Heart Lake Volunteer Road Ecology Monitoring Project

Phase II, 2013

Toronto and Region Conservation for The Living City

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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) and local volunteers to deliver the Heart Lake 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 Provincially Significant Wetland (PSW) complex adjacent to Heart Lake Road between Sandalwood Parkway and Mayfield Road in Brampton, Ontario.

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

Phase II of HLREMP field data collection of WVCs was undertaken by staff and volunteers between April 8, 2013 and September 30, 2013. The study area was redefined and focused along Heart Lake Road between Sandalwood Parkway and Countryside Drive. Outlined in this report are Phase II data collection and mitigation options which have been investigated to move forward with a strategy to reduce WVCs within this PSW.

The report and the findings will be shared with TRCA, OREG and CoB in order to implement mitigation along Heart Lake Road to reduce WVCs and protect this diverse ecosystem.

Acknowledgements

This project and report was made possible through the generosity of our volunteers, City of Brampton (CoB), Ontario Road Ecology Group (OREG) and project partners. Sincere and heartfelt thanks are extended to all partners and volunteers who have dedicated their time and efforts to the Heart Lake Road Ecology Volunteer Monitoring Project (HLREMP).

Heart Lake Road Ecology volunteers spent time training for safety and efficient data collection protocols to ensure a level of integrity is maintained with information obtained. Field work was conducted in all weather conditions and the devotion and commitment shown by the volunteer members in protecting wildlife in this endeavour, is to be commended.

Special thanks to Bob Noble who spent many hours managing field data and cross referencing images.

Volunteers:

Gillian Carson	Betty-Anne Goldstein	Chris McGlynn	Alana Ziobroski
Diana Christie	Susan Janhurst	Elizabeth Morin	Lyle Ziobroski
Liz Cici	Dayle Laing	Bob Noble	
Ron Fay	David Laing	Leo O'Brien	
Gord Ferguson	Jim Laird	Shawn Patille	

2013 Road Ecology Monitoring Volunteers

Acknowledgements are also extended to staff at the agencies and partners listed below for their support.

ACO Canada
City of Brampton (CoB)
Ontario Road Ecology Group (OREG)
Region of Peel
Royal Ontario Museum
Toronto and Region Conservation Authority (TRCA)

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1.0 Introduction

Wildlife faces stressors from many fronts throughout their life spans which contribute to regional declines. Stressors include: pollutants, climate change, disease, toxins, invasive species and genetically modified organisms. Wildlife migrates to breed, feed and hibernate throughout their life cycles and roads present notable threats to these migrations. Birds, small and large mammals, insects and fish populations are adversely affected by roads. Sedimentation, spills, pollution and other road-related waterway disturbances are threats representing an important conservation issue – biodiversity loss. Biodiversity is represented by variety of species, their genetics and diversity of ecosystems, along with the resilience, health and interactions of these components. Roads and transportation networks are a primary anthropogenic mark on earth's landscape resulting in habitat loss, fragmentation and degradation. As it becomes more evident that mortality from attempted road crossings is a large threat to wildlife, data collection, research in mitigation design and implementation are important to establish improvements in road network management across the province.

Road ecology is an emerging field of study which examines the effects of roads on wildlife populations and their impacts on ecological processes. In the past sixty years, major roads in southern Ontario have increased from 7,133 kilometres to 35,637 kilometres (Fenech et *al*., 2000). Every 38 minutes there is a wildlife/vehicle collision (WVCs) in Ontario (MTO 2011) and this statistic does not include unreported collisions with smaller species such as amphibians, reptiles and mammals.

Road ecology is the study of interactions between the natural environment and roads. The four main threats roads pose to biodiversity are:

1. Habitat loss;
2. Direct mortality caused by WVCs;
3. Population subdivision, less gene flow and increased vulnerability to environmental stochasticity (eg: extreme weather events, disease, etc.); and
4. Inaccessibility to critical resources such as mates, food and habitat.

Together these four threats result in smaller populations which are less likely to persist. (Jaeger, et al, 2005)

Locations where roads act as barriers to habitat connectivity and cause concentrated wildlife road mortality are termed "hotspots", making them critical areas to research and mitigate. Herpetofauna is a classification which includes reptiles and amphibians and some taxa in this grouping are at risk of becoming extirpated (i.e. locally extinct). Herpetofauna are slow-moving and have not evolved to avoid roads or vehicles making them particularly vulnerable to WVCs. Unlike other issues plaguing these taxa, threats created by roads can be mitigated to relieve survival pressures these groups encounter. Provincial legislation acknowledges this threat and through the Endangered Species Act (ESA) and recovery strategies, mitigating road mortality is recognized and supported as a priority to help protect and recover most Species at Risk (SAR) herpetofauna. The revised implementation strategy of ESA supports herpetofauna road mitigation and under the Standard Condition approach requires proponents to proceed with "road improvement activities with the protection of reptiles and amphibians and benefits provided through the installation of fencing and improved passage".

(http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_080242_e.htm)

Region of Peel is committed to road ecology and is working with its partners to achieve the following goal; "to assist transportation managers make informed decisions to proactively protect and enhance wildlife connectivity when designing new and expanded road projects."

In 2011, Phase I of Heart Lake Volunteer Road Monitoring Project (HLREMP) was delivered in partnership with Toronto and Region Conservation Authority (TRCA), City of Brampton (CoB), Ontario Road Ecology Group (OREG) and local volunteers. 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. The study area (Figure 1) is a Provincially Significant Wetland (PSW) complex bisected by Heart Lake Road between Sandalwood Parkway and Mayfield Road in Brampton, Ontario.

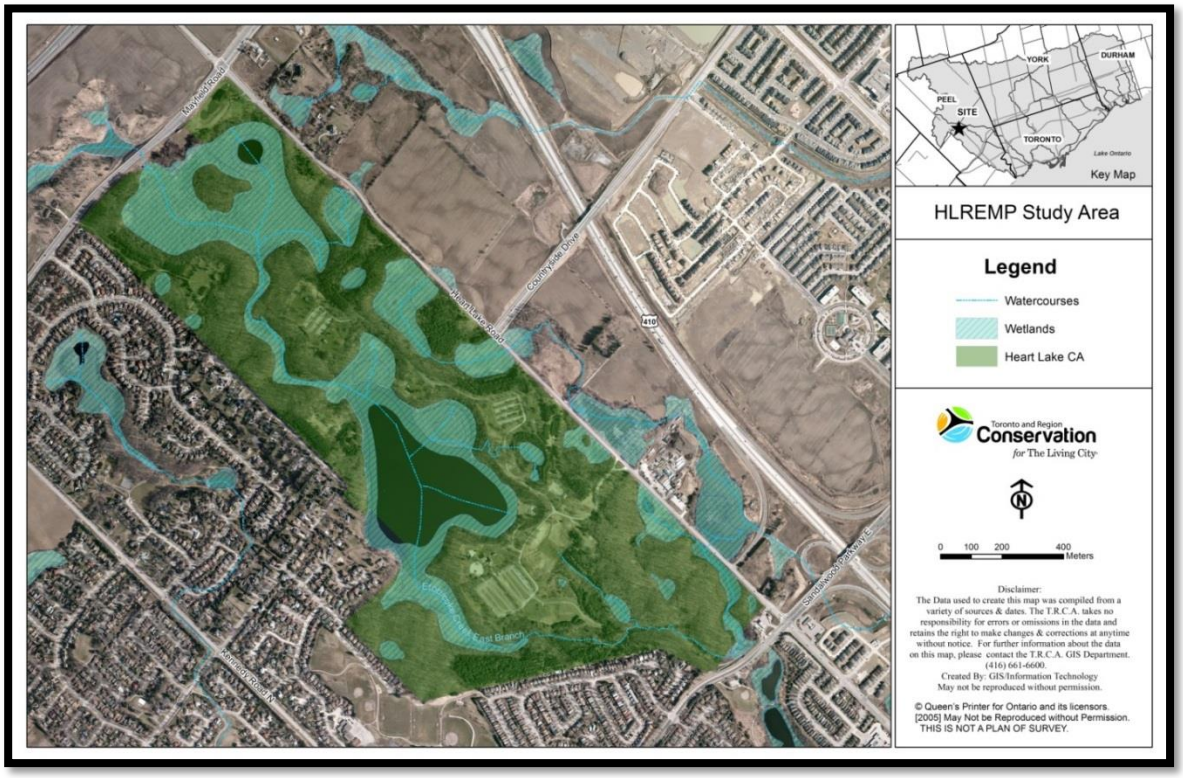

Figure 1. HLREMP Study Area - Heart Lake Road from Sandalwood Parkway to Mayfield Road, including Heart Lake CA.

Data collection in 2011, (online report at: http://www.trca.on.ca/dotAsset/151730.pdf) resulted in a total of 1,988 wildlife observations. Of the total, 1,239 were fatalities and 749 were live sightings. When analyzing the relative number of WVCs, frog/toad ranked the highest with 1,044 individuals, followed by 94 turtles, 45 mammals, 25 birds, 17 snakes and 14 unknown. This was shared with CoB staff and project partners leading to further consultation and exploration of options for mitigation. Existing culverts were located in 2012, and considered as a possibility for facilitation of wildlife movement between habitats fragmented within the study area. Options for directional fencing to guide wildlife toward the existing culverts for safer passage were also considered as part of the mitigation strategy.

In an effort to better understand "hotspots" (key areas of fatalities) identified from data in Phase I, it was decided to conduct Phase II. Based on findings from Phase I, Phase II study area (SA) was redefined to focus data collection in areas with high levels of WVCs. Phase II site boundaries extended along Heart Lake Road from Sandalwood Parkway to Countryside Drive (Figure 2).

Monitoring was scheduled to begin at peak amphibian breeding season which occurs when temperatures are conducive to their emergence from hibernation and continued through to early fall in an effort to capture primary movement of resident populations of reptiles, amphibians, mammals and birds.

Volunteer monitoring protocols were better defined to reduce errors and ensure accuracy of data with respect to species identification and location.

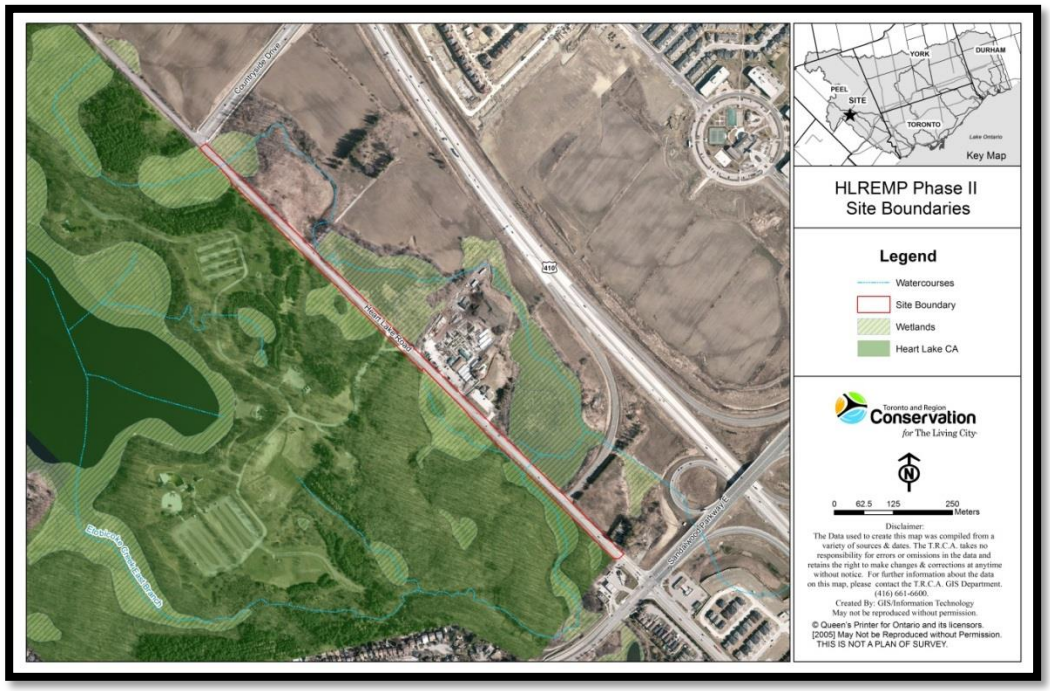

Figure 2. HLREMP Phase II Site Boundaries– Heart Lake Road from Sandalwood Parkway to Countryside Drive.

In addition to the volunteer monitoring component of Phase II, a study (Appendix G) included directional fencing and three "mock culverts" being placed at the wetland on the west side of Heart Lake Road just north of HLCA entrance (Figure 3). This was undertaken in order to determine variation in efficacy in attracting and passing of three culvert types; a corrugated steel pipe (CSP), a concrete pipe and a dedicated wildlife culvert produced by ACO Systems Ltd.

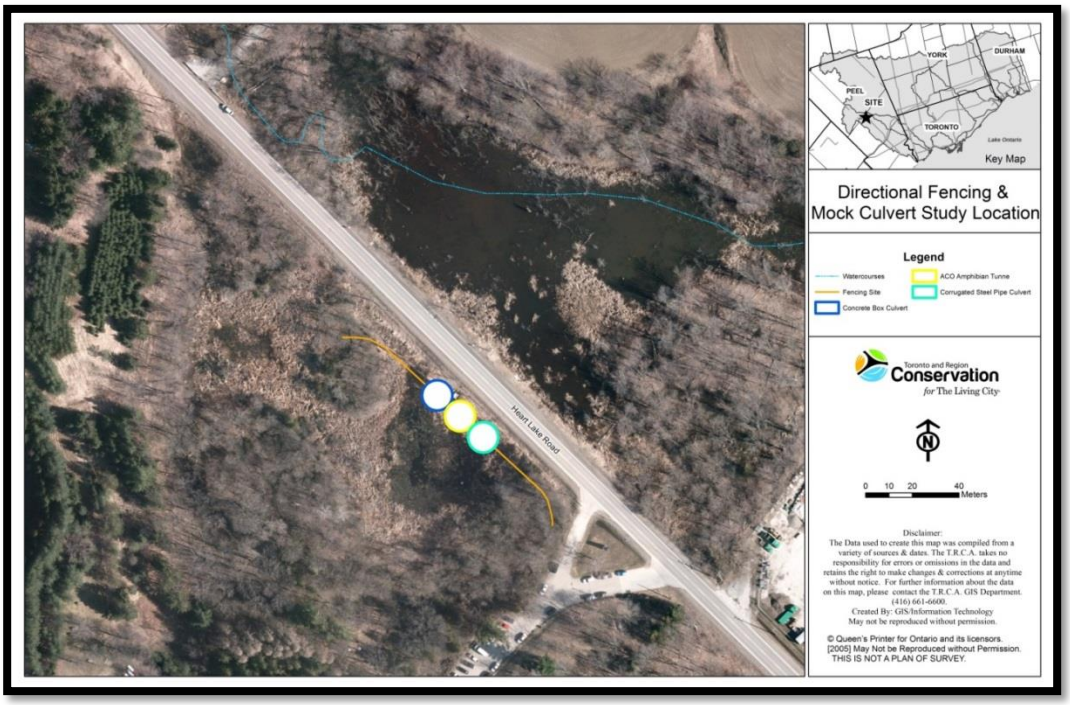

Figure 3. Directional Fencing & Culvert Study Location, west side Heart Lake Road.

The following report analyzes data collected within the SA, helps raise awareness and provides insight of impacts Heart Lake Road has on local biodiversity. It outlines results of data collected in order to better inform decision makers to develop and implement mitigation strategies at this designated PSW complex.

2.0 Materials and Methods

2.1 Phase II Site Boundaries

The study was conducted on a 1 km segment of Heart Lake Road between Sandalwood Parkway and Countryside Drive in Brampton, Ontario (Figure 4). Heart Lake Road is a municipal two-lane, paved road with gravel shoulders between 0.5 m and 1.5 m in width. At the SA, Heart Lake Road bisects a Provincially Significant Wetland (PSW) complex.

Figure 4. HLREMP Phase II Site Boundaries and wetland areas– Heart Lake Road from Sandalwood Parkway to Countryside Drive.

The water in Wetland A is almost level with the road. Wetland B, C, and D, water levels sit at a lower elevation with an approximate 2.5 m sloped berm leading to a gravel shoulder. The surrounding roadside habitat is a mix of wetland, woodlot, field and commercial property. The land bordering the study sites west side is Heart Lake Conservation Area (HLCA) which is owned by TRCA. HLCA occupies 169 hectares and its diverse ecosystem includes two kettle lakes, the headwaters for Spring Creek and a wetland complex. It has one of the largest individual blocks of forest in Etobicoke Creek watershed and surficial geology of glacial till and riverine deposits. Also found within HLCA are sections of the PSW, an Environmentally Significant Woodland area and a bog of Natural and Scientific Interest. This area provides nesting opportunities for at least seventy-five species of birds, including a regionally significant heronry and is home to thriving populations of several herpetofauna and mammal species including two species that are listed as SAR (snapping turtle, *Chelydra serpentina* and the milk snake, *Lampropeltis triangulum*).

2.2 Personnel:

Staff:
TRCA's Etobicoke and Mimico Creek Watersheds project manager and project coordinator, as well as OREG coordinator and field researcher oversaw the study. Staff coordinated project permits from City of Brampton and Ministry of Natural Resources, volunteer recruiting, scheduling, communications, data management and reporting. Arrangements were made at a local veterinarian clinic to receive wildlife in need of care (including euthanasia) prior to commencing road survey and data collection. Dedicated field staff was required in order to deliver this program and maintain consistency throughout the duration of this study.

Volunteers:
Volunteers were recruited in 2011, for Phase I of HLREMP through TRCA's Environmental Volunteer Network, articles in the Brampton Guardian local newspaper and by word of mouth. Phase II volunteers were recruited using the list from Phase I. A group of seventeen people committed to Phase II, and received training in accordance with TRCA's health and safety guidelines, permit requirements and monitoring protocols.

Project Data Manager
A project volunteer with data analysis expertise and species identification skills managed and summarized field data and images. After each monitoring session, field data sheets were placed in a waterproof folder within the equipment field box. At least once per week, field data sheets and digital camera memory cards were collected from the field box. Data were entered and recorded using Microsoft Excel and image management was conducted using Adobe Photoshop Lightroom software.

