontario, north to Lake Superior	15-18 cm – black body with orange or yellow spots
Blue-spotted Salamander *(Ambestoma laterale)*	N/A	Southern Ontario north to Manitoba boarder	7-12 cm – black body, blue spots/flecks
Jefferson Salamander *(Ambesoma jeffersonianum)*	Endangered	Small area around western end of Lake Ontario	12-18 cm – grey-black body, blue-white flecks – lightish-grey belly
Red-spotted Newt *(Notophthalmus viridescens viridescens)*	N/A	Southern Ontario north to shoreline of Lake Superior, along border to Manitoba	7-10 cm – greenish to yellow body, black spots, line on back of red spots outlined in black – 3 life stages, aquatic larvae, terrestrial eft [5], aquatic adult

[3] 49.4 cm recorded
[4] 25.1 cm recorded

Eastern Red-back Salamander *(Plethodon cinereus)*	N/A	Southern Ontario north to Lake Superior	5-10 cm – dark reddish stripe down body and tail, sides grey – no lungs, respiration through skin
Four-toed Salamander *(Hemidactylium scutatum)*	N/A	Band from Georgian Bay to Ottawa region and Western area of Lake Ontario to Lake Erie	6-8 cm – body reddish-brown, orange tail with groove at rear legs – underside white with black dots –4 toes [6] on all feet
Northern Two-lined Salamander *(Eurycea bilineata)*	N/A	Band East from Georgian Bay to Ottawa region	6 – 9 cm – no lungs – yellow-brown band on back with small back spots, yellow belly, grey sides
Northern Dusky Salamander *(Desmognathus fuscus)*	Endangered	Small area in Niagara Gorge	8-9 cm – grey to brown, line runs from eye to behind mouth – no lungs – young have yellow or red stripe on back, fades with adults

Note: Other Species Salamanders:
Eastern Tiger, Extirpated, Ontario
Allegheny Mountain Dusty – Endangered Provincially, Threatened Nationally
Small-mouthed – Endangered Provincially
Spring Salamander – Extirpated, Ontario– Special Concern Nationally

Table 4 - Lizard

Species Name	Category of Risk	Geographic Location	Facts
Five-lined Skink *(Plestiodon fasciatus)*	Special Concern, Endangered	Eastern Shore Georgian Bay bands out to Southern Canadian Shield and Southwestern Ontario	25-30 cm – brown, grey, olive body, 5 yellowish-white stripes – juvenile brighter stripes, brilliant blue tail – male, reddish-orange jaw

Table 5 - Snakes

Species Name	Category of Risk	Geographic Location	Facts
Blue Racer Snake *(Coluber constrictor foxii)*	Endangered	Pelee Island	90-152 cm - grey or green-blue – dark head, white throat, bluish belly – juvenile is grey, dark spots on back, white/black specks on head
Butler's Garter Snake *(Thamnophis butleri)*	Endangered	Isolated areas, Southwestern of Ontario	35-55 cm – body greenish-brown or black, 3 orange or yellow stripes – small head – yellowish-green belly
DeKay's Brown Snake *(Storeria dekayi)*	N/A	Southern Ontario to Georgian Bay	20-35 cm – body pale grey-brown to red-brown – light stripe with dark spots along back – dark bar angled down on side of head – belly cream-pink
Eastern Fox Snake *(Pantherophis gloydi)*	Threatened Endangered	Isolated area Georgian Bay and Carolinian zone	90-140 cm – body yellowish-brown with black square-like marks on back and roundish marks on side – head may be reddish-brown – belly yellow with black spots
Eastern Garter Snake *(Thamnophis sirtalis sirtalis)*	N/A	Most of Ontario	45-65 cm – black, green, brown with 3 yellowish stripes – belly yellow-greenish
Eastern Hog-nose Snake *(Heterodon platerhinos)*	Threatened	Small band running East from Georgian Bay, Southern Ontario	50-85 cm – grey, brown or black, blotches along back – neck expands when threatened forming triangle shape – flat head, nose turned up
Eastern Milk Snake *(Lampropeltis triangulum)*	Special Concern	Southern Ontario, South of Lake Superior	60-90 cm – grey, cream, tan, dark blotches outlined in black – white belly, black spots

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[5] No eft stage in some populations
[6] Other terrestrial species have 5 toes on back feet

Eastern Rat Snake *(Pantherophis spiloides)*	Threatened Endangered	Isolated areas, Carolinian zone and Eastern Lake Ontario	100-185 cm – black, may have blotch pattern – young are grey, dark blotches – white throat – belly greyish-brown
Eastern Ribbon Snake *(Thamnophis sauritus)*	Special Concern	Southern Ontario	45-70 cm – black, 3 yellow stripes – white crescent-shape in front of eye – belly yellow-green
Eastern Smooth Green Snake *(Opheodrys vernalis)*	N/A	Southern Ontario north to Lake Superior	30-55 cm – bright green body – yellow belly
Lake Erie Water Snake *(Nerodia sipedon insularum)*	Endangered	Isolated areas Lake Erie, Pelee Island	60-110 cm – grey to grey-brown – some bands on body – belly white, yellowish-grey
Massasauga Rattle Snake *(Sisturus catenatus)*	Threatened	Georgian Bay, isolated areas Lake Erie	45-80 cm – grey to brown – blotches down back outlined in white – alternate spots along side – black belly – squarish tail – only venomous snake in Ontario
Northern Water Snake *(Nerodia sipedon sipedon)*	N/A	Southern Ontario to South end of Lake Superior	60-110 cm – brown-dark brown, blackish bands back and sides – creamish belly, reddish crescents shapes
Northern Red-bellied Snake *(Storeria occipitomaculata occipitomaculata)*	N/A	Southern Ontario to Lake Superior, along border to Manitoba	20-25 cm – red to grey brown – neck has 3 light brown or yellow spots – orange-red belly
Queen Snake *(Regina septemvittata*	Endangered	South Western Ontario	35-65 cm – yellow-brown body, yellow stripe on lower area – back may have 3-5 darker stripes
Red-sided Garter Snake *(Thamnophis sirtalis parietalis)*	N/A	Manitoba Border	40-70 cm – black-brown, 3 yellow stripes – reddish on side – green, black belly
Ringneck Snake *(Diadophis punctatus)*	N/A	Southern Ontario to Lake Superior	25-40 cm – shiny, steel-blue, grey or brown body – pale ring on neck – orange-yellow belly

Note: Timber Rattlesnake - Extirpated

Appendix H: Literature Reviews completed by Fleming College Students

G.1 Monitoring roadside ecosystems - The ecological effects of roads on adjacent ecosystems

Ashlea Veldhoen

Introduction

The effects of roads on the ecological systems and processes over which they are paved are numerous. In our study, we will be compiling data collected at Heart lake Road in Brampton, Ontario in efforts to mitigate and promote the conservation of the delicate ecosystems present on either side of the road. Heart Lake Road runs directly through a wetland near Heart Lake Conservation Area and used to be the only road travelling though the area. **Roads fragment natural ecosystems and road ecology is a field borne from this effect. Fragmentation of habitat is often correlated with the decline of biodiversity of species, reduction of wildlife populations, habitat loss, disturbed soils, and increased vehicle–wildlife collisions.** This literature review will be investigating the effects of roads on the biota of local ecological systems.

Annotations

Angold PG. (1997). The Impact of a road upon adjacent heath land vegetation: effects on plant species composition. *Journal of Applied Ecology.* British Ecological Society. 34(2), 409-417.

This study was conducted to investigate the effects of a road on heath land vegetation in New Forest, Hampshire, U.K. The author cites several scientific papers detailing the effects of roads and the fragmentation of ecosystems. The study was conducted on 5 sites adjacent to a major road and nine supplementary sites along 5 minor roads stemming from the major road. Qualitative analysis was done at each of the sites, investigating the height/growth of vascular plants, the abundance and appearance of grass species and the abundance (or lack thereof) of lichen species. It was found that vascular plants were responding positively adjacent to the road, most notable were the grass species – they experience enhanced growth compared to individuals found elsewhere, and there was a “decrease in the abundance and health of lichens beside the road” (Angold, 1997). It was also found that the edge effect in the adjacent communities was linked to the amount of traffic the road experienced and extended up to 200 m on either side of a 2-lane highway. The author hypothesizes that the increased health and growth of vascular plants near the road is due to the increased amounts of nitrous oxides from vehicle exhausts and that the correlation between traffic and edge effect should be taken into account when planning to expand old roads or create new ones. The author suggests building buffer zones on both sides of the road to help minimize its environmental impact and edge effect. The full article could not be accessed and therefore could only provide very limited amounts of information on the ecological effects of roads on adjacent vegetative communities, however enough information could be extracted to be relevant to my study by providing a basic understanding of the study and the impacts that roads have on adjacent vegetative communities.

Clewell A.F., Aronson J. (2007). *Ecological Restoration: principles, values and structure of an emerging profession.* Washington: Island Press. 20-25, 169-179.**

Teaching young ecologists the ecological consequences of impairment in ecosystems by analyzing restoration projects and case studies carried-out globally, with the goal of preparing students to plan, carry-out and follow-up with their own restoration projects is the goal of this book. This book uses cutting-edge data from reputable sources as well as records of real-world projects to demonstrate ecological impairment and the remediation steps that are needed in order to restore an ecosystem to a functional, self-sustaining state. In chapter two, ecological impairment and recovery, the authors give a description of current ecological disasters that are causing entire countries to become poverty stricken. The authors include five sub-chapters describing the eight consequences of reallocating resources and ecological impairment. These eight consequences include: Losses of Specialized Species and Relative or Actual Gains of Generalist Species; Colonization by Invasive Species; Simplification of Community Structure; Changes in Microclimate; Changes in Frequency Distribution of Plant Life Forms; Losses in Beneficial Soil Properties; Reduction in Capacity for Mineral Nutrient Retention and Alteration in the Moisture Regime. All eight of these consequences of ecological impairment can be found at the Heart Lake Road site where the road intersects with a large wetland and virtually splits it into two halves. The overriding message in this book is that systems can never be restored to their past states, but can be readapted to develop a certain way in the future based on the characteristics of the land and the species which are capable of inhabiting it. A site may never be what it once was, the impairments may have caused permanent changes or damages to the ecosystem, but it can be recovered and directed to grow into a functional and self-sustaining system.

This book is an excellent resource and reference for analyzing disturbed sites such as the one on Heart Lake Road, and can be used in such a way to help ecologists understand the methods which must be used to restore a system to a functional state. The book provides a method for creating a restoration plan, defining habitat types using the Ecological Land Classification guide, and how to encourage species to migrate into the newly restored area. This book is relevant to our studies as it will provide us with details about how to mitigate wetland sites to increase their appeal to fauna species and discourage them from crossing the road to find breeding ground or resources – in this way we can provide the Toronto and Region Conservation Authority with mitigation options that are long lasting, self-sustaining and cheaply maintained.

**Coffin AW. (2007). From roadkill to road ecology: A review of the ecological effects of roads. *Journal of Transport Geography.15,* 396-406.

The purpose of Coffin's study (2007) is to provide a review the ecological effects of roads on the abiotic and biotic components of adjacent (or pre-existing) ecosystems. The author is a transportation geographer reporting on the effects of roads on ecological communities.
The source provides great detail on the effects of roads on biotic components of ecosystems, including roads as a way of mortality and as a barrier to fauna in local ecological communities. The source provides examples of how roads change hydrology and water quality and results in erosion and chemical and sediment transfer into hydrological systems. The source fails to provide specific examples where wetland ecosystems are affected but goes into detail mainly about the effects of roads on forest ecosystems. The source is a review of current literature as well as a reflective essay, throughout the document facts are supported by citations from current literature on the subject of road ecology as well as studies concerning the human impacts on global ecosystems. The author goes into detail about a research project on the effects of roads on tropical ecosystems in Belize that used simulation modelling to predict road configuration on animal population persistence. It was found that the effect roads had on populations was dependent on the animals' behaviours when they encountered roads "i.e. to what degree that species avoids crossing roads and the probability of it being killed if it does" (Coffin, 2007). The researchers of the Belize study also concluded that by building roads close together it allowed for greater population persistence in the surrounding areas and measures should be taken to protect the un-fragmented habitat from future road construction. The author notes that "transportation geographers are in a prime position to contribute to emerging science of road ecology in hopes of providing both analytical and theoretical tools to study the landscape scale effects of road networks" (Coffin, 2007). The section named "the effects of roads on biotic components of ecosystems" was very relevant to the subject of this literature review yet it does not provide specific case studies where wetlands are the subject, which would have more helpful to my study.

Eberhardt E. (2009). Current and potential wildlife fatality hotspots along the Thousand Islands Parkway in Eastern Ontario, Canada. Carleton University.

This study was completed to assess the effects of roads on animal mortality. Conducted on the Thousand Islands Parkway near the St. Lawrence Islands National Park, the study analyzed the number of kill sites located along the parkway. Of the 63 species identified along the road, 3 were species of special concern and 2 were threatened as indicated by the Committee on the Status of Wildlife in Canada. The authors used kernel density to identify the "hotspots" where the most kill sites were located, and used a "network K-function" for statistical clustering of data and a "roving window analysis" to investigate the relationships between traffic volume, time of day and other variables and the road kill found along Thousand Islands Parkway. The results showed that traffic volume was negatively correlated with frog and toad kills, which the authors interpreted as an indicator of decreasing populations within the species. The authors suggest that further mitigation efforts should account for habitats that may have been inhabited in the past as wells as accounting for the current mortality hotspots. This article provides key points on the effects of roads on animals but is limited to a single study area that lacks landscape variability, which may add ambiguity to the data in that main population sources may be more difficult to find in a homogenous habitat.

Fahrig, L., and T. Rytwinski. (2009). Effects of roads on animal abundance: an empirical review and synthesis. *Ecology and Society* 14(1): 21. [Online] Retrieved October 11, 2011, from http://www.ecologyandsociety.org/vol14/iss1/art21/

The authors found and compiled the data collected from 79 different studies completed concerning the effects of roads on the abundance of 131 species and 30 species groups, in an attempt to create a complete review on the topic. The review was completed by Fahrig and Rytwinski (2009) and results showed that the negative impacts of wildlife-vehicle interactions (WVCs) on animal abundance outnumbered the positive effects by a factor of 5. From data extracted from the documents used for the study, it was found that the abundance of "amphibians and reptiles were usually negatively affected by roads, birds showed mainly negative or no effects, with a few positive effects for some small birds and for vultures, small mammals were effected either positively or were not affected at all, abundance of mid-sized mammals showed either negative effects or no effect at all, and the abundance of large mammals was predominantly negatively affected. The authors the synthesized the data collected, including species attributes and developed a set of predictions of the circumstances which led to either negative, positive or no effect of roads on animal abundance" Fahrig, L., and T. Rytwinski. (2009). The authors organized their findings on what they named "species type", which categorizes species based on the strength of their affinity or attraction (based on food requirements, movement and their preference concerning traffic or disturbance caused by the roads) to go to the road. The authors recommend further research is done on the mitigation options where species affected by traffic disturbance are concerned, including reducing road and traffic density on the landscape. They also make note that more care be taken during the planning stages of road development to account and consider whether the species of concern is mainly due to road mortality vs. traffic disturbance. This source is very relevant to my research regarding the ecological effects of roads on adjacent communities and provides a comprehensive view on the intensity at which WVCs are occurring.

Findlay CS and Borages J. (2000). Response time of wetland biodiversity to road construction on adjacent lands. *Conservation Biology*. 14(1). 86-94

This study was conducted to investigate the response time of wetland biodiversity to road construction on land adjacent to the road based on the known effects of road construction on biodiversity. The authors documented the lags in wetland diversity loss in response to road construction. Using regression models, the authors set species richness of different taxa as a function of current and historical road densities on adjacent lands (Findlay & Borages, 2000). The study showed that variance in herptile and bird species richness increased when using current density data in multiple regression models. The authors understand this to be an indicator that the full effects of roads on certain taxa may not be noticed for several generations within a community. The authors stress the significance of the lags in response to “changes in anthropogenic stress” on land-use planning and environmental impact assessment. This study is relevant to my topic in that it provides information regarding the historical impacts of roads on species richness and diversity in wetland systems adjacent to roads, and suggests that the historical data is imperative to future land-use planning and when conducting environmental impact assessments.