2.3 Field Equipment

A field equipment box was kept at HLCA for staff and volunteers to conduct surveys. The box was chained to a tree and hidden from public view with only project staff and volunteers having an access code. The locked box contained the following equipment and resources:

- safety vests;
- hard hats;
- safety glasses;
- nitrile gloves;
- leather work gloves (to handle live snapping turtles, etc.);
- hand sanitizer (for use after monitoring);
- UV Protectant;
- clip boards;
- copy of permits (Appendix A);
- data sheets (regular and waterproof paper), (Appendix B);
- copy of volunteer waiver form (Appendix B);
- monitoring protocol guidelines, (Appendix B);
- safety protocols (Appendix B);
- emergency contact information (volunteer and TRCA contact information);
- wildlife identification sheets (Appendix C);
- wildlife acronyms (Appendix C);
- writing utensils appropriate for weather conditions ;
- FujiFilm FinePIX XP150 Waterproof Digital Camera;
- rechargeable batteries for camera ***;**
- additional memory cards for camera ***;**
- REED Digital Psychrometer (Model No. 8726)*;
- thermometer ***;**
- plastic box with perforated lid to be used for small, injured animal transport (i.e. a turtle);

- terry cloth towels, (for animal transport);
- carpet (primarily used for live transport across road for snapping turtle);
- shovel;
- dust pans; and
- replacement orange survey flags for fixed Global Positioning System (GPS) points ***;**
  (***** Indicates: as shown in Figure 1)

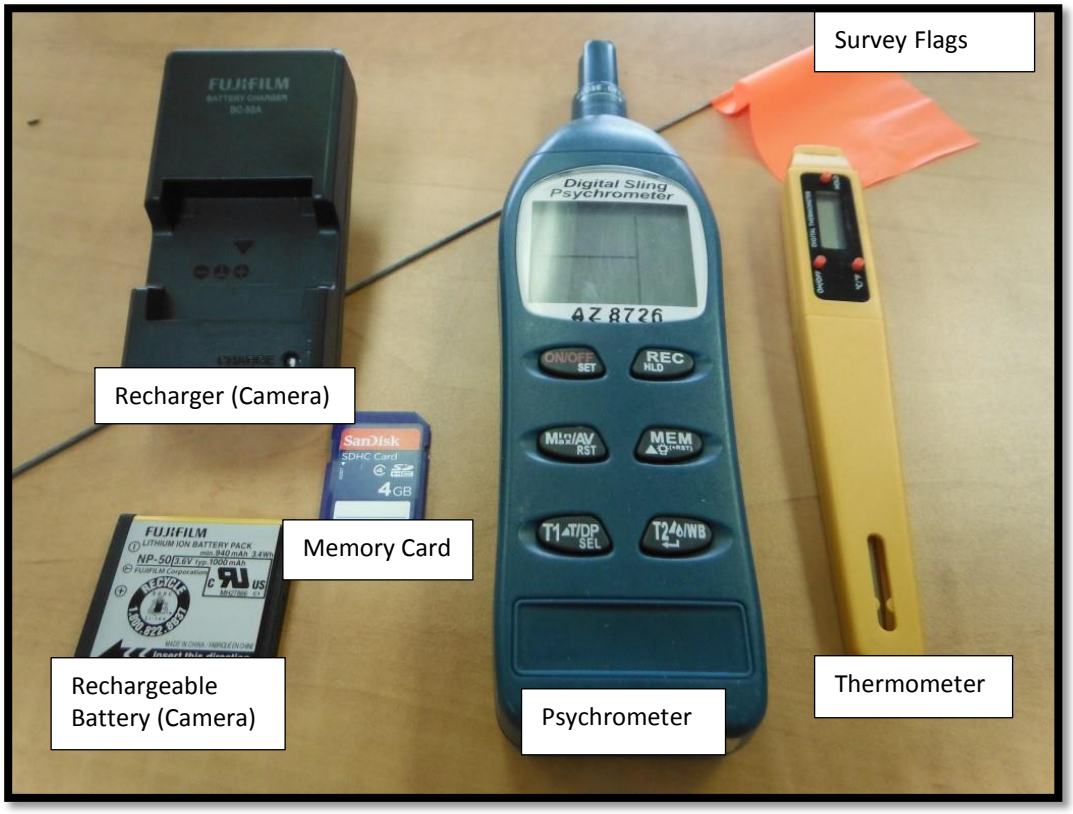

Figure 5. Field Equipment as indicated by asterisk in list above.

City of Brampton Works and Transportation Department provided orange 'caution people at work' signs (Figure 6) during the field season that were kept in-situ at the north and south limits of study area. Numbered orange survey flags were placed at pre-determined GPS locations as set by TRCA staff.

Figure 6. City of Brampton signage.

2.4 Safety Protocol:

A safety training session was held by TRCA staff on April 30, 2013, prior to volunteers commencing monitoring sessions. All volunteers were required to attend safety training including proper use of safety equipment, road safety protocols, personal protection during inclement weather conditions (i.e. heat, rain, storm events) and wildlife interactions. Volunteers were also trained in a standard protocol (Appendix B) for field data collection in order to maintain consistency and repeatability. This protocol was made available in written form and kept in the material supply bin on site. Volunteers were required to sign liability waivers indicating they would respect and follow protocols prior to participating (parents/legal guardians signed for volunteers under age eighteen).

Participants were required to monitor in groups of no fewer than two people in order to ensure vehicle/road safety was followed in accordance to permit and TRCA protocols. Personal protective equipment was required to be worn during each survey which included: safety vest, hard hat, safety glasses, nitrile and/or leather work gloves and close-toed shoes. Volunteers were responsible to come prepared and protected against weather conditions during their scheduled survey period (e.g. sunscreen, drinking water, sunglasses, insect repellent, rain gear, etc.). Each volunteer carried a cell phone, was provided with emergency contact information and project staff contacts (e.g. project coordinator, local veterinarian, emergency contacts, etc.).

Volunteers (Figure 7 and 8) did not wear ear-buds and did not engage with electronic devices (e.g. no texting, etc.) to avoid distractions (e.g. hear and see approaching vehicles) while on road right-of-way's to ensure personal safety and allow for awareness of environment and traffic conditions.

Figure 7. Volunteer at south east Heart Lake Road.

Figure 8. Volunteers on west side of Heart Lake Road.

2.5 Survey Protocol, Data Collection and Management:

At onset of study and field monitoring (March 2013), TRCA staff established 30 fixed GPS points using orange survey flags which were labelled and staggered at a distance of approximately 25m increments, within the SA. These markers were placed at a safe distance from paved surfaces. Points #1 - #15 were on the west side of Heart Lake Road commencing slightly north of Sandalwood Parkway. Points #16 - #30 were on the east side commencing on the south side of Countryside Drive ending slightly north of Sandalwood Parkway (Figure 10). Dividing the study site into 25m increments allowed for increased sighting accuracy during data collection for the volunteers.

Data collection commenced on April 8, 2013 by TRCA staff and continued through peak herpetofauna breeding season (June) and beyond. During breeding season, monitoring and data collection was conducted primarily in late afternoon and evening (Figure 9) when species movement is more frequent (at night in warm/moist conditions). In addition to the road surveys, two Marsh Monitoring stations were installed to assess the status of frog/toad populations on either side of Heart Lake Rd. This frog monitoring project was conducted following Marsh Monitoring Program (MMP) initiated by Bird Studies Canada in the 1990s.

Figure 9. Staff night monitoring (Photo Credit: Vanessa Hussey).

MMP Protocol provides a convenient method for conducting long term monitoring of both birds and frogs in marshes of a wide variety of size and quality (BSC 2008). Two locations were chosen at Wetland Area C (Figure 4), on both east and west sides of Heart Lake Road and marked with reinforced bar posts and geo-referenced using a GPS unit. Observations and counts were undertaken in a 100m semi-circle from the station marker since in general, stations are located at the edge of the wetland. It was important to ensure orientation of the semicircle was constant for repeatability. Orientation was documented using a compass (Appendix D).

Surveys were conducted on relatively warm and moist nights that have little to no wind (based on the Beaufort Wind Scale) and began a half hour after sunset and ended before midnight. To report and map the frogs, a point was mapped on the field sheet representing the position of separate choruses' audible from the station. These choruses were mapped both within and beyond the count semi-circle (Appendix D).

The intensity of each chorus is indicated by a number-code associated with each observation:

- 0 - None heard;
- 1 - Individuals can be counted, calls not overlapping;
- 2 - Calls overlapping but individuals can still be distinguished and;
- 3 - Full chorus, calls continuous and overlapping, individuals not distinguishable.

Once volunteer monitoring started (May 1, 2013), volunteers set up "people at work signs", informed HLCA staff that monitoring would be taking place and left appropriate signage on their vehicle dashboard indicating volunteer activities were taking place.

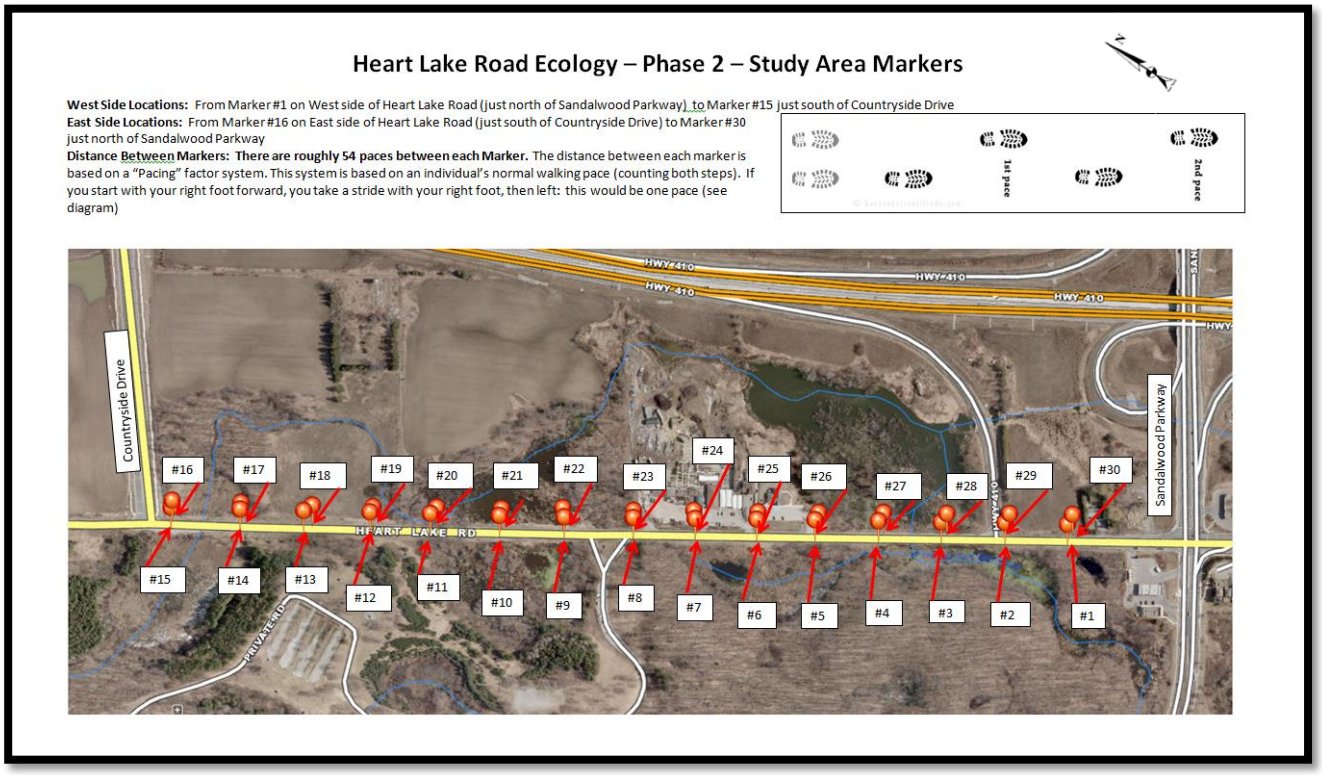

Figure 10. GPS Locations – labelled and numbered orange survey flags.

Volunteers used the fixed orange survey flag numbers to record sighting locations, as opposed to obtaining GPS coordinates for each sighting. Prior to commencing each monitoring session, temperature and moisture readings were obtained using a REED Digital Psychrometer (Model No. 8726). Environmental data including percent cloud cover (0%, 25%, 50%, 75%, 100%), precipitation (none, light, moderate, heavy) and wind strength (approximate km/hr or obtained online at Environment Canada) were also recorded.

The road was divided using the middle yellow line as a centre point to approximately 1.5m into roadside habitat, or further as conditions allowed. Parking for volunteer vehicles was provided at HLCA which was located between Point #8 and #9. Monitoring started at Point #9, where participants walked in a northerly direction, in pairs, facing traffic on the gravel shoulder keeping as far from traffic as possible. At Point #15, participants carefully crossed the road and continued monitoring the east side in a southerly direction from Points #16 - #30. After carefully crossing back to the west side of Heart Lake Rd, they monitored north from Points #1 - #8, completing the monitoring route.

These areas were monitored for evidence of wildlife/road interactions (e.g. carcass remains, scat, tracks, etc.) and live sightings. Observations were recorded using the following criteria:

Status:	Dead on Road (DOR), Dead Beside Road (DBR), Alive on Road (AOR), Alive Beside Road (ABR).
Position:	Shoulder, White Line, Middle of Lane or Yellow Line
Proximity:	(from edge of pavement) 0.25 m, 0.5 m, 1 m or > 1 m
Behaviour (alive):	Foraging, Basking, Crossing, etc.,
Side of Road:	N, S, E, W

Location observations of WVCs were documented on field data sheets provided (Appendix B). Upon encountering an observation, sighting location was recorded using closest fixed orange survey flag numbers as a reference. All sightings were photographed and documented using a FujiFilm waterproof digital camera and the numbering sequence recorded as a cross-reference to the wildlife sighting number on field data sheets. To ensure images corresponded to individual field data sheet sets, an image of field data sheet page(s) were photographed at the end of each monitoring session. It is to be noted that by cross referencing each sighting on individual data sheets with a corresponding numbered image, duplications of fatalities were able to be detected by the volunteer managing data input. This allowed for an increased accuracy of data reporting. Completed field data sheets were stored in a waterproof folder within the equipment box.

Wildlife remains of each recorded observation were discarded into roadside habitat to avoid recounting data by subsequent volunteers in future monitoring sessions. Observations of DOR species such as: worms, ants, flies, snails, slugs and other common invertebrates were not documented. Observations of dragonflies, bees and butterflies were recorded in the comment box of field data sheets. While there are presently no road mitigation options for these latter invertebrates, there are conservation issues for these taxa and data may prove beneficial in the future.

2.6 Monitoring Schedule

Volunteers began monitoring May 1, 2013 and ended on September 30, 2013. A monitoring schedule was set up each month using Doodle Poll free online scheduling software and monitored by staff. Monitoring times were set up starting at 0800 hrs. (8:00 a.m.), ending prior to sunset and divided into two hour segments. Each volunteer accessed Doodle online and entered their name to a preferred time slot on a first-come-first-serve basis with the understanding monitoring was to be conducted with a minimum of two people.

A summer student was hired by OREG and TRCA to:

- conduct monitoring sessions as needed;
- aide volunteers during monitoring sessions;
- maintain a log of activities and sightings;
- ensure volunteer supplies and resources were available; and
- participate in Stewardship activities to raise awareness of road ecology.

3.0 Results

Data from Phase II were collected, analyzed and evaluated in an effort to:

- determine actual time spent collecting field data relative to total time available through project duration;
- better understand and document population and wildlife diversity via Marsh Monitoring Protocols and live sightings;
- compile raw data – grouping taxa and species where possible;
- group taxa as either adult or juvenile;
- plot WVC locations using Geographic Information System Software (GIS) and Ortho imagery;
- compile total fatalities by species during total study time period; and
- determine hot spot(s) of concentrated WVCs within SA.

Over the course of Phase II which was a twenty five week study period from April 8, 2013 to September 30, 2013, project staff and 17 volunteers contributed 404 hours to field data collection. Total time spent collecting field data was 202 hours based on volunteers working in pairs (Figure 11). Total monitoring sessions for the time period was 134 (Figure 12). The duration of each session varied each day/week due to amount of WVCs encountered and recorded. The actual time spent monitoring represents approximately 2.4 % of total available time based on 12 daylight hours (Figure 13). Since volunteers were not monitoring for approximately 97% of the available time and did not monitor before or after daylight, the number of WVCs during the study period is potentially higher than study results indicate.

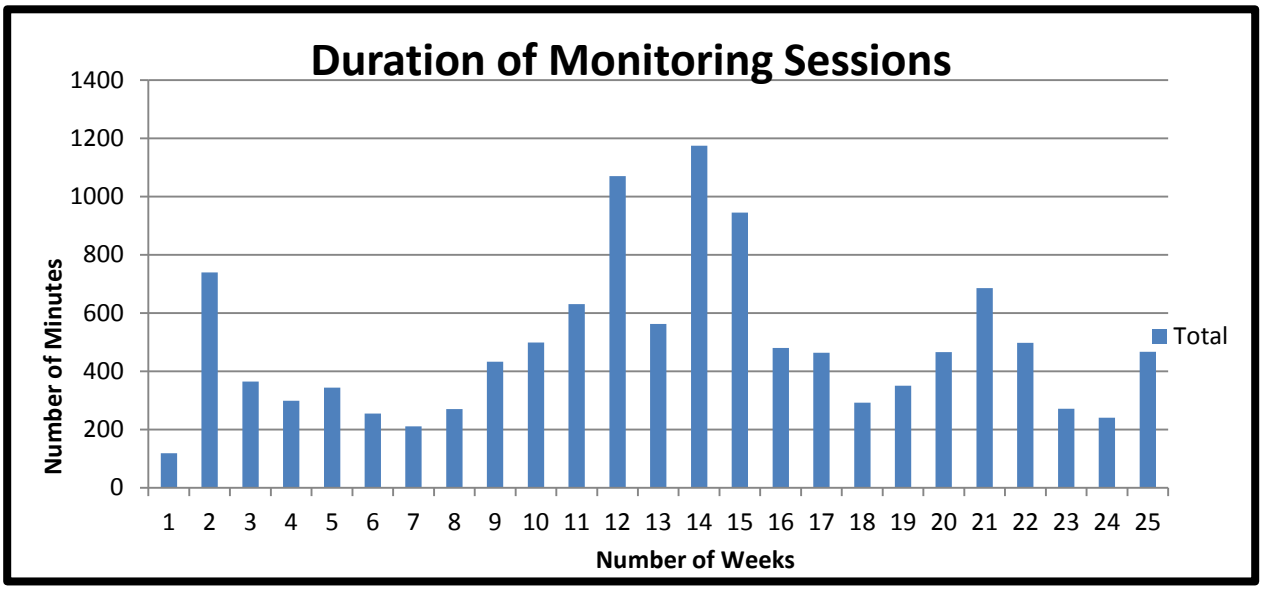

Figure 11. Breakdown of monitoring efforts - 202 hours.

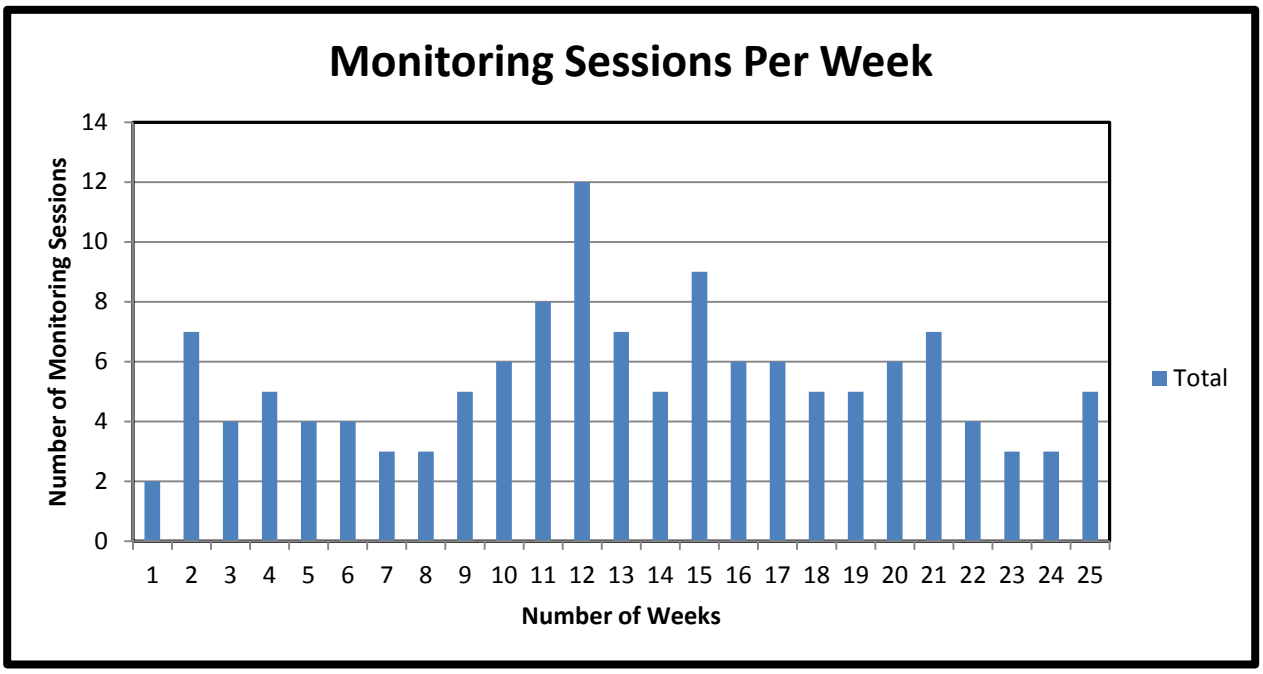

Figure 12. Total Monitoring Sessions - 134.

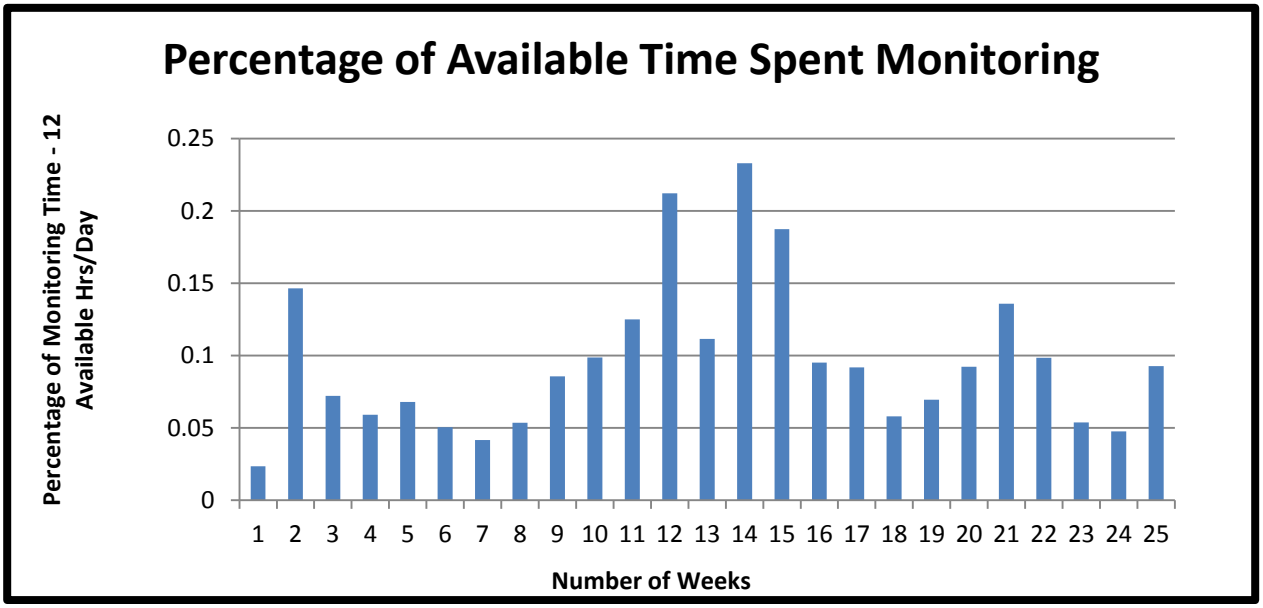

Figure 13. Actual Time Spent Monitoring Based on a 12 Hour Day (2.4%).

Over the course of Phase II, a total of 2,078 WVCs were observed. When analyzing the relative number of WVCs, frog/toad ranked the highest with 1,773 individuals at 85%, followed by 101 turtles at 5%, 77 mammals at 4%, 60 birds at 3%, 37 snakes at 2%, 28 unidentified at 1% and 2 salamander/newt (Figure 14).

Efforts were made to accurately identify each observation on field data sheets with corresponding digital image(s). Where required, images were reviewed by TRCA and partner ecologists and biologists to confirm identification. Some WVCs were difficult to identify due to extent carcass damage.

Wildlife population information for the study area was not available; therefore it cannot be determined whether the numbers of DOR constitute a significant proportion of the resident populations.

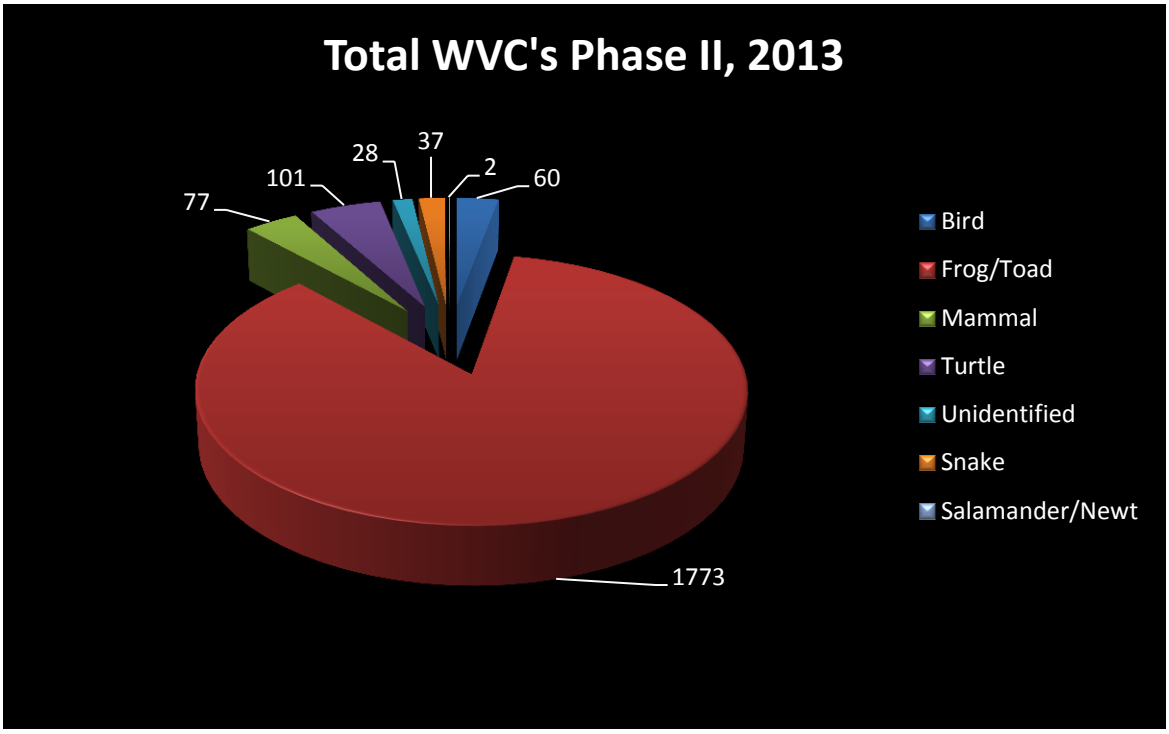

Figure 14. Total WVCs, Phase II, 2013.

WVCs were plotted by taxa and species using GIS and ortho imagery. The following map indicates total number of WVCs (2,078). The total WVC numbers are presented as points indicating multiple fatalities in specific locations within the study area (Figure 15).

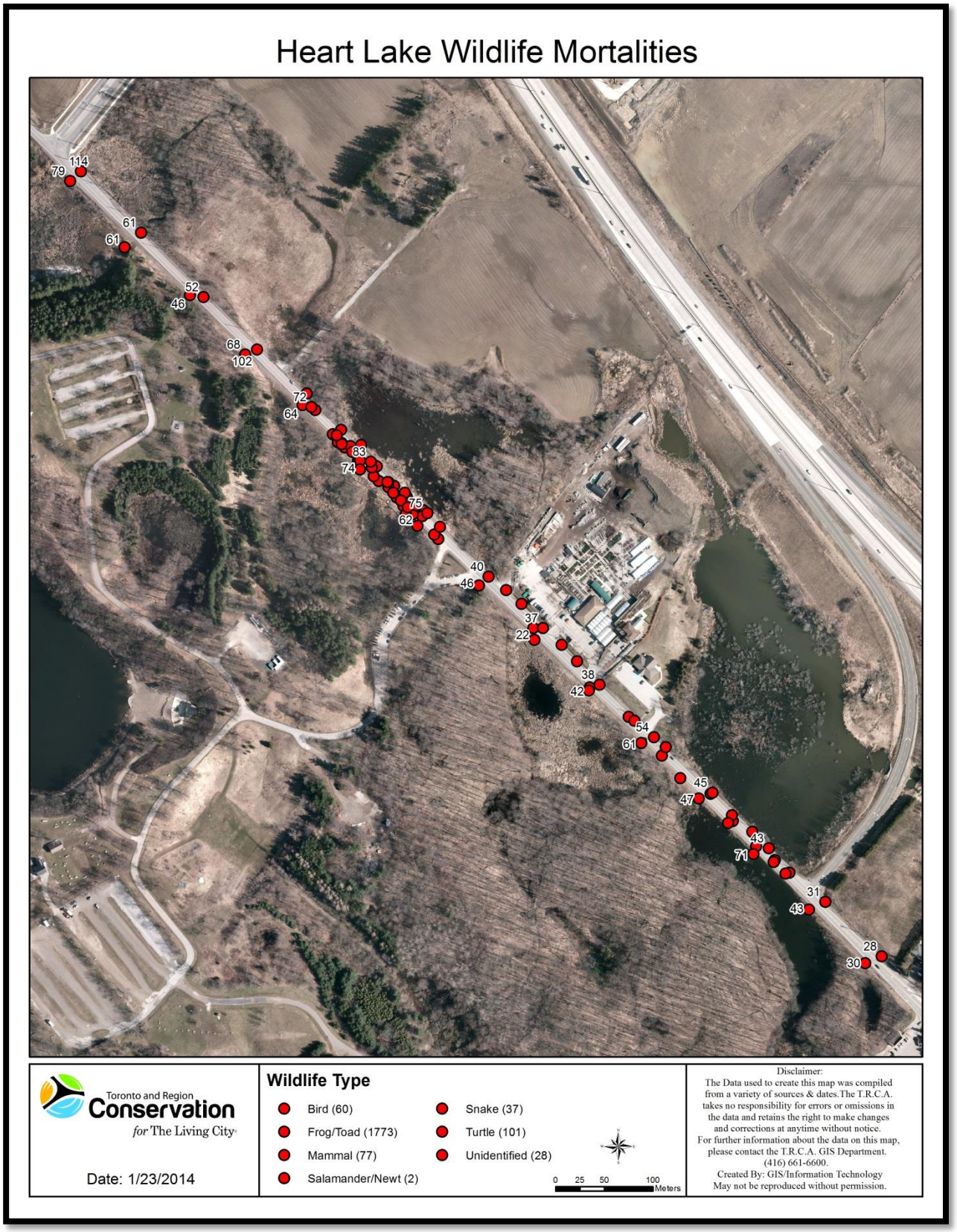

Figure 15. Total WVCs in study area (2,078).

The following sequence of maps (Figures 16 to 21) indicates total number of WVCs broken into species fatalities within the SA. These numbers are presented as points indicating multiple fatalities in specific locations.

Figure 16. Frog Mortalities in SA (1,773).

Figure 17. Turtle Fatalities (101).

Figure 18. Mammal Fatalities (77).

Figure 19. Bird Fatalities (60).

Figure 20. Snake Fatalities (37).

Figure 21. Salamander/Newt Fatalities (2).

3.1 Nest protectors

Snapping turtles were observed nesting (Figure 22) at three gravel shoulder locations within the SA. In order to protect the nests against predation, cages were installed on July 3, 2013, at two locations in the north section of the SA and on July 7, 2013, at a mid-section location of the SA. Cages were constructed by staff using 2 cm hex wire netting and held in place with 15 cm plastic stakes (Figure 23). On July 15, 2013, cages were discovered missing from the two north locations and subsequently replaced. When discovering missing cages, volunteers were not able to see signs of predation or damage to nest site. City of Brampton was notified of these protective cages to prevent disturbance during regular road maintenance works. The cages were monitored by volunteers for predation, disturbances and remained in place until September 2, 2013. It was decided to remove cages at this time for hatching season.

Figure 22. Nesting Snapping Turtle.

Figure 23. Turtle Nest Protector – west side of Heart Lake Rd.

4.0 Data Interpretation

Other variables influencing data collection related to this study are briefly explained in the following sub-sections.

4.1 Monitoring Sessions and Observations

The SA was monitored on an opportunistic basis dependent upon volunteer and staff availability. Efforts were made during the twenty five weeks to conduct monitoring sessions at an earliest start time of 0800 hrs (8:00 a.m.), making it possible to collect fresh data before it was unidentifiable or lost to traffic volume and scavengers. Additional opportunistic surveys were conducted by project staff when weather conditions would support mass amphibian movements (e.g. warm, moist nights). Attempts were made to accurately identify each observation on field data sheets with corresponding digital image(s). Where required, images were reviewed by TRCA and partner ecologists and biologists to confirm identification. Some WVCs were difficult to identify due to extent of carcass damage (Figure 24 and 25).

Figure 24. Unidentified carcass.

Figure 25. Unidentified carcass.

4.2 Traffic Data:

There are no existing CoB traffic count stations within the SA and therefore a request was submitted to CoB Works Department staff and a station was positioned covering both north and south traffic. Counters were located slightly south of Countryside Drive and slightly north of Hwy #410/Sandalwood Parkway off-ramp. CoB Works Department provided in-kind traffic data collection at the SA between June 7 and June 13, 2013, (See Appendix F). Vehicle volume totals are listed below:

Weekday: (Friday June 7th and Monday June 10th to Thursday June 13, 2013)
Average Daily Traffic was 5,435 vehicles/day

Weekend: (Saturday June 8th and Sunday June 9, 2013)
Average Daily Traffic was 7,073 vehicles/day

Speed: 85% of vehicles were travelling at an estimated rate of speed of 78.1 km/hr or < (posted speed limit; 60 km/hr)

The traffic survey indicates high volumes of vehicles along this section of Heart Lake Road during this seven day period. Although above traffic count numbers represent a specific and short time period (including the 25 week study period), throughout the year local residents and project volunteers have expressed concerns of high volumes of traffic and speed along Heart Lake Road.

These volumes of traffic may be impacting data collection as some specimens may be run over multiple times by vehicles which could impact WVC counts by (Figure 26 and 27):

- Displacing and/or crushing the body making it difficult/impossible to identify through visual observation; and
- Removing the carcass from study area (body sticking to tire or thrown into surrounding habitat).

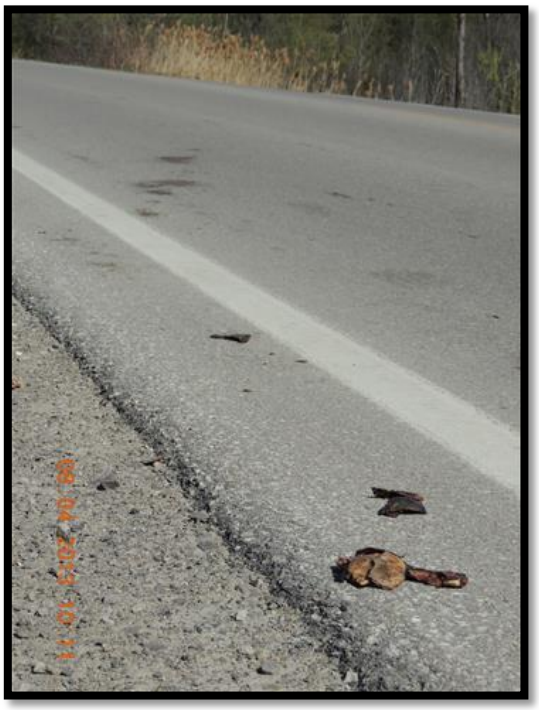

Figure 26. Midland painted turtle remains,

Figure 27. Midland painted turtle, remains collected for identification.

4.3 Scavenging

Fatalities of species along roads leave them highly visible to both diurnal and nocturnal scavengers. A scavenging related study in Florida using birds and snakes resulted in 60% to 97% of carcasses being removed within 36 hours (Antworth RL, *et al,* 2005*)*.

When collecting data of wildlife fatalities, accurate numbers may be affected by scavenging and therefore needs to be considered (Antworth RL, *et al*. 2005). Additional information regarding scavenging is available in Appendix E of this report.

5.0 Discussion

This PSW complex adjacent to HLCA has valuable habitat which is home to an abundance of wildlife and species diversity. Within this system, certain species require distinct, separate habitats (i.e. wetland and terrestrial) at different points in their life cycle to breed, forage and hibernate. The surrounding area is highly urbanized with a growing residential population, increasing traffic volume and new development is ongoing. These are contributing factors to high frequency of WVCs within SA.

5.1 Amphibians:

Twenty-six of Ontario's herpetofauna (including eight salamander species) are SAR. The majority of these species are restricted to the southern portion of Ontario, an area which holds the vast majority of human population, and by extension, the highest density of roads. Loss of habitat, vehicle mortality from migration across roads and negative impacts caused by contaminants and pollution are all contributors to the decline of Ontario's herpetofauna.

Frogs are an essential component of wetlands, consuming large numbers of invertebrates and larvae, and are a significant food source for other wildlife. Frogs and salamanders are indicator species and their presence or absence indicates 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. 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).

Phase II data collection began early April in order to capture peak movement of amphibians as they migrated from hibernation to breeding areas. Data collection ended on September 30, 2013 and temperatures remained warm which may have resulted in additional WVCs not captured in this study. It should be noted that due to the late start date, two species in particular which are well-represented within the HLCA area are likely to be very much under-represented in these results: wood frog (*Lithobates sylvaticus*) and spring peeper (*Pseudacris crucifer*) both emerge as early as late March and undergo synchronised mass migrations from overwintering habitat in upland forests to wetland breeding habitats.

The frog populations at HLCA are especially significant within the Etobicoke watershed context since they represent the most southerly location for several of these species in the watershed. Wood frog, spring peeper and grey tree frog (*Hyla versicolor*) have not been reported in the past decade anywhere south of Sandalwood Parkway. The leopard frog is likewise absent in the watershed below Sandalwood Parkway except for a small population persisting near the lakeshore at Marie Curtis Park.

Phase II data collection revealed 1,773 frog and toad fatalities within the study area. Results for individual species are as follows:

- Unknown - 1016
- Leopard Frog - 460 (Figure 28 and 29)
- Green Frog – 180 (Figure 34 and 35)
- American Toad - 61
- Spring Peeper - 38 (Figure 30 and 31)
- Wood Frog - 9 (Figure 32 and 33)
- Gray Tree Frog - 9

Figure 28. Leopard Frog, Heart Lake Road.

Figure 29. Leopard Frog fatality, Heart Lake Road.

Figure 30. Spring Peeper, Heart Lake Road.

Figure 31. Spring Peeper Fatality.

Figure 32. Wood Frog (egg sack visible), Heart Lake Road.

Figure 33. Wood Frog fatality, Heart Lake Road.

Figure 34. Green Frog, Heart Lake Road.

Figure 35. Green Frog fatality, Heart Lake Road.

5.2 Turtles:

Of the nine species of turtles in Ontario seven are listed as SAR, a Regulation under the Endangered Species Act 2007. Depending on species size, age of maturity can range between 4 to 36 years (Wyneken, 2008). The number of eggs laid by an adult female varies and less than 1% of those eggs will reach sexual maturity. An adult female is a vital part of species continuation and a loss of 1% to 2% percent 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 development, both of which create fragmentation. This puts them at a higher risk of mortality as they migrate to feeding, breeding and hibernation habitats. Turtle eggs are dependent upon specific conditions to incubate. The exposed, sandy-gravel conditions located on the shoulder of roads provide an ideal location for the turtle to lay her eggs putting her, as well as hatchlings, at risk of WVCs, leading to reduced populations and number of eggs laid each year (KTTC, 2011).