Forman, Richard T. T. (2004). **Road ecology's promise: what’s around the bend?. *Environment*. *46(*4), 8-21.

This document provides information concerning the effects of roads on both the abiotic and biotic components of an ecosystem while using language that can be understood by most people without a background in science or ecology. This document is an informative and motivational piece to inform the lay person about leading edge research and development happening in the newly emerging field of road ecology. It can only be called an informative and motivation piece because no scientific analysis was carried out and a heavy bias against current transportation planning, policy and practices is very apparent throughout the work. The quote below is the author’s description of the beginning of road ecology studies in the United States. The author later says that road ecology had been studied in European countries at least 10 years before the U.S. started collecting data.

“In 1991, the U.S. Congress passed its big highway act (ISTEA, the Intermodal Surface Transportation Efficiency Act), which permitted the use of some highway funds for environmental enhancements. In 1997 Congress passed a successor transportation act (TEA-21) to fund highways, including their environmental dimensions. A series of road ecology conferences (ICOET, the International Conference on Ecology and Transportation) began, and the Transportation Research Board of the National Research Council (NRC/TRB) appointed committees that published two books containing chapters highlighting the importance of road ecology.” (Forman, 2004).

These events marked the beginning of studies in road ecology monitoring and assessment which can now be applied to transportation planning (within municipalities and provincial lands). With the ecological data in place, the author is mainly concerned with the cultural or human factors in research and development of roads and the newly found interest in ecology within transportation communities and is looking to promote interest in the field of road ecology. With the language being written out in layman’s terms, I was able to increase my understanding of the subject without the normal confusion induced by the use of unfamiliar scientific terms. In contrast, I found this work to be biased against the common driver as well as the government. The haughty and alarmist undertones take away from the overall message of the article which is to promote the study of road ecology so that it can be used in transportation planning and development.

Rentch JS, Fortney RH, Stephenson SL, Adams HS, Grafton WN and Anderson JT. (2005). Vegetation–site relationships of roadside plant communities in West Virginia, USA. *Journal of Applied Ecology*. British Ecological Society. Blackwell Publishing, Ltd. 42, 129–138. [Online]. Retrieved October 11, 2011 from http://search.ebscohost.com.rap.ocls.ca/login.aspx?direct=true&db=aph&AN=16187688&site=ehost-live

This study was completed to analyze the relationship between vegetative communities and roads within the mountainous regions located in West Virginia, USA. Data were collected from 13 major 4-lane highways in the state of WV using “analysis of variance (in species), multiresponse permutation procedures and indicator species analysis” (Rentch et al, 2005). The study analyzed nutrient values in the soil shouldering each highway, plant species richness, diversity and evenness. Results showed that mean soil nutrient values varied highway to highway, but when the position of the highway was analyzed, soil nutrients tended to stay relatively the uniform. Species richness, diversity and evenness also remained relatively uniform when highway position was concerned. When the results of the multiresponse permutation were analyzed, they suggested that each highway was associated with different plant species assemblages, and the vegetative communities appeared distinctive to each highway. An indicator species analysis was used to support this hypothesis, its results showed that "54 species showed a statistically significant ($P< 0{\cdot}05$) affinity to one highway over all others" (Rentch et al 2005). Upon further analysis of these 54 species, more than half were identified as non-native or exotic invasive species, communities tended to stay relatively uniform when highway position was considered, 25 of the 54 species showed a preference to a specific position along the highway, and of those 25, 8 were exotic. The results of the research suggest that despite the high disturbance caused by the construction of roads in mountainous regions, the vegetative communities that propagate and establish themselves tend to stay uniform. The authors recommend that highway agencies manage roadside vegetation using similar methods, while focusing on encouraging the growth of native species to provide erosion control while minimizing the spread of exotic invasive species.

Schipper, P. M., Comans, R. J., Dijkstra, J. J., & Vergouwen, L. L. (2007). Runoff and windblown vehicle spray from road surfaces, risks and measures for soil and water. *Water Science & Technology,* 55(3), 87-96. Retrieved October 11, 2011 from http://search.ebscohost.com.rap.ocls.ca/login.aspx?direct=true&db=eih&AN=24466813&site=ehost-live

This study was completed to investigate the risks and measures for soil and water associated with runoff and vehicle spray from road surfaces. The authors indicated that the primary sources of pollution included polycyclic aromatic hydrocarbons (PAH), mineral oil, heavy metals and salt which originate from vehicles, roadside barriers and salt distributing vehicles during the winter months. The dry deposits combine with rain water and vehicle spray and get distributed into the shoulder of the road anywhere from 50 m to 150 m from the roadway. The study was completed over a period of 13 months along two roads within the Netherlands, and was designed to collect extensive data regarding the risks of the sediment pollution to soils and water quality as well as the geochemical and physical factors that determine those risks. Post-data collection, the results suggested that the pollutants were readily absorbed into natural soils, indicating a possible risk to groundwater quality. The authors suggest that measures be taken to protect the groundwater in vulnerable areas by changing the policy within the Netherlands to allow the removal of contaminated topsoil before the pollution reaches the groundwater. Finally, the authors advise that runoff should not be allowed to reach open water or surface water. This source was essential to gathering an understanding of the chemical and physical effects of runoff and vehicle spray on groundwater resources and hydrological systems. In turn, this knowledge can be applied to my research on the ecological effects of roads on adjacent ecosystems (specifically wetlands), and the species that inhabit them, while acknowledging that further research should be carried out specifically concerning the affects of runoff and vehicle spray on the water quality and chemistry within wetlands adjacent to the road.

Conclusion

The sources collected for this Literature Review provided in-depth information regarding the ecological effecs of roads on adjacent plant and animal communities, especially pertaining to the wetlands. Roads usually have a detrimental effect on ecosystem structure, function and health where the road is constructed through a pre-existing system (i.e. in the case of Heart Lake Road and the surrounding wetland area). However, once the system adapts to the road construction, new communities are able to establish and flourish, as in the case of Rentch JS et al's study of highways in the Virginia mountains in 2005. It can be said however, that wetlands and the species which inhabit them ultimately become more vulnerable to physical stressors as habitat fragmentation due to road construction reduces their mobility between nesting and hibernation sites, as well as feeding and breeding grounds, increases their mortality by exposing species to direct danger due to vehicles, and overall may reduce populations to numbers which may eventually extirpate local populations from the area. Roads also contribute negatively to wetland systems by damaging and in some cases completely removing the riparian zone, degrading the soil, increasing erosion and increases the flow rate of contaminated runoff directly into the system. This contributes to the pollution of the wetland which in most cases is irreversible once particulate matter settles into the peaty soil underneath the water. Pollution of the wetland system will negatively affect the health of the plants and animals living within the system, and may eventually lead bioaccumulation of toxins in ducks and geese, which lead to birth defects and malformation of babies born, as well as an increase illness and disease, within local populations. To conclude this study, mitigation options must take a holistic approach when looking to repair the damaged systems along Heart Lake Road, and must take into account wildlife populations, migration routes, hibernation, nesting, feeding and breeding sites, as well as plant life, riparian zone functionality and health, and water chemistry, soil porosity and chemistry and road size, structure and contaminants found. These factors must all be accounted for when choosing a permanent mitigation solution, and must be provided for at some point in time during the mitigation process in order to truly recreate a healthy and functional wetland ecosystem.

G.2 The Alteration of Abiotic Components from the Development of Road Networks

Laura Baldwick

Introduction

Heart Lake Road located in Brampton, Ontario divides a wetland resulting in wildlife-vehicle interactions. The development of the road has interfered with the wildlife that is living within the wetlands. When a change is made to an ecosystem, it causes changes to other areas within that ecosystem. When roads are developed there are many ecological effects that follow this development. Abiotically speaking, there are alterations to the water quality, erosion of river banks and sediment transportation, effects of chemicals, and noise pollution (Coffin, 1997). These factors all have effects on the wildlife and plant populations that live on the habitats around the roads. The roads affect the biota by being a source of mortality or acting as a barrier (Forman, 1998).

Thesis

The road networks created by human development greatly affect the ecosystem that lines the road. The alteration of the chemical conditions as well as the movement of water and sediment can cause changes within the ecosystem.

Annotations

Boarman, W.I., and Sazaki, M. 2006. A highway's road-effect zone for desert tortoises (*Gopherus agassizii*). *Journal of Arid Environments* 85, 94-101.

Roads and highways affect the wildlife populations surround them. Wildlife is directly affected through road mortality or indirectly by alteration of the habitat like fragmentation or introducing invasive weeds and other plants. The desert tortoise is an endangered species found in the Mojave Desert, California. The researchers of the study were looking to see if the roads affected these populations and if it did what the road-effect zone was. The researchers used 30-m wide strip transects to estimate the tortoise populations along the highway. These transects were located at 0, 400, 800 and 1600 m from the edge of the highway. Mean sign count was 0.2/km at 0m, 4.2/km at 400 m, 5.7/km at 800 m, and 5.4/km at 1600m from the highway edge. The results of the study suggest that tortoises are depressed in a zone at 400 m from the roadways. They measured for a road-effect zone by evaluating the density of animals with the respect to the road edge. The authors speculate that the major cause of death in this zone is road mortality. This article shows how organisms are affected by the roads that run through their habitat. It was interesting to set the road-effect theory in an example and where mitigation should be installed.

*** Coffin, A.W. (1997). From roadkill to road ecology: A review of the ecological effects of roads. *Journal of Transport Geography* 15, 396-406.

Roads affect the biotic and the abiotic components of the environment. The author breaks up the review article into three sections describing abiotic, biotic and ecological effects of roads on the environment. The article assesses the abiotic components giving past examples of changes in water quality, erosion of river banks and sediment transportation, effects of chemicals, and noise pollution. These factors all have effects on the wildlife and plant populations that live on the habitats around the roads. The roads affect the biota by being a source of mortality or acting as a barrier. Saying this, the road systems also act as a habitat for some small mammals and insects as these organisms use the road side for feeding or other activities. The ecological effects discuss the issues with the land such as habitat loss and fragmentation. The author also discusses the road edge effect, and acknowledges that some species thrive on the road side but others avoid the road. The author recommends that transport geographers which have been studying roads specifically, their economical and structural aspects start contributing to the growing science of road ecology. The author explored a variety of topics that discussed each topic clearly through the use of sub headings and a clear and concise sentence structure. The article gives an overview of how road systems affect the natural world around them known as road ecology.

Committee on Ecological Impacts of Road Density and Nation Research Council. 2005. Assessing and managing the ecological impacts of paved roads. The National Academies Home. Washington, D.C. Retrieved from: http://www.nap.edu/openbook.php?record_id=11535&page=62.

Wildlife populations can be reduced by wildlife-vehicle interactions. Although this is not their leading cause of death for a majority of species, the added threat of being killed by vehicles has the potential to cause serious problems for population levels. In extreme cases, it could cause extirpation of species with examples like the Florida panther and grizzly bear. The road-effect zone varies in distance depending on species, location and disturbance type. Wetland species diversity has seen to be negatively correlated when roads are up to two km away. In the case of Heart Lake Road, the road passed through the wetland. Heavy metals and chemical pollution released from cars can degrade the wetland quality as it introduces nitrogen oxides, petroleum, lead, copper, chromium, zinc, and nickel to the area. From the winter maintenance of the road the plant community structure can change as salt-sensitive species are replaced with less-sensitive species, which can cause changes to other wildlife in the area. Ecological indicators are used by planning and construction stages to ensure the quality of the land and the organisms within it. Sometimes using only ecological indicators does not include all the factors. The authors outline many conclusions and recommendations for roads. The recommendations emphasize research, attention and improvements to support the ecosystems that the roads run through.

*** Forman, R.T and Alexander, L.E. (1998). Roads and their major ecological effects. *Annual Review of Ecology and Systematics* 29,201-231

Road ecology is a new area to the scientific community. The authors, Forman and Alexander, provide information to the reader from biological as well as planning views. This review has a section titled water, sediment, chemicals, streams and roads. Within this section, the authors divide it into the specific areas required to give detailed information about each. The use of diagrams helps reinforce their information. The discussion of chemical transport goes into detail providing information about the deicing agent, NaCl, and the damage it can cause on areas adjacent to the roadways. The authors discuss economic development and the question of whether roads cause development or development causes the building of roads. An example of roads built in a forested area led to economic development as well as habitat fragmentation and deforestation. The review is concluded by discussing mitigation options for the animals that live by roads. The best option outlined is to permanently close the road, but a temporary closure during peak periods is also sufficient (ex. Turtle hatchings). The authors outlined the major ecological effects giving examples and providing clear explanation. The information is consistent with other articles written about this topic.

Gabor, S.T., North, A.K., Ross, L.C., Murkin, H.R., Anderson, J.S. and Raven, M. 2004. The importance of wetlands and upland conservation practices in watershed management: functions and values of water quality and quantity. Duck's Unlimited Canada. http://www.ducks.ca/conserve/wetland_values/pdf/nvalue.pdf.

There are five major categories of wetlands in Canada swamps, marshes, fens, and shallow waters. Wetlands can also be classified by their position on the land as lacustrine, riverine, palustrine and isolated. Wetlands have many functions, which benefit humans as well as support the wildlife that lives within them. The hydrological functions of wetlands include storage of surface water, recharge of groundwater supplies, reduction in peak floodwater flows and erosion prevention. Wetlands store surface water, preventing flooding when there is excess water. This function prevents the land from being eroded, movement of sediment and damage to homes. Wetlands recharge groundwater soruces as the wetland slowly percolates underground aquifers. Wetlands act as nutrient sinks. They accumulate everything that is introduced to them including chemicals. Wetlands can convert inorganic nutrients into organic mass. They are capable assimilation by microbes and denitrification. Phosphorus is retained in wetlands by adsorption to peat and clay particles. The range of percent retention for nitrogen in a natural wetland is up to 87% and phosphorus up to 94%. Wetlands are hydrologically, chemically and biologically linked to the landscape where they are found. It is important to understand the habitat and water quality that exists in a wetland. Knowing how a wetland works provides a clearer understanding of how the road can affect the function of the wetland.

Gleason, R.A., and Euliss, N.H. 1998. Sedimentation of prairie wetlands. *Great Plains Research* 8, 97-112.

Sedimentation occurs in all wetlands, it is considered as a water quality benefit in small portions but when there is lots of sedimentation it is harmful to the wetland as it can shorten their life-span or cause the wetland to fill in. Natural processes can cause wetlands to fill with sediment, human interactions accelerate the process of erosion and sedimentation. When wetlands fill with sediments they loss certain functions that usually paired with wetlands. In terms of primary production, sedimentation can suppress them and alter the natural food chain interactions. The increased sediment reduces the depth of the photic zone and this reduces the light available. This in turn affects the aquatic invertebrates of the wetland. The alteration of the vegetative cover affects the wildlife that feed upon the wetland. The authors outline several areas of research that are needed within the field of sedimentation in wetlands. Reduction of sediment inputs, this is more specific to agriculture and their practices. The effects of wetland functions needs more research in the areas of wildlife habitat, groundwater recharge, nutrient cycling, water quality improvement, and production. This paper was more related to prairie wetlands but when roads are built it results with lots of sediment being deposited into the wetland and it changes the composition of the wetland, leading to the alteration of the components discussed above.

Roe, J.H, Gibson, J. And Kingsbury, B.A. 2006. Beyond the wetland border: estimating the impact of roads for two species of water snakes. *Biological Conservations* 130, 161-168.

Roads cover over six million km of the United States. These roads expanding road networks have large volumes of traffic driving on them. Roads are associated with increasing mortality and restricted movement of terrestrial and semi-aquatic wildlife. This study looks at two species of water snakes that differ in vagility, use of terrestrial habitats and conservation status. The researchers are looking at the snake movements across roads in three different areas in Indiana. Using models, the researchers were able to determine the probability of a mortality (road mortality = $1-(1-p_{killed})^{ncrossing}$). The researchers suggest that roads that cross over the travel roads of snakes from wetland to wetland can act a mortality trap. The more vagile the species, the greater act first it is. The authors recommend that wetland conservation not just consider the quality of habits, like wetlands but also look into mitigation options like terrestrial corridors between wetlands to offer safe passage for long migrations or dispersal. An interesting aspect for this study is that is was done completely mathematically with models. Through mathematics the authors were able to determine the mortality of the two types of water snakes.