Phase II data collection captured peak movement of turtles in spring migration from hibernation to breeding areas. Data collection ended on September 30, 2013 and although some hatchling movement was captured, temperatures remained warm which may have resulted in additional hatchling movement and WVCs not captured in this study.

Turtle populations at HLCA are of great significance at the watershed level. There have been no reports of midland painted turtles (*Chrysemys picta marginata*) at any wetland south of this location in the Etobicoke Watershed, and only one location is known for snapping turtle. The particularly high number of painted turtles killed on the road during the course of the survey suggests that the local population is thriving, but also begs the question: just how much more of this level of mortality can the population withstand? This question is even more pertinent in the case of the snapping turtles. Although this latter species is dying in lower numbers on this stretch of road than its smaller cousin, snapping turtles are extremely long-lived and take many years to reach sexual maturity; therefore the loss of even a small number of adult snapping turtles (particularly mature females) is potentially devastating for a local population (this was one of the reasons for the species' listing as SAR).

Phase II data collection revealed 101 turtle fatalities within SA. Results for individual species are as follows:

- Midland Painted Turtle - 76 (Figure 36 and 37)
- Snapping Turtle - 15 (Figure 38 and 39)
- Unknown - 10

Figure 36. Midland painted turtle basking, east wetland Heart Lake Road.

Figure 37. Midland painted turtle fatality, Heart Lake Road.

Figure 38. Snapping turtle, Heart Lake Road.

Figure 39. Snapping turtle fatality, Heart Lake Road.

5.3 Mammals

Unlike amphibians and reptiles, many mammals remain active year round. Phase II data collection from April to September captured many mammal fatalities but additional WVCs occurring before and after the study would not be captured.

There are a variety of mammals ranging in size found within the study area. Larger mammal fatalities such as deer and coyote receive more attention due to size and impacts related to human and vehicle damage. Small mammal WVCs, much like amphibians and reptile WVCs, often go unnoticed and unreported. Populations of these small mammals are an extremely significant prey item for predators across several taxa (e.g. for milk snake, SAR) and therefore any local decline in small mammal populations will likely have repercussions for the status of many other local species.

Phase II data collection revealed 77 mammal fatalities within SA. Results for individual species are as follows:

- Unknown - 34
- Raccoon - 13 (Figure 40)
- Muskrat - 7 (Figure 41)
- Gray Squirrel - 6
- Virginia Opossum – 3
- Deer Mouse - 2
- Red Squirrel - 2
- Star-nosed Mole - 2
- Striped Skunk - 2
- Eastern Chipmunk - 2
- Eastern Cottontail - 2
- American Mink - 1 (Figure 42)
- Domesticated Cat – 1

Figure 40. Raccoon fatality, gravel shoulder Heart Lake Road.

Figure 41. Muskrat fatality, Heart Lake Road.

Figure 42. American Mink fatality, Heart Lake Road.

5.4 Birds

The wetlands surrounding this study area provide resting and feeding areas for migratory birds, nesting habitat, nurseries for fledglings (Figure 50) and attract a variety of common and locally significant bird species year round.

Aquatic habitat proximity within SA contributes to bird WVCs due to minimum buffer zones between vehicle traffic and preferred habitat. One theory of high rates of bird fatalities is the inability to reach clearance height from trees closely bordering roadways and subsequently being hit by passing vehicles (Jaeger JAG, 2012).

In North America at least 20 species previously categorized as common have declined more than 50% in the last forty years. One likely contributor is the expansion of paved roads, mostly in terms of widening, and corresponding increases in the speed and volume of vehicles on those roads. It is difficult to measure the true extent of vehicle induced mortality because estimates are typically far lower than the actual number of birds killed; estimation accuracy is reduced by variation in researcher efficiency, scavenger bias, and incorrect attribution of cause of death (Kociolek et al, 2010).

Phase II data collection revealed 60 bird fatalities within the study area. Results of individual species are as follows:

- Unknown - 15
- American Goldfinch - 13
- Cedar Waxwing - 8
- Canada Goose - 5 (Figure 47 & 48)
- American Redstart - 2 (Figure 43)
- Black-billed Cuckoo - 2
- Hooded Merganser - 2
- Northern Cardinal - 2
- American Robin - 1
- Grey Catbird - 1
- Mourning Dove - 1
- Northern Flicker - 1
- Northern Rough-winged Swallow - 1
- Pie-billed Grebe - 1 (Figure 49 & 50)
- Red Winged Blackbird - 1
- Song Sparrow - 1 (Figure 44)
- Tree Swallow - 1 (Figure 46)
- Wilson's Warbler - 1 (Figure 45)
- Yellow Warbler – 1

Figure 43. American Redstart fatality, Heart Lake Rd.

Figure 44. Song Sparrow fatality, Heart Lake Rd.

Figure 45. Wilson's Warbler fatality, Heart Lake Rd.

Figure 46. Tree Swallow fatality, Heart Lake Rd.

Figure 47. Canada Goose fatality, Heart Lake Rd.

Figure 48. Canada Goose and gosling, Heart Lake Rd.

Figure 49. Adult male Pied-billed Grebe fatality, Heart Lake Rd.

Figure 50. Pied-billed Grebe fledglings, Heart Lake Rd.

5.5 Snakes:

Ontario snake migration to hibernacula typically occurs in the fall when temperatures start to drop. Phase II data collection, ended on September 30, 2013 and temperatures were still relatively warm which may have been prior to peak migration activities. As temperatures continued to drop, additional snake movement may have occurred resulting in additional WVCs not captured in this study.

Ten of the seventeen species of snakes in Ontario are listed as SAR. 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 humans attempt to deliberately deplete these species.

Phase II data collection revealed 37 snake fatalities within the study area. Results of individual species are as follows:

- Eastern Garter snake - 16 (Figure 52 & 53)
- Unknown - 17
- Eastern Milk snake (SAR) - 2 (Figure 51)
- Northern Red-bellied Snake – 2

Figure 51. Eastern milk snake fatality (SAR), Heart Lake Rd.

Figure 52. Garter snake, Heart Lake Rd.

Figure 53. Garter snake fatality, Heart Lake Rd.

5.6 Salamander & Newts

Salamanders and newts are an important component of local ecosystems, as they consume large quantities of insects and are a food source for other wildlife. As with other amphibians, these creatures are very sensitive to changes in the environment and are recognized as indicator species. Ontario's SAR lists four types of salamanders as endangered and two are extirpated, meaning they no longer exist in Ontario.

Phase II data collection revealed 2 salamander/newt (Figure 54) fatalities within the study area, both of which were unidentifiable due to condition of the remains.

Figure 54. Eastern Newt, Heart Lake Rd.

5.7 Unidentified

It is important to consider when analysing results of these WVCs, many smaller species particularly among the amphibians (e.g. spring peepers, and any yearling frogs), disappear very quickly after being involved in a WVC especially in wet weather. Most amphibians move at night resulting in greater number of WVCs occurring in the evening. If the road becomes wet shortly after the fatality, carcases rapidly deteriorate and will likely be completely gone by the following day. This suggests that frog WVC totals presented in the preceding text will be a fraction of the actual number of fatalities. Furthermore, many carcasses are scavenged in early morning hours by foraging birds and mammals, and it becomes clear that despite large numbers of WVCs presented in this study, they may only represent a portion to total WVCs during the study period.

Phase II data collection revealed 28 fatalities which were unidentifiable (Figure 55) within SA. Despite efforts to accurately collect and identify data through images and outreach to biologists, some fatalities could not be identified. In some cases deterioration of the carcass was so extreme that identification could not even be made to class – mammal, bird, reptile or amphibian.

Figure 55. Unidentified fatality (28 total) – Heart Lake Rd.

6.0 Mitigation Recommendations

The designation of a PSW complex within this highly urbanized area along Heart Lake Road provides both unique challenges and opportunities. Moving forward with mitigation to reduce WVCs will require a strategy that integrates or incorporates a variety of techniques.

High volumes of WVCs in Phase I (2011) and Phase II (2013) as indicated in the charts below (Figures 56 and 57) provide rationale to move forward with mitigation. Hotspots (Figure 58) confirmed by data collection indicate areas to target mitigation and reduce WVCs and help protect local wildlife populations.

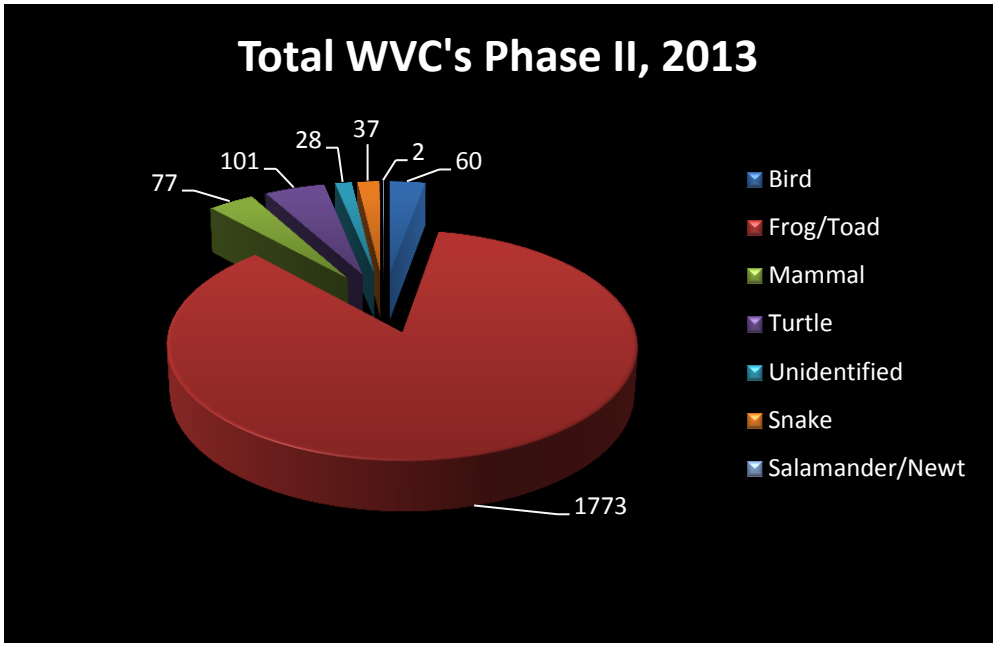

Figure 56. Phase II, HLREMP fatalities 2013.

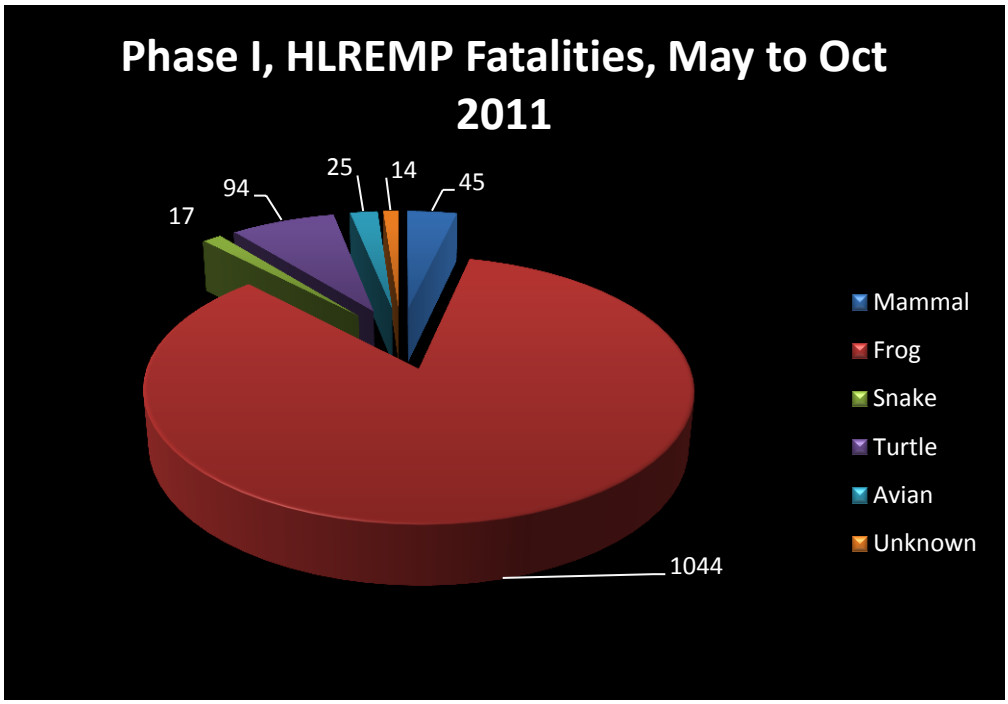

Figure 57. Phase I, HLREMP fatalities 2011.

Data from Phase I and II show fatalities occurring along the entire length of SA(s). Phase II data interpretation grouped fatalities at fixed GPS points within SA represented by the following:

- Yellow = 1
- Light pink = 2 to 42
- Dark pink = 43 to 54
- Red = 55 to 71
- Burgundy = 72 to 114

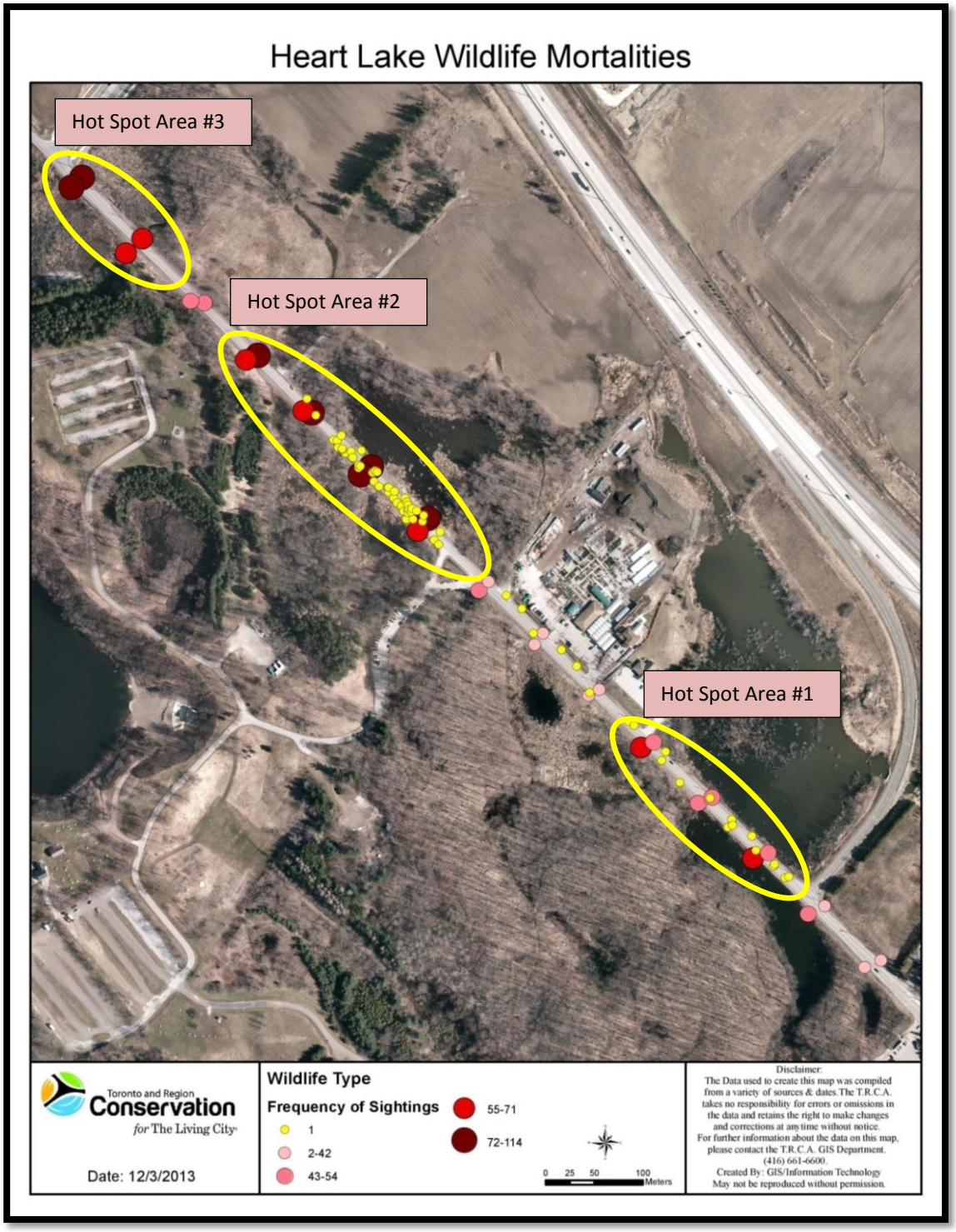

Figure 58. WVC Hotspots, Phase II SA.

From these data sets, staff determined that hotspots are represented by red and burgundy icons are areas which experience largest number of fatalities ranging from 55 to 114 at a fixed GPS location. As indicated, there are seven (7) red icons and seven (7) burgundy icons. These are grouped into three (3) sections to help divide SA into manageable areas in order to move forward with implementing mitigation techniques to reduce WVCs.

There are effective and affordable mitigation strategies to assist with protection of biodiversity and recovery of SAR. Mitigation is feasible within SA but there are ecological and engineering complications as decades ago this road was built through a wetland complex and as a result, poses challenges to any construction upgrades. Construction timing and methods will have to be sensitive to the PSW and there are unique engineering considerations to be integrated. SAR are found in the study area and road mortality mitigation for these taxa is referenced in ESA (http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_080242_e.htm).

Mitigation involves taking advantage of existing land elevations and contours and includes overpasses, underpasses, fencing and raised roads. When considering these options in species conservation, assessment of existing habitat is essential. It may not be feasible and/or possible to restore heavily fragmented areas due to existing depletion and/or extinction of species (Jaeger JAG, 2012).

The following sections provide an overview of mitigation considerations that can be implemented within SA to help protect local wildlife populations and reduce WVCs. This would include physical changes to infrastructure, planning policy changes, habitat and breeding area enhancement, community education and continued monitoring to track success of mitigation

6.1 Wildlife Culverts and Directional Fencing

Reptiles and amphibians are an important component to ecosystems. Amphibians stay within close proximity of their breeding sites, and most juveniles stay within one kilometer. When a road bisects seasonal habitat and breeding sites, 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, culverts, concrete box structures, wildlife directional fencing systems and relocation 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).

Oversize culverts and wildlife directional fencing systems should be strategically placed at wildlife crossing hotspots with proper installation and post-project monitoring and maintenance programs in place. Following completion of 2011 study, results were shared with CoB staff and Brampton Environmental Planning and Advisory Council (BEPAC) which led to recommendations to locate existing culverts and determine if their conditions were suitable to safely facilitate wildlife movement across the road. Field investigations revealed a small number of pre-existing culverts along Heart Lake Road which were located by CoB and TRCA in 2012. Staff found these culverts to have the following limitations for wildlife passage:

- Not in ideal locations for wildlife crossing;
- Undersized;
- Blocked with debris;
- Below water level;
- Serve primarily as a hydrological function to allow water flow between bisected wetlands; and
- Limited airflow and light penetration.

When using culverts for wildlife passage, 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 the culvert(s) should be placed relatively close to crossing hotspots (*Bissonette & Cramer,* 2008). Since existing culverts are not suitable for wildlife passage at hotspots, installing new structures

should be considered. Specialized wildlife tunnels (Figure 59) are preferred where they can be installed, as they provide air flow and lighting resulting in improved interior conditions. An alternative suitable option is oversized concrete box structures or CSPs (diameter = 1.2 m or greater) (Figure 60 and 61). These units are larger and combined with overhead grate-type road surface openings (minimum 0.6 x 0.6 m) similar to catch basins with covers (Figure 62) provide greater air flow and lighting which is more inviting to reptiles, amphibians, and small mammals.

For this study, options to decrease WVCs include installing oversize culverts with road surface grate-type openings to allow air-flow and lighting and permanent directional fencing. 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).

Depending on site conditions, perched oversized CSPs for dry passage of small wildlife can be installed or partially submerged swim-through oversized CSPs can be used for passage of aquatic small wildlife (Figure 63).

Figure 59. ACO Wildlife passage.

Figure 60. Oversized concrete box culvert.

Figure 61. Oversized CSP culvert (Photo Credit: Great Wall Co).

Figure 62. Overhead grate-type road surface covering.

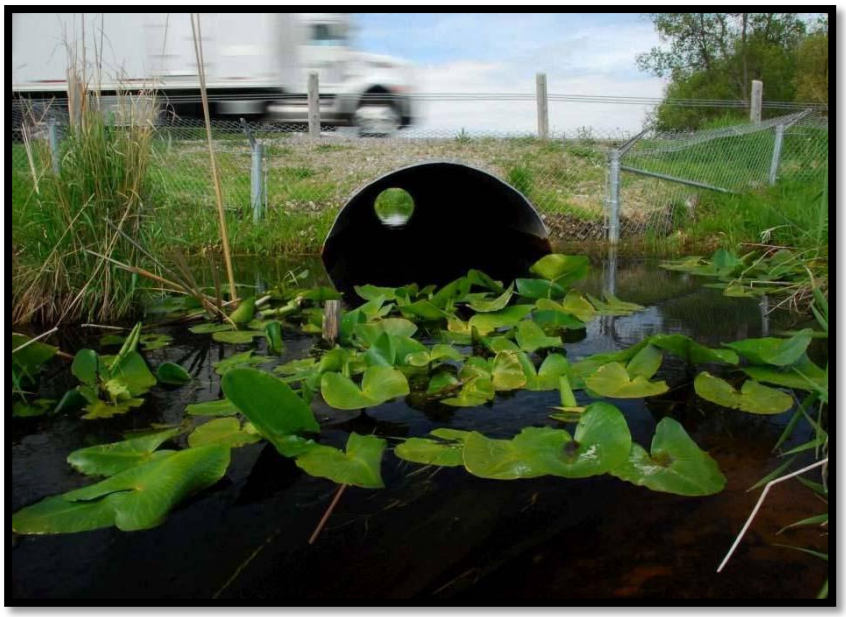

Figure 63. Oversized CSP culvert, partially submerged.

In addition to oversized culverts, permanent wildlife directional fencing is necessary to guide wildlife to culverts. There are several permanent directional fencing options that can be considered (Figure 64 to 67). Wildlife directional fencing requirements need to be installed as part of a long-term solution. Features of fencing include;

having no gaps along/under fencing preventing smaller wildlife access to road, have an angled top to prevent wildlife climbing over, be of durable materials, UV resistant, able to withstand weather conditions and winter road maintenance impacts, easy to maintain and not interfere with road safety. Additionally this fencing is targeted to smaller wildlife and does not restrict movement of larger wildlife. Fencing specific for managing WVCs for larger wildlife can also be considered as part of a strategy in applicable locations (Figure 68), while still protecting smaller species.

Figure 64. Directional wildlife fence, buried guardrail (Photo Credit: Aresco MJ).

Figure 65. Directional wildlife fence, steel piling (Photo Credit: Aresco MJ).

Figure 66. Directional wildlife fence, ACO one-way wildlife fence.

Figure 67. Directional fencing, partially buried hardware cloth fence with rail (MNR, 2013).

Figure 68. Directional fencing, chain link with hardware cloth, one-way entry from road.

6.2 Turtle Beaches for Nesting

Disturbances from human activities can change behaviour patterns of wildlife migration, nesting and breeding activities. Gravel shoulders of roads provide ideal nesting sites for turtles which was observed by volunteers in both Phase I and Phase II of this study. During 2013 data collection, a total of three female snapping turtles (SAR) were observed nesting at Countryside Drive and Heart Lake Road on both east and west gravel shoulders, as well as the west side of Heart Lake Rd across from Lakeside Garden Gallery Nursery. This does not represent all potential nesting sites in gravel shoulders along Heart Lake Road. All three nest sites were protected by placing wire cages over each site and monitored by staff.

Additional mitigation options for this site include installation of turtle nesting and basking beaches (Figure 69) providing a safer alternative to gravel shoulders. Installing turtle beaches in areas away from Heart Lake Rd will provide safer habitat for females to nest and protect emerging hatchlings. Installation (Figure 70) involves choosing a site with south facing exposure to provide direct sunlight, allow ample drainage and being positioned in an area where there is low risk of flooding. Steps include, removing approximately 15 cm (6 inches) of existing vegetation and soil from surface, placing landscape fabric on prepped site and applying a mix of pea gravel and sand evenly over area to a depth of 40 cm (15 inches). It is recommended to construct nesting/basking beaches in fall after existing nests have hatched. Although this mitigation option will not prevent turtles from using gravel shoulders to nest, it provides a plausible alternative. Combined with other mitigation techniques as outlined in this report turtle beaches are an important component of an overall mitigation strategy for this SA.

Figure 69. Turtle Beach, Rouge Park Ontario (Adopt-A-Pond 2012).

Figure 70. Steps to install turtle nesting/basking beach (Adopt-A-Pond 2012).

6.3 Traffic Speeds and Volumes

Based on feedback from project volunteers and staff, along with traffic study results, this section of Heart Lake Road is subject to high volumes of vehicle traffic and excessive speeds. Another mitigation option to be explored for SA is implementing a three-way stop at the intersection of Countryside Drive and Heart Lake Road. The existing stop sign located on Countryside Drive for westbound traffic would be augmented by two additional stop signs for both north and south bound traffic on Heart Lake Road (Figure 71). Installing additional stop signs will help reduce speeds, preventing WVCs with certain sized wildlife by increasing motorist's chances of seeing the animal prior to collision and reduce chances of vehicle and collision related injuries. Slowing down traffic volume along this road will also provide the opportunity to reinforce the following messages:

- additional signage to reinforce messages related to the sensitivity and significance of this area;
- various wildlife vulnerable to WVCs; and
- efforts being made by CoB to reduce wildlife fatalities.

CoB currently posts turtle crossing signs on Heart Lake Road just south of Mayfield Road for southbound traffic and north of Sandalwood Parkway for northbound traffic. These signs are installed and removed to correspond with turtle movement. Examples of additional signage are shown in Figures 72 to 76. Consideration should also be given to signs, both graphic and electronic, being installed and removed at specific times throughout the year. This would help motorists acknowledge signs and raise awareness of species diversity.

Figure 71. Intersection, Heart Lake Rd and Countryside Dr (north view).

Figure 72. Wildlife crossing sign (Photo Credit: University of Guelph).

Figure 73. Wildlife crossing sign (Photo Credit: Toronto Zoo, OREG).

Figure 74. Wildlife crossing sign (Photo Credit: Nature Conservancy).

Figure 75. Wildlife sign (Photo Credit: Photo Gallery).

Figure 76. Road sign, Provincially Significant Wetland, (Photo Credit: Kawartha Naturalists).

Additional traffic surveys should also be conducted along Heart Lake Road to better understand traffic volumes and patterns to assist planners with managing and reducing traffic volumes. Lower traffic volumes, reduced speeds and wildlife signage are additional components of an effective mitigation strategy for this SA.

The Ministry of Transportation of Ontario (MTO) is developing a Wildlife Mitigation Strategy to undertake short (e.g. signage) and long-term (e.g. fencing and dedicated wildlife passages) mitigation for small and large animals. The key elements of the strategy include:

- gather available data on wildlife populations and habitats intersected by roads (including SAR) as well as road mortality and wildlife/vehicle collision data;
- perform geospatial analyses on these data to map and prioritize the areas of greatest need for wildlife mitigation from a conservation and safety perspective;
- collaborate with municipal, regulatory and non-government partners (including OREG and academia) to establish a coordinated strategy for effective siting of mitigation measures; and
- identify and review tools to assist in related areas such as public awareness, education and standardized collision data collection.

As Brampton moves forward to reduce WVCs along Heart Lake Road, consultation with MTO would provide additional guidance and resources for the development of their mitigation strategy and implementation of mitigation projects.

6.4 Education and Awareness

There is a need to raise awareness amongst decision makers, various levels of government and the public. The following recommendations should be considered to help with 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 related to ecological effects of roads. 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; and
- Construction and Building Community – collaborate with transportation and planning agencies and local Conservation Authorities to educate developers on Road ecology and develop certification programs for the installation of various mitigation options.

Additionally, city planning and developers should work together to better understand and integrate road ecology into urban development process. This can be accomplished by:

- Conducting 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;
- Reviewing and incorporating wildlife movement data into project designs prior to improving and/or expanding existing roads or for new road construction. These types of projects may provide a greater opportunity to install a permanent barrier to guide wildlife toward preferred crossing areas, replace undersized culverts, or install new culverts or tunnels at identified crossing hotspots; and
- Co-operation between government and conservation organizations (i.e. OREG, TRCA) to develop policy and legislation in areas of road ecology to aid transportation and planning agencies in designing more ecologically-sustainable transportation networks.

7.0 Conclusion and Next Steps

The objective of Phase I 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. Phase II provided an opportunity to further investigate WVCs, determine hotspots and provide a solid mitigation strategy.

Data analysis from Phase II reveals continued high volumes of WVCs along this stretch of Heart Lake Road and evidence of diverse wildlife including SAR. Mitigation options have been outlined in greater detail to allow decision makers the opportunity of implementing a solution.

Staff and partners working on this project have recognized mitigation is necessary and strongly support moving forward with implementation of mitigation within SA. Understanding there are challenges with respect to infrastructure and site conditions, implementing a mitigation strategy to address all WVCs in the SA will require a significant amount of time, effort and financial commitment. It is imperative that CoB take the initial step to move forward by targeting at least one of the identified hotspots and implementing one or more of the techniques outlined in this report.

All project partners are committed to moving forward and assisting CoB with this initial step as well as the development of a long term mitigation strategy.

Based on discussions and field observations between TRCA and CoB staff in 2012, the preferred initial target area is located in hot spot Area #2 (Figure 58), slightly north of the entrance to HLCA. Staff recognized this area as being more conducive to supporting the installation of an oversized culvert and permanent directional wildlife fencing. Once a decision is made, project partners will work together to assist with design details, location and pre and post monitoring to evaluate the success of mitigation.

The Heart Lake Provincially Significant Wetland complex is not only a unique feature in an urban setting but is a valuable asset to local wildlife and Brampton residents. CoB has indicated their commitment through support of this project and will be leaders in the GTA and local municipal champions in the field of Road Ecology by implementing ground-breaking mitigation measures to decrease WVCs and wildlife protection (including SAR).

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APPENDIX A

MNR Wildlife Handling Permits

Ministry of
Natural Resources
Aurora District Office
50 Bloomington Road
Aurora, Ontario L4G 0L8

Ministère des
Richesses naturelles

Telephone: (905) 713-7409
Facsimile: (905) 713-7361

Ontario

April 9, 2013

Mr. Vince D'Elia
Toronto and Region Conservation Authority
5 Shoreham Drive
Toronto, Ontario
M3N 1S4

Dear Mr. D'elia:

Please find enclosed a copy of Wildlife Scientific Collectors Authorization #1073157 for the study to assess wildlife/road interactions on Heart Lake Road.

Please sign the licence and Schedule A – Authorizations Conditions where indicated and return a copy to me.

Please contact me if you have any questions.

Yours truly,

Laurie Uetz
Resource Management
Aurora District Office
laurie.uetz@ontario.ca

Ontario

Ministry of Natural Resources

Ministère des Richesses naturelles

Wildlife Scientific Collector's Authorization

Autorisation pour faire la collecte scientifique d'animaux sauvages

AuthorizationNo.. / N° d'autorisation	1073157
Local Reference No. / N° de référence local	
Issuer Account No. / N° de compte du délivreur de permis.	7491309

This authorization is issued under Section 39 of the Fish and Wildlife Conservation Act, 1997 to:
Cette autorisation est délivrée en vertu de l'article 39 de la Loi sur la protection du poisson et de la faune de 1997 à:

Name of Authorization holder / *Nom du titulaire de l'autorisation*

Last Name / Nom de famille	First Name / Prénom	Middle Name / Second Prénom
Mr. D'elia	Vince	

Name of Business/Organization/Affiliation (if applicable) / Nom de l'entreprise/de l'organisme/de l'affiliation (le cas échéant)

Toronto and Region Conservation Authority

Mailing address of Authorization holder / *Adresse postale du titulaire de l'autorisation*

Street Name & No./PO Box/RR#/Gen. Del./ N° rue/C.P./R.R./poste restante			
5 Shoreham Drive			
City/Town/Municipality / Ville/village/municipalité		Province/State Province/État	Postal Code/Zip Code Code Postal/Zip
Toronto		ON	M3N 1S4

This authorization permits the above-named person to:
Cette autorisation permet à la personne nommée ci-haut de:

☒ **Capture wildlife of the species and sex, in the numbers, and in the area set out be below.**
Capturer les espèces d'animaux sauvages selon le nombre et le sexe indiqués ci-dessous dans les lieux indiqués ci-dessous

and/or / et/ou

☐ Keep game wildlife or specially protected wildlife in captivity for the purposes of education or science.
Garder des animaux sauvages spécialement protégés et du gibier sauvage en captivité à des fins éducatives et scientifiques

☒ Release the captured wildlife in the area of capture, if the captured wildlife is not to be removed from that area
Remettre en liberté les animaux sauvages capturés dans la zone de capture si les animaux captures ne doivent pas être enlevés de cette zone

OR / OU

☐ **Capture and kill wildlife of the species and sex, in the numbers, and in the area set out be below.**
Capturer et tuer les espèces d'animaux sauvages selon le nombre et le sexe indiqués ci-dessous dans les lieux indiqués ci-dessous

Species / Especés	Sex / Sexe	Numbers / Nombre	Location / Endroit
Spring Peeper			Heart Lake Road - See Schedule A
Leopard Frog			Heart Lake Road - See Schedule A
Wood Frog			Heart Lake Road- See Schedule A
Painted Turtle			Heart Lake Road- See Schedule A

Yes/Oui ☐ Additional list attached / Liste additionnelle ci-jointe

Authorization Dates / *Dates d'autorisation*

Effective Date / Date d'entrée en vigueur (YYYY-MM-DD)	Expiry Date / Date d'expiration (YYYY-MM-DD)
2013-04-05	2013-07-31

Authorization conditions / **Conditions de l'autorisation**

This authorization is subject to the conditions contained in Schedule A if included./Cette autorisation doit respecter les conditions de l'annexe A si celle-ci est jointe.

Yes/Oui ☒ No/Non ☐ Schedule A included. / Annexe A ci-jointe

Authorized by (please print) / Autorisé par (veuillez écrire en caractères d'imprimerie)	Signature of Authorizer / Signature de la personne chargée d'autoriser	Date of Issue/Date de délivrance (YYYY-MM-DD)
Steven Strong		2013-04-05

Signature of Authorization holder / Signature du titulaire de l'autorisation	Date (YYYY-MM-DD)
Vince D'Elia	2013-04-05

Personal information contained on this form is collected under the authority of the Fish and Wildlife Conservation Act, 1997 and will be used for the purpose of licencing, identification, enforcement, resource management and customer service surveys. Please direct further inquiries to the District Manager of the MNR issuing district.

Les renseignements personnels dans ce formulaire sont recueillis conformément à la Loi sur la protection du poisson de la faune, 1997 , et ils seront utilisés aux fins de délivrance de permis, d'identification, d'application des règlements, de gestion des ressources et de sondage sur les services a la clientèle. Veuillez communiquer avec le chef du district du MRN qui délivré le permis si vous avez des questions.

FW2018 (04/00)

Wildlife Scientific Collector's Authorization
Autorisation pour faire la collecte scientifique d'animaux sauvages
Schedule A – Authorization conditions
Annexe A - Conditions de l'autorisation

Authorization No.
No d'autorisation. **1073157**

This authorization is subject to the conditions listed below.

1. This authorization is valid at Heart Lake Road, between Sandalwood Parkway and Mayfield Road, City of Brampton, Regional Municipality of Peel.

2. This authorization is valid only for the persons, species, numbers, areas and calendar year indicated. A written report covering the operation of the preceding year must be submitted to the authorization issuer within 30 days of the termination date, but in no case later than January 31 next following the year of issue. The report shall contain a statement outlining the objectives of the operations, the methods used, the number and species of wildlife caught and their fate as well as a map indicating where the collections took place. An analysis is not required. The submission of a satisfactory report is a prerequisite to any subsequent renewals.

2. Before carrying out any operation under the authorization in any area the authorized person shall inform the Area Supervisor of his or her intentions at least a week before commencing work and include information as to the type of operation, location, duration, and the name or names of personnel involved. The forgoing does not apply to the collection of road killed specimens of a type indicated on the authorization.

3. When possible, all wildlife captured under this authorization shall be released alive in the area of capture. When further examination of the animal is necessary in the laboratory permission must be obtained as part of this authorization under section 40(2)(c) of the Fish and Wildlife Conservation Act. Where furbearing mammals are collected the authorized person must contact the issuing office and make arrangements to pay the royalty. Dead animals which are no longer required must be cremated or buried. The authorized person will inform the issuer of any burial site. Any animal suspected of being infected with a communicable disease shall be incinerated in a facility approved under the Environmental Protection Act for that purpose.

4. A copy of the original authorization must be carried by the authorized person when working at the designated sites. An assistant of the authorized person who is carrying out activities under this authorization during the absence of the authorized person shall carry a copy of the authorization on his or her person.

5. All collection gear shall be clearly marked with the authorized person's and the organization's name.

6. This authorization is not valid in Provincial Parks, park reserves, National Parks, Conservation Areas, Crown game preserves or sanctuaries established under the Migratory Birds Convention Act without written permission from the authorized person in charge of the area concerned.

7. Gloves and containers may be used.

8. This authorization does not allow access to any property without permission of the landowner.

9. Sections 5 and 6 of the Fish and Wildlife Conservation Act 1997, and the provisions of the regulations relating to open seasons and bag limits do not apply to a person capturing or killing wildlife under this authorization.

10. The authorization holder may be assisted by Paul Prior, Casey Cook and Mandy Karch.

Signature of authorization holder / Signature du titulaire de l'autorisation **Date**

Vince D'Elia — April 9, 2013

City of Brampton Road Permit

FLOWER CITY
BRAMPTON.CA

ROAD OCCUPANCY & ACCESS PERMIT

THE CORPORATION OF THE CITY OF BRAMPTON
WORKS AND TRANSPORTATION DEPARTMENT - MAINTENANCE & OPERATIONS DIVISION
8850 McLaughlin Road, Unit 2, Brampton, Ontario L6Y 5T1
Phone: (905) 874-2500 Fax: (905) 874-2599
website: www.brampton.ca

PERMIT NO: USE13-9097

NAME / COMPANY NAME	DAVID TOMASONE / Toronto and Region Conservation Authority
ADDRESS	8850 MCLAUGHLIN ROAD BRAMPTON ON
BUSINESS TELEPHONE NUMBER	Day: (905)874-3504x Cell:
BUSINESS FAX NUMBER / COMPANY WEBSITE / e-MAIL ADDRESS	
CONTRACTOR / CONSULTANT	
AFTER HOURS / EMERGENCY CONTACT PERSON	Vincent D'Elia
AFTER HOURS / EMERGENCY TELEPHONE NUMBER	Cell: (416)661-6600

	YY	MM	DD
DATE OF APPLICATION:	13	04	08
COMMENCEMENT:	13	04	08
COMPLETION:	13	07	31

PERMIT COST:	$0.00
RESTORATION/ SECURITY DEPOSIT:	$0.00
TOTAL:	$0.00

ASSOCIATED PERMIT(S) _____
SITE PLAN ASSOCIATED SP- _____
INSURANCE CERTIFICATE _____
PUC APPLICATION # _____

WORK DESCRIPTION DETAILS:
Occupying Road or Blvd, Trucks Equipment or Material. Toronto Region and Conservation Authority annual animal mortality survey.