*** Spellerberg, I.F. (1998). Ecological effects of roads and traffic: A literature review. *Global Ecology and Biogeography Letters* 7(5), 317-333.

The subject of the article was to survey the literature on the ecological effect of roads on the environment. The article also looked at the specific habitats and protected areas and the potential mitigation options. The article provides many literature examples that are compiled to form a literature database on the subject. When the article was published there were 388 references in the database. To compile all of the information to create this review and make the database several other database programs were used. Within the discussion section of this review, the author discusses some topics briefly, like deicing solutions, while he goes into depth on topics such as pollution and disturbance effects of biota and ecosystems. The author assesses the risk and impacts of road projects, enforcing how monitoring programs should take place once an environmental impact assessment is completed. A clear section is written on the areas of research in the field of road ecology that needs to be looked at more, such as, the long term effects. This review had tables of literature divided by headings which allows the reader to find more references based on the category in which their looking.

World Bank. 1996. Environmental Assessment Process: Roads and the Environment – the handbook. Washington, DC: World Bank, Environment Department. http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1107880869673/chap_1.pdf.

Environmental assessments are important to conduct before road developments as they identify any potential impacts and provide options for minimizing them. For the assessment to be conducted correctly there needs to be many different groups involved in the process such as the road planning people, construction as well as landowners and environmentalists. The handbook is designed for any audience who is looking for information on the topic of road development. It outlines the difference between new, existing, urban and rural projects. New projects consist of building a road for the first time and concentrating on impacts while existing project look into mitigation options. Urban projects involve the displacement of people but rural impacts focus on removal of productive agriculture and other lands involved in harvesting. There are three important steps in environmental assessment screening, scoping and analysis of alternatives. These steps need to integrate biophysical, social and economic considerations, although sometimes others get more attention than others. The environmental assessment can take between six and eighteen months which causes the budget to be higher for the project as the assessment can be greater than five percent of the cost. This roads and environment handbook provided information necessary to realize the amount of effort that goes forth before building a road. It provides evidence that when the Heart Lake Rd was built there was knowledge that wildlife would be living there and had the chance of being struck by a vehicle.

Conclusion

Road networks cause problems for ecosystems, specifically the wildlife that use the road as a passage way. The alteration of the chemical conditions is caused by the vehicles that drive along the roads. Heavy metals and chemical pollution released from cars can degrade the wetland quality as it introduces nitrogen oxides, petroleum, lead, copper, chromium, zinc, and nickel to the area (CEIRD, 2005). A major chemical that ends up in wetlands is deicing solution, NaCl, that is put down in winters to prevent ice build up on the roads (Spellerberg, 1998). Wetlands are natural filters of chemicals but they accumulate everything that is introduced to them and it can become too much (Gabor et *al.*, 2004). Sedimentation is caused by sediment being deposited into the wetland. Wetlands naturally fill with sediment but anthropogenic interactions can cause this process to happen faster. Wetlands lose certain function when this happens; primary producers are suppressed and this alters the food chain (Gleason and Euliss, 1998). The photic zone is suppressed and there is reduced light (Gleason and Euliss, 1998). This affects the aquatic invertebrates which affect the vegetation cover and the wildlife (Gleason and Euliss, 1998)

To try and prevent wildlife-vehicle interactions from happening there are environmental assessments conducted when there is planning for road development. The environmental assessment looks at impacts and provides options for minimizing them (World Bank, 1996). When a road is already in existence mitigation options can be put in place to prevent death of wildlife. Roe et *al.* (2006) conducted a study on water snakes using models to determine the mortalities on the road. From their models it was determined that mitigation options are necessary to prevent deaths of the snakes, one of the species being a threatened species (Roe et *al.*, 2006). A study completed by Boarman and Sazaki (2006) showed that tortoises are depressed in a zone at 400 m from the roadways when looking into the road-effect zone. Information gained from scientific studies enforces the need for a safe method for wildlife to cross over road networks that are in their habitat. Road networks that run through areas bring great stress the ecosystem. The wetlands located on both sides of Heart Lake Road are exposed to chemicals from the vehicles that pass by and sediment from the activities that occurred with the development of the road and the maintenance. The mortalities in this area are tied to the vehicles on the road more so than the alterations of the wetlands.

G.3 The Value of Citizen Science as a Research Approach to Road Ecology

Carolyn Lobbezoo

Introduction

Road ecology is a newly emerging research area that involves environmental monitoring along roadways. A valuable research approach within this study area is citizen science. Citizen science is defined as local citizens participating in the collection of data within a scientific experiment (Lee et al., 2006). The data is not only significant to help researchers understand road ecology but also educates local citizens regarding the threats that road networks pose to species and their habitats (Evans et al., 2004; OREG, 2010). This is also a valuable approach to ecological monitoring because government lacks the resources for continuous monitoring, thus, saving them time and money (Lee et al, 2006). However, to make road ecology research influential on decision-making it needs to be credible and reliable (Hunsberger, 2004; Roedenbeck et al, 2007). Citizen science is extremely relevant to the Heart Lake Road Ecology Monitoring Project because this is the research method in use. The objective of the project is to create a report which analyses the data in hopes of impacting the future decisions made by the City of Brampton and Region of Peel. Therefore, this literature is important for learning how credible data is collected and recorded along with crucial aspects necessary for success of the project, such as strong communication and partnerships.

Thesis

Citizen science is a valuable research approach to ecological monitoring that requires strong partnerships, generates credible and reliable data, and is important to utilize because not only does it raise public education and participation regarding road ecology issues, but it also generates databases that governments do not have the time or money to collect.

Annotated Bibliography

Bissonette, J., & Kassar, C. (2006). Data Issues in Describing Road Mortality Hotspots and Creating Predictive Models. Data Issues in Road Ecology Chapter 3. Retrieved from <http://www.wildlifeandroads.org.>.

This article discusses general problems with generating credible data, specifically the effects of scale resolution and how the data is collected. The case study pertains to four state routes within Utah: 40, 89, 189, and 91. The purpose of the study is to see if there is correlation between traffic volume and/or speed and the number of wildlife-vehicle collisions. This study did not show a relationship between the two variables but the study reveals the importance of how data is collected. Data must be collected and used specifically for its intended purpose. For example, data collected for record-keeping must be kept separate from data that is being collected for analysis of wildlife-vehicle collisions. The study also identifies that if one's objective is to define hotspots of road kill for mitigation action then it is essential to collect data accurately to the mile marker. When the objective of data collection and research is to inform decisions made by government officials the following requirements should be met: 1) road kill data are spatially explicit, 2) data regarding explanatory variables and road kill are recorded at appropriate scale resolutions and extents, 3) data are recorded accurately and completely, 4) the model consider road geometrics and environmental variables, and 5) the model considers both driver behavior and animal behavior. These variables create a credible and reliable model to ecologically monitor the roadways.

Evans, E., Abrams, E., Roux, K., Salmonsen, L., Reitsma, R. and Marra, Peter P. (2004). The Neighborhood Nestwatch Program: Sense of Place and Science Literacy in a Citizen-based Ecological Research Project. *Conservation Biology*, 19: 589-594.

This article reports on a citizen science project called Neighbourhood Nestwatch. The goals of the project are to collect data to help researchers understand ecology of eight bird species in the Washington, D.C. area as well as to educate people about bird biology. The participants are asked to note behaviours and activities that link birds to their habitats, other birds, and to populations of predators which may impact nest success. Data is recorded on sheets provided to the participants. As a result of this program, participants are noticing new species and ninety percent of participants reported learning from their participation. Interestingly, the participants also voiced concerns about the quantity and quality of data and meeting the goals of the project. However, the report outlines success of the project relies heavily on good communication between stakeholders, including staff scientists and participants. Participants can learn a lot from open communication with stakeholders as well as clearing up any uncertainty with data collection. Yet, communication is something all parties need to constantly work on to ensure the project can have full educational potential. Ensuring all participants understand the overall goal is crucial to project success as well as increasing one's education.