LOCATION OF WORK: From: Intersection of HEART LAKE RD and SANDALWOOD PKY E To: Intersection of HEART LAKE RD and COUNTRYSIDE DR

1.) HEART LAKE RD From: 2,011.35 meters To: 3,338.95 meters

OPEN CUTTING OF THE ROAD AND/OR REMOVAL OF SIDEWALK IS NOT PERMITTED WITHOUT PRIOR WRITTEN APPROVAL

CONDITIONS FOR ISSUANCE (SPECIAL PROVISIONS)
Traffic Controls as per Book 7. Personal protection equipment to be worn at all times. Signage to be posted daily, prior to activity. Inspection work to be conducted on the roadway shoulders from **9:00am-3:00pm**

TRAFFIC CONTROL:
TRAFFIC SIGNING WILL BE IN ACCORDANCE WITH BOOK 7 OF THE ONTARIO TRAFFIC MANUAL - TEMPORARY CONDITIONS.
ACCESS FOR EMERGENCY VEHICLES MUST BE MAINTAINED AT ALL TIMES.
ROAD CLOSURE(S) IS NOT PERMITTED WITHOUT PRIOR WRITTEN APPROVAL.
APPLICANT MUST ADVISE ALL ESSENTIAL SERVICES IN THE EVENT OF AN EMERGENCY ROAD CLOSURE.

2 LANES TO BE MAINTAINED DURING WORK HOURS 2 LANES TO BE MAINTAINED AFTER WORK HOURS

OPERATING HOURS: FROM 9:00 TO 15:00

I, THE UNDERSIGNED HAVE READ AND UNDERSTOOD THE INFORMATION PROVIDED AND AGREE TO ABIDE BY ALL GENERAL CONDITIONS, SPECIAL PROVISIONS AND ALL CONDITIONS LISTED ON THE FACE AND BACK OF THIS PERMIT. ALL IN ACCORDANCE WITH BY-LAW 93-93 (AS AMENDED)

AUTHORIZED REPRESENTATIVE PRINT: Vince DElia SIGNATURE: _____

FOR OFFICE USE ONLY

APPROVAL _____ PHONE NO.: (905) 874-2517

PERMIT FILE DATE _____ INITIALS _____

Personal information is being collected under the authority of the Municipal Act for the purpose of processing permit applications. Questions about this collection should be directed to the Supervisor of Permits, Works & Transportation, 8850 McLaughlin Road, Unit 2, Brampton, Ontario L6Y 5T1 Telephone: (905) 874-2500

The Corporation of the City of Brampton
Works and Transportation Department

The Applicant hereby indemnifies and saves harmless the Corporation of the City of Brampton, its Council and its employees and servants from all claims, demands, actions and proceedings, by whomsoever made or brought, in respect of any cost, expenses, loss, damage or injury, including death arising by reasons of or in connection with the issuing of this permit. Furthermore, the Applicant hereby releases and forever discharges the parties aforesaid from and against all claims or demands whatsoever which it, its successors or assigns, can, shall or may have by reasons aforesaid against any or all of the said bodies. The Corporation of the City of Brampton reserves the right to require the applicant to provide proof of Liability insurance. This permit is issued in accordance with by-law 93-93. The requirements of this Road Occupancy permit shall be performed to the satisfaction of the Commissioner of Works and Transportation, or his designate; otherwise the site may be closed until those requirements are met. The Commissioner or his designate reserves the right to cancel or suspend this permit wherever and whenever it is deemed necessary. The Applicant accepts full responsibility for any and all damage caused by all related operations.

The Applicant further agrees that all temporary reinstatement of works within the limits of the road allowance will be guaranteed and maintained safe until final restoration is performed or a maximum of twelve months from the date of substantial completion.

This permit is not valid until all copies are signed, approved and issued. A copy of this permit must be on site at all times. Permits are valid for the date, time, locations and type of work listed only.

The Applicant will ensure all personnel working under this permit do so in accordance with Ministry of Labour's Occupational Health and Safety Act for Construction Projects. Trench safety must be in accordance with current Ministry of Labour Standards (M.O.L. trench numbers must be available).

City of Brampton's General Conditions and Standard Specifications, Standard Drawings and the Ontario Provincial Standard Drawings/Specifications Manuals form an integral part of this permit.

Prior to any excavation, an underground locate must be obtained from all utilities and a copy of the stakeout report(s) must be on site, at all times. The Applicant must ensure that all storm sewer connections are inspected and accepted prior to performing the backfilling operation. All services will be protected and supported to the satisfaction of the utility concerned.

Normal Hours of Operation will be 7:00am to 7:00pm (summer) and 7:00am to 4:00pm (Nov. 15 to March 15). Specific restrictions may be imposed.

Condition	Details
Traffic Book 7 Condition	Traffic control will be performed in accordance with Book 7 of the Ontario Traffic Manual ¿ Temporary Conditions.
Snow Event Condition	During snow events, permitted (parked) vehicles must not block the snow-clearing route of snow plow vehicles.
Boulevard Restoration Condition	Boulevard restoration will consist of backfilling with clean, non-frozen native materials, properly compacted so as to prevent settlement. New sod (no.1 Nursery stock) will be placed over a minimum of 75mm clean topsoil, countersunk and rolled to match the surrounding area. The Applicant is responsible for watering and ensuring the sod grows prior to final (12 months) acceptance.
Parking Condition	Parking service vehicles on boulevards is strictly prohibited
Tree Perservation Condition	Trees on the right of way are not to be affected. When the work interferes with or causes damage to a tree, restoration details will be referred to the Parks Dept. for review. Boulevards, parkland and buffer strips must not be accessed for 24hrs after a major rainfall.
Sodding Seeding Condition	All excavated areas to be sodded to prevent erosion.

APPENDIX B

TRCA Waiver Form

TORONTO AND REGION CONSERVATION AUTHORITY (TRCA)
Environmental Volunteer Network (EVN)

WAIVER OF LIABILITY

Task / Role: **Road Ecology Data Collection Volunteer**
(volunteer job title)

In consideration of the acceptance of my application and permission to participate as a(n) **Road Ecology Data Collection Volunteer**, starting April 30th, 2013, at which time I will begin working on the following tasks:

- walking a pre designated study area and following safety & data collection protocols as outlined by TRCA (see attached Safety Protocol)
- that you are confident in performing the data collection and if uncertain obtain clarification from TRCA staff

I agree that Toronto and Region Conservation Authority (hereinafter referred to as "TRCA"), which term includes its members, officers, officials, employees, agents, servants and contractors, will not be liable to me for any accident, injury, damage, loss or other claim for death, bodily injury, personal injury or property damage, including income loss replacement and/or health care costs, resulting from my participation in the Environmental Volunteer Network.

I agree to perform my duties as a volunteer in a safe manner at all times; to act in a responsible and reasonable manner as a representative of TRCA; to treat all internal matters of TRCA as strictly confidential; to perform my duties in a professional manner and to treat others with respect.

I further agree to follow all policies, procedures and instructions as set out by the organizers of the Environmental Volunteer Network and further understand that if I do not adhere to these requirements I will not be able to participate/volunteer in the project and I will be asked to leave the premises.

I acknowledge that I have read, understood and agree to the above waiver.

IN WITNESS THEREOF, this waiver has been duly executed at Brampton,

on this 30th day of April, 2013

SIGNED IN THE PRESENCE OF:

_____
_____
(witness name) (witness signature)

_____
_____
(volunteer name) (volunteer signature)

_____
_____
(volunteer's supervisor name) (volunteer's supervisor signature)

In case of emergency, please provide contact information:

Name:	Relationship to Volunteer:
Address:	
Phone (primary):	
Phone (secondary):	

Consent by Parent or Guardian if Volunteer is under the age of 18:

I, _____, am the _____ of _____ (hereafter known as "the volunteer")
(your name here) (parent/guardian) (the volunteer's name here)

and hereby give permission to participate in the Environmental Volunteer Network. I confirm that I have advised the volunteer of:

1. the obligation to act in a responsible manner as a representative of the TRCA
2. to treat all matters of the TRCA as strictly confidential
3. to follow all the rules and regulations as set out by the organizers of the Environmental Volunteer Network
4. that by not adhering to the rules and regulations, the volunteer may endanger himself/herself and permission for the volunteer to continue to participate in the project may or will be revoked, and the volunteer will be asked to leave the premises.

IN WITNESS THEREOF, this consent has been duly executed at _____
(municipality)
on this _____ day of _____,
20_____.
(day) (month) (year)

SIGNED IN THE PRESENCE OF:

_____
_____
(witness name) (witness signature)

_____
_____
(parent/guardian name) (parent/guardian signature)

_____
_____
(volunteer's supervisor name) (volunteer's supervisor signature)

In case of emergency, please contact me:

Name:
Address:
Phone (primary):
Phone (secondary):

Field Data Sheet

Heart Lake Road Ecology – Phase 2 - Data Sheet

Observer(s): _____

Month: _____ Day: _____ Year: 2013

Start Time: _____ a.m. p.m. End Time: _____ a.m. p.m. Air Temp: ____°C

Precipitation: None Light Heavy % Cloud: 0%, 25%, 50%, 75%, 100%

Wind: Calm Gentle Strong Wind Direction From _____ to _____

Status: **AOR** – Alive On Road **ABR** – Alive Beside Road
DOR – Dead On Road **DBR** – Dead Beside Road
Position: Shoulder, White Line, Middle of Lane or Yellow Line
Proximity DBR: (from edge of pavement) 0.25 m, 0.5 m, 1 m or > 1 m
Behaviour (alive): Foraging, Basking, Crossing, etc.,
Side of Road: N, S, E, W
GPS: Easting – how far east or west from the centre of the middle of each UTM zone (top RH # on GPS screen)
Northing - how far north or south from Equator (Below easting #)

Check List

Fencing: Gaps Yes No Damage Yes No (Please note damage/repairs and location in comments section)

Pitfalls: Lids Secure Yes No **If No:** Pitfall in Culvert 1 2 3 North/South End of Fence: N S (note wildlife/damage in comments section)

Cameras: Remove Memory Card Done (place in bag & mark with camera number) Replace Memory Card Done

Comments: _____

Wildlife Observations

#	Species (note male or female if possible)	Status	Position & Proximity on Road	Easting or Marker #	Northing	GPS Accuracy	E/W Side of Rd	Photo Y/N	Comments
	Example: Snapping Turtle	AOR	Middle of lane, facing W - .25 m fm edge of W shoulder	0597560	4843928	+/- 4 m	W	Image #	Turtle crossing from E to W side of rd – size of carapace 28 cm (11") fm back of neck to tail – leeches on R rear leg
1									
2									
3									

Heart Lake Road Ecology – Phase 2 - Data Sheet (Continued From: Date: _____ Observer(s): _____)

#	Species (note male or female if possible)	Status	Position & Proximity on Road	Easting or Marker #	Northing	GPS Accuracy	E/W Side of Rd	Photo Y/N	Comments

Safety Protocol

Heart Lake Rd. Wildlife/Road Interaction Study

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

Study Site & Survey Protocol

Study Site

Heart Lake Road between Sandalwood Pkwy E and Countryside Dr. (approximately 2.5 km).

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

Volunteer Monitoring Protocols

TO: Data Collection Volunteers

RE: Heart Lake Road Ecology Monitoring STEP BY STEP Procedures for Monitoring Sessions

The following are some steps to assist with following protocols currently being used for Phase 2 of Road Ecology Monitoring.

- Put up signs at both north and south locations – sign for northbound traffic is on the east side, just north of Sandalwood Parkway – sign for the southbound traffic is located on the west side (past Countryside Drive) attached to the hydro pole with road sign (just south of the guard rail)
- Enter through **first set of green gates** and immediately park car to the right (north) side of the lot (ie: along cedar fence, as far away from the Gate-house as possible) Please do not park along the driveway entrances to Heart Lake
- Notify staff in Gate-house at entrance to Heart Lake you are commencing a monitoring session for TRCA Road Ecology Study.
- Extract key from lock box (code: 3131) located at back of Heart Lake Admission Building at parking lot and open equipment bin **NOTE: please return the key to the lock-box immediately** – do not take with you during monitoring.

Commencing Study:
Safety and monitoring equipment to take from supply bin:

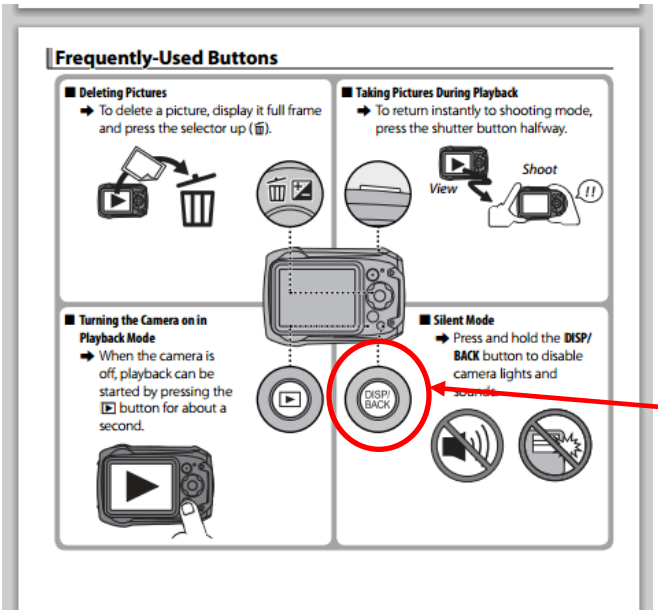
- Place laminated "permission to park" sign in dash board of vehicle
- Review safety sheet
- Close-toed shoes - CSA approved boots if possible
- Safety hard hat
- Safety vest
- Safety glasses (these are provided for your protection to prevent injury from flying debris from vehicles)
- Thermometer (take temperature and return to box)
- Pencils, pens (no **red** please) and clip board and data sheet from binder - **IMPORTANT:** please put **date and names** of volunteers on **ALL** pages of the monitoring sheets (front and back) and number the sheets. ie: 1 of 3, 2 of 3, 3 of 3 – if the sheets get separated and do not have names and dates, it will be very difficult to match them and record the data
- Camera - please take note of the image number you are starting with. The previous group will have taken their images and followed with a final image of their data sheets
- Dust pan and shovel
- Non-latex gloves and work gloves
- Lock equipment bin

Personal Safety

- Sunscreen and bug spray. Do not apply to palms of hands, especially if handling wildlife. Use back of hand to smear onto exposed skin (This is very important, as the chemicals are extremely harmful to wildlife especially amphibians)
- Keep hydrated (carry water bottle)
- Monitor weather – do not stay out if there is any thunder or lightning, stop monitoring immediately

Monitoring Protocols – We ask that you follow the route outlined below to remain consistent with existing monitoring protocols.

- **IMPORTANT:** please put **date and names** of volunteers on **ALL** pages of the monitoring sheets (front and back) and number the sheets. ie: 1 of 3, 2 of 3, 3 of 3 – if the sheets get separated and do not have names and dates, it will be very difficult to match them and record the data
- **Start** monitoring at **Marker #1** - south-west location – this is located just north of Sandalwood Parkway on the west side of Heart Lake Road (Pole with "Right Hand Turn Lane" sign).
- Proceed north (facing traffic) to Marker #15 (located at Countryside Drive).
- Walking in pairs, use the yellow center line as your monitoring guide-line and sweep across the road, across the gravel shoulder and into the ditch. As mentioned, many animals may be hit on the road and be thrown or make their way off the road into the ditch. One scans road, other scans shoulder, switch places to avoid monotony
- Live Sightings: (PLEASE NOTE: Wear gloves - do not handle species is you have any lotions, perfumes, bug repellant, etc., on your hands)
- If alive, note location, gently pick up and move the species in direction they are heading – please ensure they are moved well off the road to edge of wetland
- Please record sightings that have either full or partial remains and take images of remains. Please make sure you take images of both sides of the remains, it may give clues as to identity – if you are unable to ID the specimen, a TRCA staff may be able to ID from image. If it is just a stain on the road with no tissue/bones/flesh, please do not make a recording as this will alleviate duplicate records.
- If you see a fresh stain (blood is evident) but no remains of the animal are present, mark this in the comments section, referencing the marker number and location on the road (if the next group comes along and makes the same observation, we can cross-reference when compiling the statistical data to ensure it only gets recorded once)
- **NOTE:** To extend battery life, turn camera off after taking your image: Take an image(s) of each sighting even if it is un-identifiable or looks to be only partial remains (these may be able to be identified by other members of TRCA) – make note of the image # (or numbers if more than one) in the appropriate column – to view the image number press and hold the display back button until image appears in viewfinder If unidentified remains are found, take 2-3 photos from different angles to allow for identification later. These photos can be emailed to each other to view on larger computer screen



- Remove or scrape the remains from the road and place in ditch well away from the site in order to avoid duplication. **PLEASE NOTE**: When photographing and scraping up animals, one person always looks out for traffic and informs partner of oncoming vehicles. **VERY IMPORTANT**
- Continue north to Marker #15, crossing over to the east side of the road and continue south to Marker #30.

- Make note of any wildlife sightings as you are able: ie: pair of Turkey Vultures circling for 30 minutes just north of Heart Lake CA, at wetland located on west side where mock culverts are positioned, frogs calling and if able, which species . Note down in comments in 'Check List' section
- Remember: All information is valuable and can contribute to the final report

Completion of Study:

- Obtain "permission to park" sign from vehicle and return to equipment bin
- Return all monitoring equipment to bin: safety hard hat, safety vest, safety glasses, shovel, dust pan
- Photograph data sheet and make note of number on your data sheet, return camera to box
- Place data sheet in main binder behind tab labeled "Completed Data Sheets"
- Lock equipment bin, you are in separate vehicles, ensure both start and safely depart.
- Take down construction signs.