Frog Watch Ontario. (2011). Toronto Zoo. Retrieved on 6 October 2011 from <http://torontozoo.com/adoptapond/FrogwatchOntario.asp>.

This informative website encourages people to get involved in ecological monitoring, specifically frog watching. Its main purpose is to generate awareness among multiple communities including schools, families, landowners, agriculture groups, cottagers, and naturalists groups across the province that amphibian monitoring is fun, easy, and important. The program itself is a part of the national initiative, Frogwatch-Canada administered by Environment Canada. Frogwatch-Ontario is a partnership between Adopt-A-Pond, Environment Canada's Ecological Monitoring and Assessment Network (EMAN) and the Natural Heritage Information Centre (NHIC). Becoming involved in the project is simple and involves signing up online to receive a package in the mail. Not only does this project save amphibians in Ontario but it also helps citizens learn how to identify frogs visually and by their calls. The data submitted by volunteer is stored at the Natural Heritage Information Centre (NHIC). The website also highlights reasons why citizens should participate and the reasons include: Frogwatch observations help scientists to track climate change using phenology data, identify positive and negative population trends, and learn about range and distribution of frogs and toads. Evidently, they are stressing the importance of protecting wetland species and habitats. This is also a great example of a current ecological monitoring program in Ontario that citizens can presently get involved and participate in.

Hall, Andrea. (2009). Amphibians Finally Get Some Respect at City Hall. Retrieved on 3 October 2011 from <http://royalcityrag.wordpress.com/2009/09/22/amphibians-finally-get-some-respect-at-city-hall/>.

This article was written by a concerned Guelph citizen to inform other citizens about frog mortality rates on Laird road and the slow actions of City Hall. It is an excellent example of local stewardship and public participation within ecological monitoring. On September 22, 2009, local citizens discovered that more than 1000 frogs were hit by vehicles while trying to migrate to their wintering grounds. The concerned citizens proceeded to collect all the casualties and bring forth the issue to City Hall. The City had been looking into road closure option since the spring when a similar incident happened however nothing had been done. However, after being presented with over 1000 frogs the City closed Laird Road between McWilliams Road and Downey from dusk until dawn the following evening. This is an excellent example revealing that governments act upon evidence. Road ecology studies are important methods of generating data and evidence in hopes to impacting decision making. As a result of the evidence, the City is planning to construct amphibian movement culverts for long term protection of the species.

** Hunsberger, Carol. (2004). Exploring Links between Citizen Environmental Monitoring and Decision Making: Three Canadian Case Examples. Thesis Paper published at the University of Waterloo, Waterloo Ontario. Retrieved on 19 September, 2011 from <http://uwspace.uwaterloo.ca/bitstream/10012/970/1/cahunsbe2004.pdf>.

This article provides an in-depth analysis of citizen environmental monitoring programs which involve groups of citizen volunteers gathering environmental data for decision-making purposes. It highlights significant aspects citizen monitoring programs require to function smoothly. Therefore, this paper is a useful tool for researchers collecting data with this method. Hunsberger uses a case study approach to uncover the necessary components of citizen monitoring program and uses three Canadian case studies: Comox Valley, British Columbia, and Hamilton and Muskoka, Ontario. Qualitative interviews are conducted to retrieve information from monitoring programs in each region. The case studies reveal that credibility, data reliability, and strong partnerships between stakeholders are essential to citizen monitoring success. Credibility can be enhanced through receiving support and guidance from scientists, receiving support from the outside community, as well as all stakeholders having a common vision for the program. To collect high quality data quantitative and qualitative observations need to be recorded including who collected the data, dates and locations of observations, and method used. Strong partnerships with governments, businesses, Conservation Authorities and professionals also greatly increase the legitimacy of the project. Specifically, strong partnerships with governments at local, regional, and provincial levels are help to include program results in political agendas. This article explores a new area of study surrounding citizen environmental monitoring in Canada. Many articles have been written based on studies in the United States; however results cannot always be useful because they are case and site specific. Citizen environmental monitoring generates informative data at low costs and thus important resource to impact future local environmental management decisions.

** Lee, T., M. S. Quinn, and D. Duke. (2006). Citizen, science, highways, and wildlife: using a web-based GIS to engage citizens in collecting wildlife information. *Ecology and Society* 11(1): 11.

This article describes what citizen science is, its significance as a research approach, and provides a good example of a citizen science project. Citizen science can be defined as local citizens participating in the collection of data within a scientific experiment. This is a valuable research approach to ecological monitoring because governments lack the resources for on-going monitoring and data collection. Therefore, citizen science is a way to collect data without costing the government large sums of money, time and labour. *Road Watch* is the project discussed and it involves local citizens reporting wildlife observations along 44 kilometres of highway surrounding Crowsnest Pass, Alberta, Canada. Recruitment of participants is crucial and the project was advertized through posters, media announcements, personal communication, and the project website. What is unique about this project is that a web-based tool is used to facilitate the collection, and analysis of the data.

The project website provides access to online GIS mapping tool where the citizens enter their observations along with wildlife identification assistance. The study results include comparison of 11 months of observations and wildlife mortality and demonstrate that the use of citizen science is a useful emerging research approach that increases citizen knowledge and insight surrounding ecological monitoring issues. 56 local citizens participated which is approximately one percent of the local population. This is a significant step towards increased citizen engagement however; it is not enough to assess the success of the project in creating social change. The project also revealed that an average of 109 large mammals are recorded crossing the road or beside the road. Obtaining this data is critical because these facts impact mitigation options. The article provides a good example of the use of citizen science and helps promote this method as a legitimate research approach.

**Ontario Road Ecology Group (OREG) & Toronto Zoo. (2010). A Guide to Road Ecology in Ontario, prepared for the Environment Canada Habitat Stewardship Program for Species at Risk. Scarborough, Ontario: Neo Communications.

This informative booklet discusses the importance of road ecology and focuses on topics such as the threats of roads to the environment and wildlife, wildlife-vehicle collisions (WVC), mitigation options, and how citizens can help. This valuable resource can be a tool for all of society including: citizens, students, government at all levels, and non-government agencies. The main purpose of this booklet is to raise awareness about the threat road networks pose to the natural environment in hopes of generating sustainable solutions. Pages twenty to twenty-seven are specifically useful to educate the public on ways in which they can help reduce WVCs. This section recommends ten ways to avoid WVC and conserve the environment. A few of the recommendations are: drive cautiously, participate in community roadside clean ups and get involved either by attending public information meetings about local road projects or volunteering time to collect data on WVCs. This is an excellent example of a resource accessible to the public that can generate awareness and allow people to learn ways they can reduce their impact on the environment. In addition, beneath several of the recommendations, the authors have placed URLs where the public can find more information on ways to become involved.

Researcher studying ways to improve turtle crossings. *The Brock News*, Top Stories. 14 June 2011. Retrieved on 6 October 2011 from <http://www.brocku.ca/brock-news/?p=10531>.

This online news article discusses an emerging road ecology project that began this past summer. A Brock University professor, John Middleton, is working alongside Kari Gunson, from Eco-Kare International; Fred Schuler, from Bishop Mills Natural History Centre; and the Ontario Road Ecology Group (OREG) to create an inventory of the 700 turtle crossing signs in Ontario. The objective is to determine where and how signs are placed in the landscape in hopes of alleviating some of the mortalities across Ontario. The project is funded by the 2011 Ministry of Transportation Ontario Highway Infrastructure Innovation Funding Program. Included in this project is creating a geographic model to predict hotspots and to determine if these predicted areas are the actual locations of the warning signs. The findings of the study will guide future transportation policy regarding effective signage placement. However, the project cannot succeed without the help from citizen scientists and volunteers to collect the data. Therefore, this is an excellent example of a project that volunteers can participate in right now all across Ontario. This also represents how current these issues are and the importance of having volunteer participation to obtain the data necessary to guide future decisions.

Roedenbeck, I. A., L. Fahrig, C. S. Findlay, J. E. Houlahan, J. A. G. Jaeger, N. Klar, S. Kramer-Schadt, and E. A. Van der Grift. (2007). The Rauischholzhausen agenda for road ecology. *Ecology and Society* 12(1): 11.

This article suggests ways to make road ecology research more relevant and influential on road planning decisions. Specifically, the paper argues that road ecology research needs a framework with five important questions so that research inferences are more relevant to decision-making. The questions are:
(1) Under what circumstances do roads affect population persistence? (2) What is the relative importance of road effects vs. other effects on population persistence? (3) Under what circumstances can road effects be mitigated? (4) What is the relative importance of the different mechanisms by which roads affect population persistence? (5) Under what circumstances do road networks affect population persistence at the landscape scale? The paper also highlights the importance of study design and concludes that Before After Control-Impact (BACI) designs have the greatest inferential strength. This is because data exists from before the development of the road, during the development, and after the development. Therefore, data for the entire process can be analyzed in a prospective manner. The study identifies that this study design is not always feasible and that most studies are Control- Impact designs, meaning that data only exists after the impact. This data is still highly useful but it has a lower inferential strength. Thus, identifying the study design is important and will impact the strength of your inferences.

Conclusion

As evident in the annotations, citizen science is valuable and crucial to use as a research method for several reasons. Building strong partnerships with all stakeholders not only increases the legitimacy of the project but also helps the process to run smoothly (Hunsberger, 2004). In addition, good communication with the local government help to implement program results in future decisions. The design of the study also impacts the quality of data. Literature concludes that Before After Control-Impact (BACI) designs have the greatest inferential strength (Roedenbeck et al., 2007). However, the Heart Lake Road Ecology Monitoring Project does not have data from before the roadway was constructed. Yet, data from after the construction remains highly useful but has lower inferential strength (Roedenbeck et al., 2007). Credibility of data can be enhanced through guidance from scientists and support from the community (Hunsberger, 2004). Also, collecting quantitative and qualitative data ensures that all variables are included in the study, such as volunteers name, weather description and type/number of animals sited.

Citizen science is also valuable for raising public education and participation. Within the annotations, there are five excellent examples of previous and/or current ecological monitoring programs across North America. The prevalence of these projects identifies how important citizen participation is to the completion and success of the programs. Citizens are not only significant components of this research method but the participants are also taking away important knowledge bases. Neighbourhood Nestwatch (Evans et al., 2004), Frogwatch Ontario (2011), road closure on Laird Road, Guelph, Ontario (Hall, 2009), Roadwatch (Lee et al., 2006), and improving turtle crossing are examples of road ecology projects which rely on citizen science to collect data. Without citizen participation, this data would remain unknown.

It is fact that as the human population increases to grow, so too will the number of vehicles on the roads. Thus, since citizen environmental monitoring generates informative data at low costs, it ties into the larger context of impacting future local environmental management decisions (Hunsberger, 2004).

G.4 Road Ecology and Mitigation Options

Katie Bigras

Introduction

Road ecology is a newer field within the environmental sector, and wildlife mitigation practices are beginning to be implemented to avoid destroying wildlife populations. **Tunnel and fencing systems, culverts, and relocations of breeding sites are the best mitigation options for the reptiles, amphibians, and small mammal species.** Heart lake road is a minor roadway that divides wetlands, therefore dividing reptile, and amphibian populations. It has been found that minor roadways have a higher percentage of wildlife death than major highways. Mitigation practices have been proven to be effective at sustaining, and even reviving dwindling reptile and amphibian populations. Many mitigation options are relatively inexpensive, however regular monitoring must be kept to ensure the structures are intact and working. The following annotations are of works that look at different mitigation options, where and how mitigation should occur, and the effectiveness of mitigation practices.

Annotations

Beier, P., Majka, D., Newell, S., Garding, E. (2008).Best Management Practices for Wildlife Corridors. *Northern Arizona University*. Retrieved on Oct 10, 2011 from http://corridor design.org/dl/docs /corridordesign.org_BMPs_for_Corridors.pdf

Roads have different effects on different species. No single road crossing will be effective for all wildlife species. The authors of this paper determine the best practices for different species by means of researching different mitigation options. Wildlife overhead passes are mainly used by large mammals. Wildlife underpasses such as viaducts, bridges, culverts, and pipes are mainly used by reptiles, amphibians, and small mammals but have also been used by large mammals (especially felines). Vegetative cover is a necessity to most small mammals, amphibians, reptiles, and insects, therefore vegetated bridge under crossings usually work best. Because culverts and concrete box structures offer little to no vegetative cover, they are not an ideal crossing for most species, however despite the disadvantages, small and medium sized mammals, frogs/toads, snakes, and turtles do use these crossing when they are available. Ideally multiple crossings should be used at sites with high relative species abundance. Sites should mimic the vegetative community and need to be well maintained and monitored. This study seems to be the first of its kind and is very helpful in determining mitigation options and the practices that need to be applied for both streams and urban development.

* Bissonette, J.A., Cramer, P.C..(2008). Evaluation of the Use and Effectiveness of Wildlife Crossings: Restoring Habitat Networks with Allometrically Scaled Wildlife Crossings. National Cooperative Highway Research Program (p. 86-95). Retrieved Sept 24, 2011 from http://environment. transportation.org/environmental_issues/wildlife_roads/decision_guide/pdf/nchrp_rpt_ 615.pdf

* In this research paper, the purpose and scope was to determine where crossings should be placed in accordance with an animal's home range, and its ability to roam freely over large areas. This study is intended for groups looking to put mitigation options into place. The researchers of this paper used 103 mammals as an example to better understand how far crossings should be placed from one another by using an equation to determine maximum dispersal distance MaxDD = 40 (linear dimension of HR) and median dispersal distance (MedDD). These were related to home range size by the equation: MedDD = 7 (linear dimension of HR). Afterwards, the team compared options for spacing wildlife crossings that were most feasible for large mammals. Due to a variance in home range sizes (from 0.16 miles - >35.00 miles) it was determined that crossings every 6 miles would not work for both large and small mammals. Large and small mammals would have to be split into groups to determine the best mitigation options for them. This argument was very thorough and well done. It has not contradicted any papers I have read in the past and brings to attention the different needs of species that vary in home range sizes.

* Bond, A, Jones, D. (2010). Road barrier effect on small birds removed by vegetated overpass in South East Queensland. *Ecological Management & Restoration* VOL 11 No 1. Retrieved Sept 25, 2011 from http://web.ebscohost.com

* Many bird species are willing to fly over a road structure, which leads most people to believe that over-head road crossings (land bridges) are not valuable for bird species. The authors of this research paper undertook a study to determine whether there was in fact a road barrier effect by observing bird movement on parts of the road with and without a land bridge. The authors did 5 minute stationary intervals at eight intervals, four along the road, and four along a land bridge on the same highway. The study concluded that the relative abundance of birds crossing the road vs. crossing the land bridge had no significant different (6.25/5 minute interval over road) vs. (6.71/5 minute interval over the land bridge). The species however varied significantly. Some bird species were not noted crossing the road whatsoever, using only the land bridge as a means to get across. The authors feel this study and others like it require far more international attention. This study was well done and convincing. The data clearly demonstrates different bird species using only the over-head land bridge. The authors explored new territory that expands on other studies I have read. This study is valuable while determining types of mitigation options available.

Jolivet, R., Antoniazza, M., Strehler-Perrin, C., Gander, A. (2008).Impact of road mitigation measures on amphibian populations: A stage-class population mathematical model. *Cornell University* Retrieved Oct 11, 2011 from http://arxiv.org/PS_cache/arxiv/pdf/0806/0806.4449v1.pdf

It is well known that with urban development, amphibians suffer as a species. With proper roadway mitigation procedures, minimizing the negative impact on amphibians should be relatively easy. The purpose of this study is to determine whether under-road tunnels are in fact effective at conserving/sustaining amphibian populations. The authors of this article look at 2 amphibian populations, (common toad – *Bufo bufo* and common frog - *Ranatemporaria*) before and after mitigation measures were put in place in 1992 in the Cheseaux area. In 1994, data for both species was also collected in an area without roadways in Ostende as a control group. To get the census of migrating adults, bow-nets, drift fences and traps were used to estimate the population. The results did not show any significant trend with the two populations, however years with lower populations were prevalent in both species. A significant transient increase in both populations was found to occur four years after the installation of the tunnels. Although the authors need more data to conclude the increase of population was solely due to the mitigation procedure, it is concluded that the plausible cause of the population increase was attributed to the mitigation options in place. This article was one of the first of its kind. It is important to know that mitigation options are in fact assisting the population of amphibians. Data such as this is needed to prove that mitigation to roads is working.