APPENDIX C

Species ID Sheet - Frog & Toad

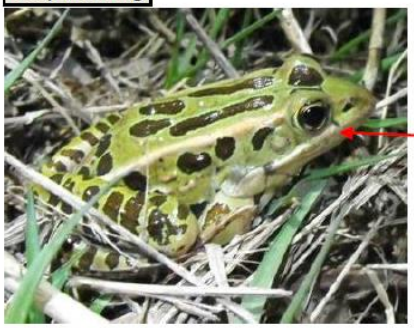
Grey Tree Frog

Spring Peeper

Key ID: "X" on back

Spring Peeper

Leopard Frog



Key ID:
Brown or black spots on back, side, legs
White line on upper lip

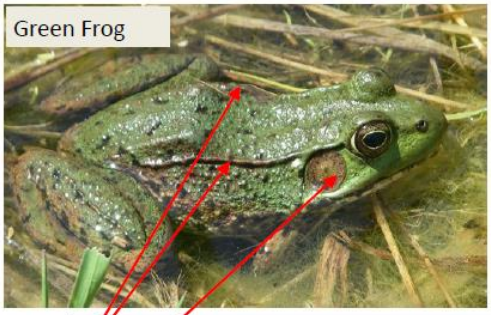
Leopard Frog

Leopard Frog

American Toad

Green Frog

Green Frog

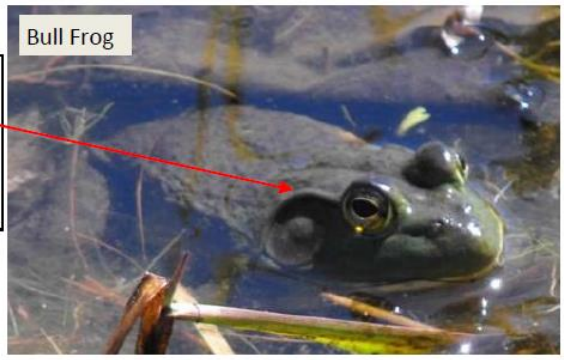


Wood Frog

Key ID:
Distinct black triangle-shape mask around eye

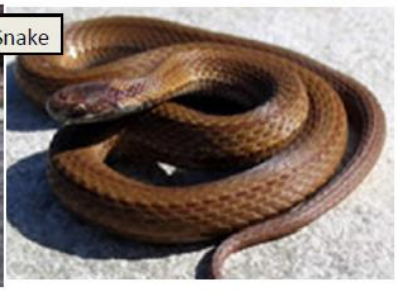
Key ID:
Ridge extend fm eye along back on both sides
bright green above upper lip
Larger tympanum (ear drum) than Leopard Frog

Bull Frog

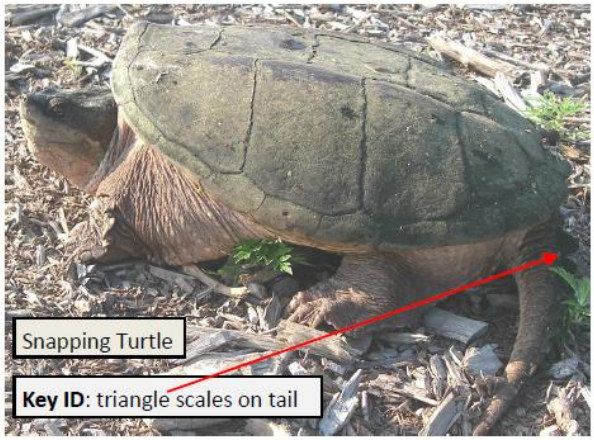


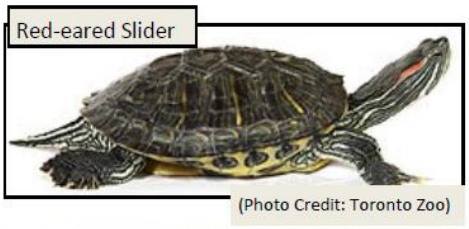
Key ID:
Ridge extends fm eye around large tympa-num (ear drum)

Species ID Sheet – Turtle, Snake & Newt



(Photo Credit: JD Wilson)





(Photo Credit: Toronto Zoo)

NOTE: Can be mistaken for Paint Turtle

Species Names and Codes

Common Name Frogs/Toads	CODE
American Toad	AMTO
Bullfrog	BUFR
Western Chorus Frog	CHFR
Green Frog	GRFR
Leopard Frog	LEFR
Wood Frog	WOFR
Pickerel Frog	PIFR
Spring Peeper	SPPE
Gray Treefrog	TGTF

Common Name Turtle	CODE
Red-Eared Slider*	SLID
Midland Painted Turtle	MPTU
Snapping Turtle	SNTU

Common Name Snake	CODE
Brown Snake (Dekay's)	BRSN
Eastern Garter Snake	EAGA
Eastern Milk Snake	EMSN
Eastern Ribbon Snake	ERSN
Northern Red-bellied Snake	NRBS
Northern Water Snake	NWSN
Smooth Green Snake	SGSN

Common Name Mammal	CODE
American Mink	AMMI
Beaver	BEAV
Coyote	COYO
Eastern Chipmunk	EACH
Eastern Cottontail	EACO
Deer Mouse	DEMO
Gray Squirrel	GRSQ
Meadow Vole	MEVO
Norway Rat	NORA
Muskrat	MUSK
Raccoon	RACC
Red Fox	REFO
Striped Skunk	STSK
Woodchuck (Groundhog)	WOOD
Virginia opossum	VIOP
White-tailed Deer	WTDE

Common Name Avian	CODE
Alder Flycatcher	ALFL
American Crow	AMCR
American Robin	AMRO
Bank Swallow	BANS
Baltimore Oriole	BAOR
Barn Swallow	BARS
Black-billed Cuckoo	BBCU
Black-capped Chickadee	BCCH
Belted Kingfisher	BEKI
Brown-headed Cowbird	BHCO
Blue Jay	BLJA
Blackpoll Warbler	BLPW
Canada Goose	CANG
Chipping Sparrow	CHSP
Common Grackle	COGR
Cooper's Hawk	COHA
Common Nighthawk	CONI
Common Yellowthroat	COYE
Downy Woodpecker	DOWO
Eastern Bluebird	EABL
Eastern Kingbird	EAKI
Eastern Phoebe	EAPH
Eastern Screech-owl	EASO
Eastern Wood-peewee	EAWP
European Starling	EUST
Great Blue Heron	GBHE
Great-crested Flycatcher	GCFL
Great horned Owl	GHOW
Green Heron	GRHE
Hairy Woodpecker	HAWO
House Sparrow	HOSP
House Wren	HOWR
Indigo Bunting	INBU
Killdeer	KILL
Mourning Dove	MODO
Mallard	MALL
Mute Swan	MUSW
Northern Cardinal	NOCA
Northern Flicker	NOFL
Pied-billed Grebe	PBGR
Pine Warbler	PIWA
Pileated Woodpecker	PIWO
Red-breasted Nuthatch	RBNU
Red-eyed Vireo	REVI
Red-tailed Hawk	RTHA
Red-winged Blackbird	RWBL
Rose-breasted Grosbeak	RBGR
Ring-billed Gull	RBGU

Common Name Avian	Code
Rock Dove	ROPI
Ruby-throated Hummingbird	RTHU
Savannah Sparrow	SAVS
Sharp-shinned Hawk	SSHA
Song Sparrow	SOSP
Swamp Sparrow	SWSP
Turkey Vulture	TUVU
Trumpeter Swan	TRUS
Tree Swallow	TRES
Warbling Vireo	WAVI
White-breasted Nuthatch	WBNU
Willow Flycatcher	WIFL
Winter Wren	WIWR
Wood Duck	WODU
Yellow-bellied Sapsucker	YBSA

APPENDIX D

Marsh Monitoring Report – Station A & B

Marsh Monitoring Program - Amphibian Data Form

Return by 31 July

Please write legibly (in pen).

VISIT INFORMATION

Route #: _____ Route Name: HEART LAKE Station (A - H): A-B

Observer #: 17789 Observer Name: DELL TUNG

Visit #: 2 Day: 30 Month: APRIL Year: 2013

Cloud Cover (10th): 3 Temperature (°C or °F): 14 Beaufort Wind Scale (0-6): 1

Precipitation (check one): (X) None/Dry ( ) Damp/Haze/Fog ( ) Drizzle ( ) Rain

CALL LEVEL CODES

Code 1: Calls not simultaneous, number of individuals can be accurately counted

Code 2: Some calls simultaneous, number of individuals can be reliably estimated

Code 3: Full chorus, calls continuous and overlapping, number of individuals cannot be reliably estimated

AmphibFrm2008.cdr, rev 02 2008

Species	In*	Out**
AMTO		
BCFR		
BULL		
CHFR		
CGTR		
FOTO		
GRTR	1	
GRFR		
MIFR		
NLFR		
PIFR		
SPPE	1	
WOFR		

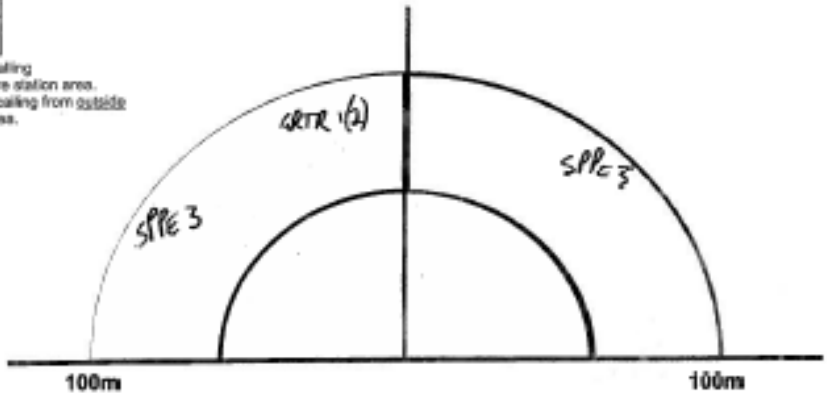
* Check if species is calling from inside 100-metre station area.
** Check if species is calling from outside 100-metre station area.

Station A

233

Station Start Time (24 hr): 20:52

Background Noise Code (1-4): 4



Marsh Monitoring Program - Amphibian Data Form

Return by 31 July

Please write legibly (in pen).

VISIT INFORMATION

Route #: _____ Route Name: HEART LAKE Station (A - H): A-B

Observer #: 17789 Observer Name: Sue Hayes

Visit #: 3 Day: 26 Month: June Year: 2013

Cloud Cover (10th): 2 Temperature (°C or °F): 24 Beaufort Wind Scale (0-6): 0

Precipitation (check one): ◯ None/Dry (X) Damp/Haze/Fog ◯ Drizzle ◯ Rain

CALL LEVEL CODES

Code 1: Calls not simultaneous, number of individuals can be accurately counted

Code 2: Some calls simultaneous, number of individuals can be reliably estimated

Code 3: Full chorus, calls continuous and overlapping, number of individuals cannot be reliably estimated

Amphibian2008.xls rev 02 2008

Species	In*	Out**
ADTO		
BCFR		
BULL		
CHFR		
CGTR		
FOTO		
GRTR	✓	
GRFR	✓	
MIFR		
NLFR		
PIFR		
SPPE		
WOFR		

* Check if species is calling from inside 100-metre station area.

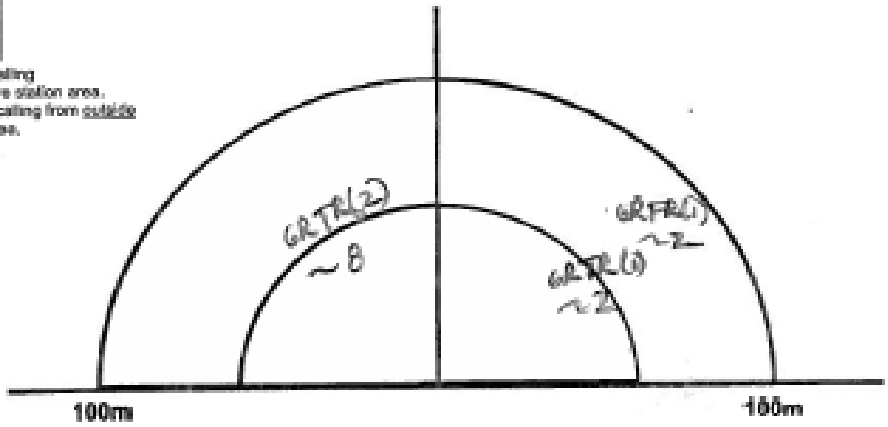
** Check if species is calling from outside 100-metre station area.

Station A

Station Start Time (24 hr): 22:02

Background Noise Code (1-4): 2

233

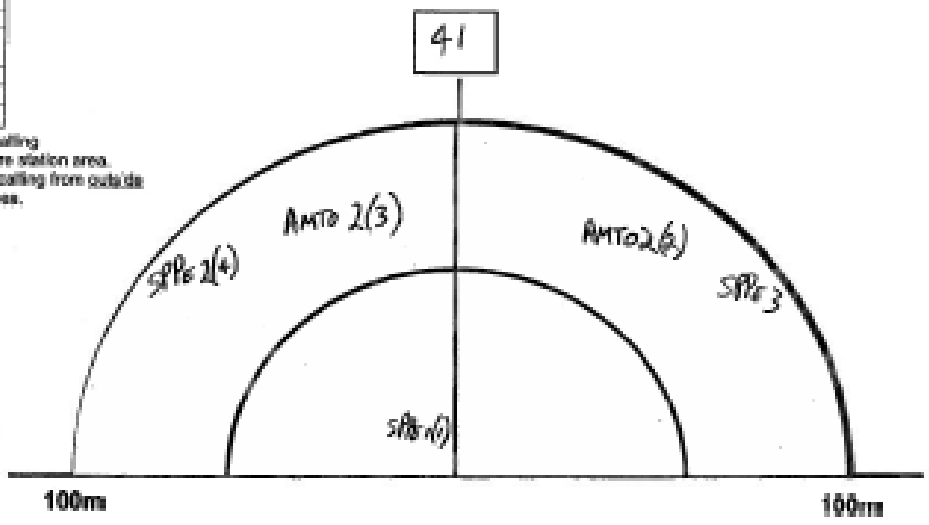


Species	In*	Out**
AMTO	1	
BCFR		
BULL		
CHFR		
CGTR		
FOTO		
GRTR		
GRFR		
MIFR		
NLFR		
PIFR		
SPPE	1	
WOFR		

* Check if species is calling from inside 100-metre station area.
** Check if species is calling from outside 100-metre station area.

Station B

Station Start Time (24 hr):	20:58
Background Noise Code (1-4):	3

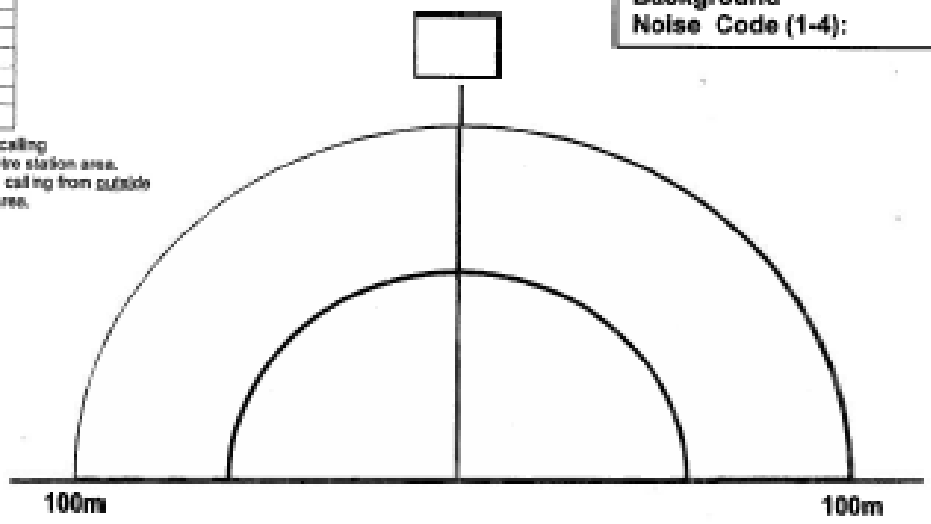


Species	In*	Out**
AMTO		
BCFR		
BULL		
CHFR		
CGTR		
FOTO		
GRTR		
GRFR		
MIFR		
NLFR		
PIFR		
SPPE		
WOFR		

* Check if species is calling from inside 100-metre station area.
** Check if species is calling from outside 100-metre station area.

Station C

Station Start Time (24 hr):	
Background Noise Code (1-4):	



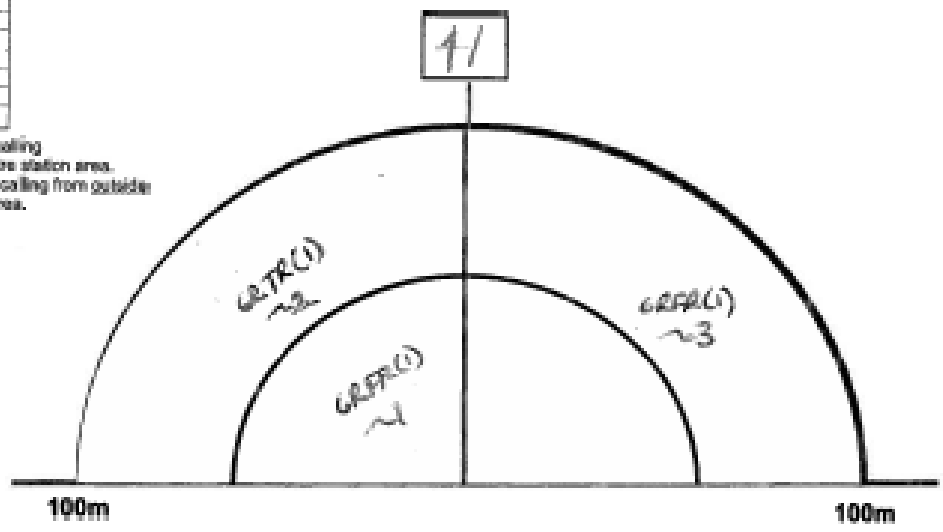
Species	In*	Out**
AMTO		
BCFR		
BULL		
CHFR		
CGTR		
FDTO		
GRTR	✓	
GRFR	✓	
MIFR		
NLFR		
PIFR		
SPPE		
WOFR		

* Check if species is calling from inside 100-metre station area.
** Check if species is calling from outside 100-metre station area.

Station B

Station Start Time (24 hr): 22:07

Background Noise Code (1-4): 2



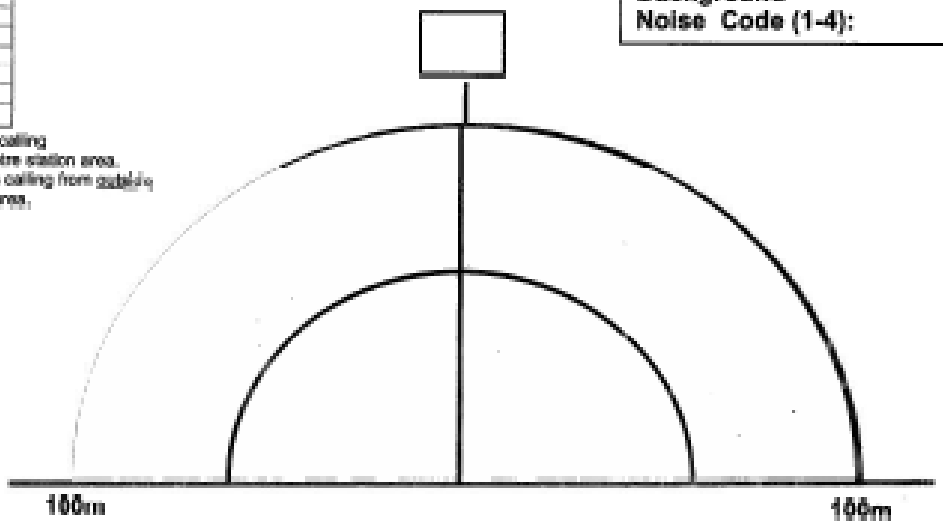
Species	In*	Out**
AMTO		
BCFR		
BULL		
CHFR		
CGTR		
FDTO		
GRTR		
GRFR		
MIFR		
NLFR		
PIFR		
SPPE		
WOFR		

* Check if species is calling from inside 100-metre station area.
** Check if species is calling from outside 100-metre station area.

Station C

Station Start Time (24 hr):

Background Noise Code (1-4):



Marsh Monitoring Program - Amphibian Data Form

Return by 31 July

Please write legibly (in pen).