Kight, C. (2001). Road Ecology: An Often Overlooked Field Of Conservation Research. *Anthrophysis When Humans and nature collide*. Retrieved Oct 9, 2011 from http://www.science20.com/ anthrophysis/road_ecology_often_overlooked_field_conservation_research-82715

On approximately 50 million kilometres of road worldwide, and roughly 750 million vehicles on the roads, little is known about road ecology mitigation options, and most people are not even aware of the impacts roads have on wildlife populations. Although roads clearly have a negative impact on both humans and wildlife, they are not regarded as a dangerous habitat feature. Often times simple mitigation options is what it takes to prevent/minimize the death toll of wildlife. Considering different options, it was found that overhead and under-road passes were among the safest options for wildlife. Due to time and money, they also seemed to be among the most affordable. Not only does this help the population of wildlife species, it has been found to increase the overall gene flow of populations as well. The author of this article was slightly brief with the findings. However it is beneficial to prove that mitigation options can be affordable and highly effective.

Lake Jackson Ecopassage Alliance, Inc. (2011).The Lake Jackson Ecopassage Providing a Safe Path for Wildlife. *Lake Jackson Ecopassage Alliance*. Retrieved On Oct 8, 2012 from http://www. lakejacksonturtles.org/#summary

Located in north-western Florida, Lake Jackson is subject to a 4 lane highway built on ¾-mile stretch of the 4000 acre sinkhole lake. Due to the 23,500 vehicles that travel this highway each day, the highway makes crossing for turtles and other wildlife virtually impossible. Over a period of 40 days, 439 turtles were killed. A temporary silt fence measuring 3600 ft and 2600 ft on either side of the highway directing turtles and other wildlife to use an existing culvert was put in place while a more permanent structure was constructed. The silt fence was effective in saving 8,800 turtles while the permanent solution was being constructed. Now that the permanent structure is in place, more species are being saved since they cannot dig under or climb over the barrier, they are all directed to an under-road passage. The permanent structure is the same concept as a silt fence but is secure and higher. This article was very well written, I feel I gained a lot of knowledge about turtle mitigation. The mitigation option they applied, I think will be soon recognized by more road ecology groups and the government as a necessary practice for turtle and other wildlife mitigation.

Ovaska, K., Sopuck, L., Engelstoft, C., Matthias, L., Wind E., MacGarvie, J. (2005) Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia. *Ministry of Water, Land and Air Protection Ecosystem Standards and Planning Biodiversity Branch*. Retrieved Oct 11, 2011 from http://www.env.gov.bc.ca/wld/BMP/herptile/ HerptileBMP_final.pdf.

Reptiles and amphibians are an important component to many ecosystems. Due to their inconspicuous nature, they tend to be overlooked when human development takes place. Amphibians stay within a few 100 metres of their breeding sites, and most juveniles stay within 1 km. When a road is placed in between a seasonal habitat and a breeding site, high levels of amphibian traffic will occur over these roads during peak breeding seasons. The authors of this paper take a look at many mitigation options for reptiles and amphibians including the best road ecology mitigation practices. Although the best management practice would be to avoid putting roads through wetlands in the first place, sometimes it is inevitable and therefore we must provide adequate linkages for reptiles and amphibians to safely cross to the other side. It is found that tunnel and fencing systems, culverts, and relocations of breeding sites tend to work best. Tunnel and fencing systems should be strategically mapped out to accommodate high traffic crossing areas and guidelines given in this paper for proper installation and maintenance of fences and tunnels should be followed. When pre-existing culverts can be used, it is essential to incorporate as much of the natural habitat as possible, if nothing else, natural substrate should be used at the culvert base versus steel. Relocation of breeding grounds is another option when road mortality is very high. In this case permanent fences, and/or enhancement or creation of alternate breeding sites may be created. The authors of this study did a great job on making the public aware of the importance of reptiles and amphibians and why/how mitigation measure should be taken. This is essential to our research when deciding what mitigation options to implement at Heart Lake road.

*Van der Ree, R., Heinze, D., McCarthy, M., and Mansergh, I. (2009). Wildlife tunnel enhances population viability. *Ecology and Society*14(2): 7. Retrieved Sept 20, 2011 from http://www.ecologyand society.org/vol14/iss2/art7/

*The Mountain Pygmy Possum (Burramysparvus) is an endangered small marsupial that lives at high-altitudes in south-eastern Australia. An annual migration takes place between October-December, however due to ski resort development, a major road is separating the male population from the female population. Tunnels have been put in place as a mitigation option, the authors of this study will use population viability modeling to predict what impacts the road and tunnel will have on population size and the probability of decline. The authors used a subset of population data collected before mitigation (1983-1985), and after mitigation (1986-2003) and a set of data from another Mountain Pygmy Possum population unaffected by the road. Using a Ricker function ($[N_{t+1}/N_t] = a + b\times N_t + s\times S_t + \text{norm}(0, \sigma)$) with an addition to account for sex ratio, the future population was predicted. A Bayesian approach was taken. By substituting the pre-tunnel and post-tunnel sex ratio, and the sex ratio of the unaffected population the effect of the tunnel as a mitigation option was predicted. The study found that without any mitigation, the population of B. parvus would have a 40% decline in females in 20 years compared to the population unaffected by a road, and that with the mitigation option in place, there will only be a 15% decline of females compared to the population unaffected by the road. The authors suggest continuing to use population viability as a more accurate way of determining mitigation success then previous studies using only observation to determine if wildlife populations are truly benefiting from mitigation options. This study was well done and convincing because it shows that population sizes are still decreasing even with mitigation options. The authors explored new territory and were amongst the first group to conduct population viability modeling with road ecology. I have not read material such as this and I feel more studies such as this one should be done as mitigation options continue to improve.

Van Langevelde, F., Van Dooremalen, C., Jaarsma, C. F. (2009).Traffic mortality and the role of minor roads. *Journal of Environmental Management* 90, 660-667. Retrieved Oct 10, 2011 from http://www .falw.vu.nl/en/Images/2009-02_tcm24-62140.pdf

There is no doubt that roads have a major impact on wildlife populations. The majority of road kill/mitigation studies however have been done on major roadways (4+ lanes). The authors of this article argue that minor roadways (2 lanes) have a greater impact on wildlife populations. Firstly, the authors took into consideration the road area vs. traffic volume on both major and minor roadways in the Netherlands. In the area of study, major roadways occupy 5600 ha and minor roadways occupy 20,700 ha. Although the area is greater for minor roadways far less traffic travel on minor roadways. On major roadways the traffic is steady and speed limits are on average 100-120km/hr vs. 60-80km/hr on minor roadways. For these reasons it is hypothesised that wildlife is more willing to cross a road with less traffic density than a major roadway that acts as a constant barrier and obvious threat to their well-being. Data collected on road mortality per road type collected from 1990-2005 was used to determine that 64% of deaths occurred on minor roadways and 34% were on major roadways. The authors of this paper would like to see minor roadways taken into consideration for mitigation as well as major roadways. Although this study was conducted in the Neatherlands, it was argued that the data was relevant in most Urban Developments. This study is important to argue that minor roads such as Heart Lake road is as, if not more important to mitigate than major roadways. It was well written and had hard evidence to back up the findings.

Conclusion

There is no doubt that in earlier roadway construction, wildlife had been completely overlooked. The best way to mitigate for wildlife is to build roads around wetlands and wildlife hotspots. When avoidance is un-avoidable, building roads with mitigation in mind is what needs to be done. For existing roads, over-head and under-road crossing are highly effective and becoming more and more popular. When determining what mitigation options we can apply at Heart Lake Road, we must consider the species being killed and the hotspots in which the deaths are taking place. Because of the existing culverts at Heart Lake road, it would be inexpensive and very effective to clean up these culverts and add fencing directing reptiles, amphibians, and small mammals to the culvert crossings.