MARSH MONITORING PROGRAM

VISIT INFORMATION

Route #: _____ Route Name: HEART LAKE Station (A - H): A-B

Observer #: _____ Observer Name: DELL TUNÉ

Visit #: 1 Day: 15 Month: 04 Year: 2013

Cloud Cover (10th): 6 Temperature (°C or °F): 10 Beaufort Wind Scale (0-6): 0

Precipitation (check one): (X) None/Dry ( ) Damp/Haze/Fog ( ) Drizzle ( ) Rain

CALL LEVEL CODES

Code 1: Calls not simultaneous, number of individuals can be accurately counted

Code 2: Some calls simultaneous, number of individuals can be reliably estimated

Code 3: Full chorus, calls continuous and overlapping, number of individuals cannot be reliably estimated

Amphdfrm2008.cdr. rev 02/2008

Species	In*	Out**
AMTO		
BCFR		
BULL		
CHFR		
CGTR		
FOTO		
GRTR		
GRFR		
MIFR		
NLFR		
PIFR		
SPPE	/	
WOFR	1	

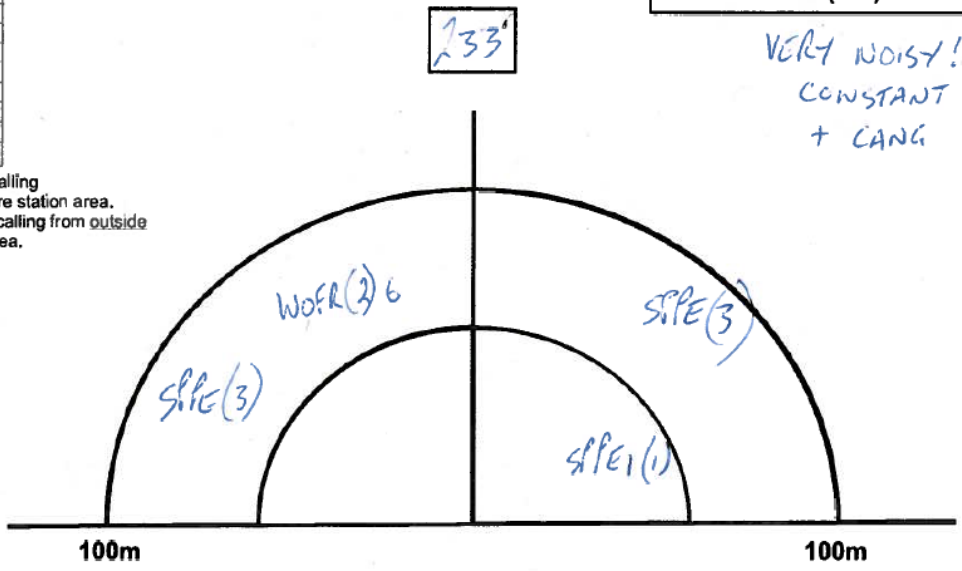
* Check if species is calling from inside 100-metre station area.
** Check if species is calling from outside 100-metre station area.

Station A

Station Start Time (24 hr): 20:32

Background Noise Code (1-4): 4

VERY NOISY! CONSTANT TRAFFIC + GANG

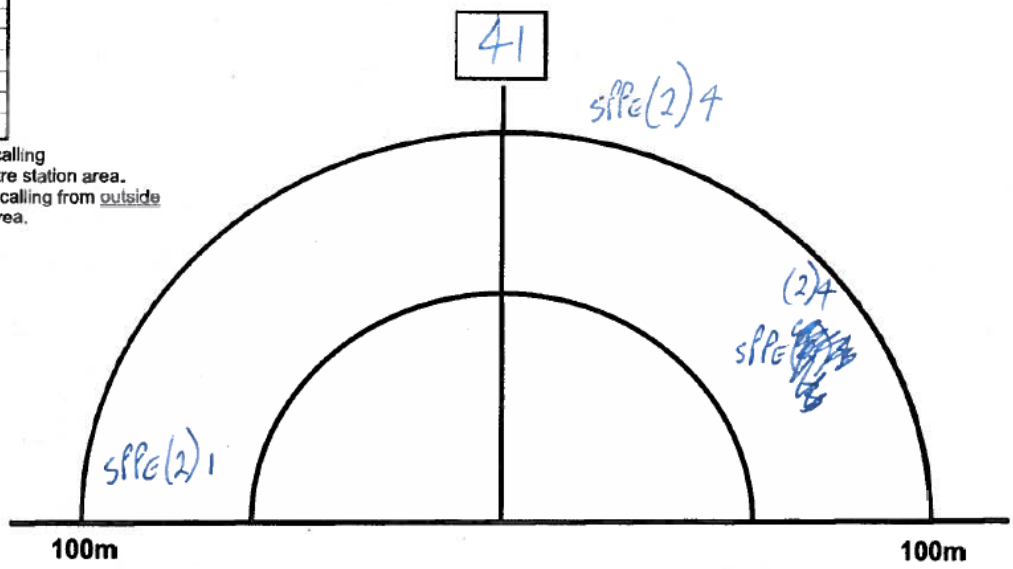


Species	In*	Out**
AMTO		
BCFR		
BULL		
CHFR		
CGTR		
FOTO		
GRTR		
GRFR		
MIFR		
NLFR		
PIFR		
SPPE	1	
WOFR		

* Check if species is calling from inside 100-metre station area.
** Check if species is calling from outside 100-metre station area.

Station B

Station Start Time (24 hr):	20:39
Background Noise Code (1-4):	4

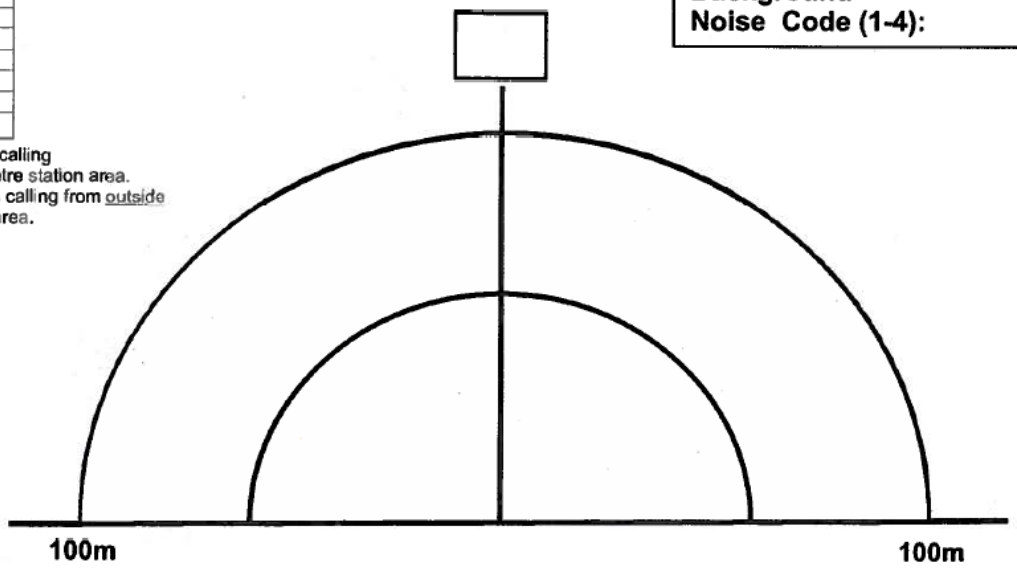


Species	In*	Out**
AMTO		
BCFR		
BULL		
CHFR		
CGTR		
FOTO		
GRTR		
GRFR		
MIFR		
NLFR		
PIFR		
SPPE		
WOFR		

* Check if species is calling from inside 100-metre station area.
** Check if species is calling from outside 100-metre station area.

Station C

Station Start Time (24 hr):	
Background Noise Code (1-4):	



APPENDIX E

Research Summary

Evaluating the effectiveness of road mitigation measures.
Van der Grift EA, Van der Ree R, Fahrig L, Findlay S, Houlahan J, Jaeger JAG, Klar N, Madrinan LF, Olsen L. July 2012. Available online at: Springer http://link.springer.com/article/10.1007/s10531-012-0421-0 **Biology Conservation. Volume 22, Issue 2, 2013, pp 425-448.**

Summary: the overall points of this paper highlight why/how to initiate a monitoring study, how it affects humans/wildlife and steps to consider in setting up the study. There are excellent tables outlining questions and possible outcomes and insight to endpoints. Ie: wildlife populations over time after mitigation.

Highlights: In the past two decades, there has been an increase in efforts to study and understand measures and methods of vehicle/wildlife fatalities. Although crossing structures have been implemented in areas of North America, more research is required to evaluate their effectiveness. It is essential to have collaboration between policy makers, road agencies, engineers and scientists in order to effectively use financial resources for road expansion and protection of wildlife and habitat.

Historically indicators to warn motorists of wildlife include; warning signs, reduced speed postings, animal detection systems, fencing and modifications to roads and overpasses. Globally, more research and funds are being allocated to road and wildlife interaction. Between 1992 and 2008 the US spent more than 90 million dollars on mitigation measures.

Although studies have shown success that wildlife will use crossing structures, more study is needed to determine if populations have in increased or if there are gene flow alterations in species populations.

It is important to set up guidelines of mitigation including a monitoring plan to determine if a wildlife crossing will be effective. Criteria such as;

1. Target species and mitigation method
2. Variables to measure ie: study design, sampling scheme
3. Study site and survey methods
4. Costs of evaluation and feasibility of monitoring

Some factors related to a study include;

- human safety; example: moose/vehicle collision
- animal welfare; loss of animal changes local populations but not regional populations and
- wildlife conservation; loss of species leads to its status of protection (endangered, threatened, etc)

Effects of roads and traffic on wildlife populations and landscape function; Road ecology is moving toward larger scales.
Van der Ree R, Jaeger JAG, Van der Grift EA, Clevenger AP. Ecology and Science 2011 Vol 16, Art 48.

Summary: Special issue of Ecology and Society focusing on 17 papers related to road ecology. This overview of all submissions and the reasons for this special edition, points out the lack of research on ecosystem level effects. No papers were submitted on this topic despite it being a criterion. All submissions; Canada, Australia, Netherlands and US, primarily focused on populations and community effects. This paper highlights the need to establish communication between scientific research, regions and road agencies.

Highlights: Humans are the primary reason of biodiversity decrease through habitat loss, fragmentation, climate change and pollution. Globally, an approximate 750 million vehicles are on apx. 50 km of roads and the numbers increase annually. One of the first documentations of road ecology was in 1925 by Dayton Stoner who recorded 225 vertebrate fatalities (29 species) over 632 miles in Iowa.

Term "Road Ecology" originally a German term "Straßenökologie" in 1981, was translated to English by Richard Forman (*et al*) author of the book "Road Ecology; Science and Solutions". The 1990's showed increased interest via research, leading to present where there are now dedicated organizations and conferences on this topic.

The goal of road ecology is to determine what effects roads have ecologically and help to lessen negative impacts such as habitat fragmentation, wildlife mortality, changes related to light, moisture and wind on habitat, various pollutants (noise, chemical, light), changes due to invasive vegetation and feral animals.

It is important that we not only count and realize wildlife fatalities related to roads but how they affect the area beyond. How they affect populations, genetics and extended areas these species use for hibernation, feeding and breeding.

It is therefore important to open lines of communication between researchers, road managers, developers and the general public to gain a better understanding of the importance of planning roads effectively. Most regions have the phrase "environmentally sustainable" in their mission statement. Valid and viable research is needed to help obtain this goal as it relates to development or alteration of roads and their effects to wildlife and surrounding habitat.

As populations rise and vehicles increase, more roads are required to handle the volume. Secondary routes are being used more frequently to handle overflow on main throughways in urban settings.

Quantify the road effect zone; Threshold effects of a motorway on Anuran populations in Ontario Canada. Eigenbrod F, Hecnar SJ, Fahrig L. 2009. Ecology and Society, Volume 14, Article 24.

Summary: Study of road effects on 7 species; wood frog, spring peeper, western chorus frog, northern leopard frog, American toad, grey tree frog and green frog. Study took place along Hwy 401, eastern Ontario.

Highlights: Purpose was to quantify how far from the road do vehicles effect the richness and population numbers of these species.

Based on a previous study, ponds located 500 m from the road side were identified as showing the highest effects.

- 34 ponds, 17 from 68 m to 500 m and 17 from 500 m to 3,262 m, from the edge of the road,
- covering 48 km along Hwy 401 in Eastern Ontario
- All ponds were sampled in 2006 and 22 (subset) sampled in 2007
- Traffic volume (average) = 18,300 vehicles/day (Sept 2006)
- 8 auditory night surveys (Apr 1 to Jul 12), 4 routes, random order – 4 visual day surveys Apr 2 – Jul 12
- 9 of 14 frog species noted: wood, western chorus, spring peeper, northern leopard, grey tree, green, mink and bull
- Variables measured: pH, conductivity, pond area, % emergent & floating vegetation (2 m from pond), overhang, forest vegetation (w/in 100 m pond edge), degree of sun exposure,
- Generalized linear regression and general piecewise linear regression model for species and richness.

Results:

- Significant difference in slope parameter
- Piecewise regression models gave at least as good a fit to data as linear models for richness
- Richness breakpoint; 450 m to 800 m from road
  - 200 m to 300 m for spring peeper, American toad, grey tree frog
  - 600 m to 1,000 m for wood frog
  - 1,100 m to 2,400 for chorus frog
- Statistically significant relationship for richness of wood frog and spring peeper with distance to highway to threshold
- Leopard frog and green frog abundance higher when further away from highway

Results: road effect zones exist for species richness extending from 250 m to 1,000 m from highway. All species negatively affected by road. Wetlands within 250 m, show low populations due to negative effects.

Behavioural responses of Northern leopard frogs (*Rana pipiens)* to roads and traffic: implications for population persistence.
Bouchard J, Ford AT, Eigenbrod FE, Fahrig L, 2009. Ecology and Society, Volume 14, Issue 2, Article 23.

Summary: General objective of road ecology is to study negative effects of roads to wildlife. This study focuses on Northern Leopard Frog which, by previous studies, shows their population persistence are affected by roads.

Highlights: How species react to roads and related obstacles ie: barriers, habitat loss and inability to access habitat, can be a factor in understanding if populations of species can remain stable. This is difficult to determine and would require research on avoidance behaviour of a number of species.

Purpose: do migrating leopard frogs respond to roads, (ie: avoid them) - do they avoid them in heavier traffic - what is the probability of them getting killed and does it depend on traffic volume.

- Study area: Ottawa and Kemptville ON
- Spring migration from Rideau River to breeding ponds
- Sites were; 10 x 20 m habitat bands set up as a Cartesian plane – (2) adjacent to low traffic, (2) adjacent to high traffic and (2) >100 m distance
- Frogs captures as they approached road, placed in bucket, bucket then inverted at origin, left to rest for 2 minutes, bucket removed
- All frogs moved in the direction they were facing, observer (5 m away from origin) visually followed movement with red filter flashlight – each hop landing coordinates recorded
- Frogs stopped moving with un-filtered light (red light did not alter movement)
- Recorded fate of each frog after 10 m habitat band and arrival at road
- Dates: April 13th to 21st 2004 – 2 to 4 sites visited each night\
- Sites visited 3 to 4 times at same time of frog observations to count traffic in both directions over 30 minute period
- To determine if frogs slowed and if it was traffic related, time to cross 10 m bands analyzed with ANOVA – variables: high traffic, low traffic & no road and temperature (frog activity changes with temperature)

Results:

- 193 frogs captured and released – (60) control sites, (66) low traffic sites, (67) high traffic sites
- Significant interaction between distance to road, traffic level and frog direction of movement – tended to deviate from straight course to road and distance to road decreased
- Results support assumption they do not avoid roads which results in fatalities
- Movements were slower near roads than non-road areas and slower near high traffic roads
- Changed from straight line path at 3.3 m from road
- All frogs released near road attempted to cross

- 28% in high traffic were killed – this is high in relation to 1 car passing per minute
- Behaviour near roads changes, tend to be immobile, slows movement (Mazerolle et al 2005)
- Pauses between hops longer on roads (personal observation Bouchard)
- Did human presence influence movement? Frogs did not attempt to flee when observers in area with flashlights, did not alter direction when released – indicates urge to cross road stronger than flee response
- Road mortality affects breeding population, reduces genetic exchanges (Jaeger et al 2005)

Conservation of frogs; deterrent methods be put in place to reduce mortality.

Hit and Run: Effects of Scavenging on Estimates of Road killed Vertebrates.
Antworth RL, Pike DA, Stevens EE, 2005. Southeastern Naturalist Dec 2005. Vol 4, Issue 4, pp 647-656.
Published By: Humboldt Field Research Institute.

Summary:
Along a coastal road in Central Florida, researchers used both bird and snake carcasses to investigate the rates at which they scavenged from the road.

Highlights:
Researchers discovered that 60-97% of the carcasses disappeared within 36 hours of being placed on the road. Regardless of the carcass size, there was a higher rate of removal for snakes than birds. Researchers also noticed that there was a quicker removal rate for birds carcasses placed in the centre of the road than at the sides of the road.

Purpose:
Road ecology studies on vertebrates involves collecting information on populations, life cycles and habitats; and also needs to include examining scavenging, as studies may not accurately reflect what is happening on the road.

Avian Study:
Trail Time: Mid-March, Mid-May and Mid-June 2004
Trail Length: 36 hour period on the weekend
Study Site: 19.6 km two-lane coastal high way, with a variety of vegetation along the edges
Speed Limit: 56-80 km/h
Bird Carcass: Commercially purchased domestic chicken chicks, weighing approximately 30 grams
Placement: Chick carcasses were randomly placed both in the centre and at the edge of the road
0.4km apart

Study:
- On the first day chick carcasses were placed at 9:00am
- Flags were placed 10m off the road to mark the placement of the chick carcasses
- On the first day chick carcasses were checked every 2 hours until sunset
- During the 2 hour checks, vehicles and vultures were also counted and recorded; and road sides were checked for missing chick carcasses
- On the first day before sunset, the remaining chick carcasses were placed on a 0.5m2 board covered with moist sand to identify animal tracks during the night
- On the second day, the boards were examined for chick carcasses and animal tracks
- On the second day, chick carcasses were placed again at 9:00am, and checked every 2 hours until sunset
- Study ended at sunset on second day, and all remaining chick carcasses were collected and disposed of

Snake Study:
Trail Time: August 2004
Trial Length: 36 hour period
Study Site: 14.4 km two-lane coastal high way, with a variety of vegetation along the edges; different stretch of road was used than in the avian study
Speed Limit: 56-80 km/h
Snake Species: Yellow-bellied racer snake, Eastern indigo snake, Western coachwhip snake, Banded water snake, Rough green snake, Eastern ribbon snake, and Common garter snake were the snake species used in the study.
Snake Carcass: Collected 36 snakes of 7 species from March – July 2004 on Cape Canaveral Air Force Station, Canaveral national Seashore and Merritt Island National Wildlife Refuge, Florida.
All snake carcasses were kept frozen and thawed before using in the study. All snake carcasses were identified, measured and condition recorded.
Placement: Snake carcasses were placed 0.4km apart on either side of the road.

Study:

- On the first day snake carcasses were placed at 9:00am
- Flags were placed 10m off the road to mark the placement of the snake carcasses
- On the first day snake carcasses were checked every 2 hours until sunset
- During the 2 hour checks, vehicles and vultures were also counted and recorded, and road sides were checked for missing snake carcasses
- Study ended after 36 hours, and all remaining snake carcasses were collected and disposed of

Results for Avian and Snake Studies:
The snake carcasses were taken from the road at a faster rate than the chick carcasses. Snake carcasses remained on the road within a 2-26 hours range. Chick carcasses remained on the road within a 2-32 hours range. 97.2% of the snake carcasses were scavenged from during the 36 hours study. 90% of the chick carcasses were scavenged from the centre of the road, 67% were scavenged from the east side of the road, and 61% were scavenged from the west side of the road. The snakes may have been easier to recognize by their shape, and due to previous road-kill wounds may have been easier to sense by aerial scavengers, like vultures. Vultures, raccoons, skunks and fire ants were the scavengers of all the carcasses identified both on the track boards and sighted in the area. Road ecology studies need to include scavenging when examining populations of wildlife residing near roads.

Questions arise with the use of commercially purchased chicks versus the wild snakes collected for the scavenging research, as it does not appear to be consistent, as scavengers no doubt have a dietary preference based on what is usually available in the area. And why did the researchers not feel the need to use the board at night during the snake study?

How quickly are road-killed snakes scavenged? Implications for Underestimates of Road Mortality. Degregorio BA, Hancock TE, Kurz DJ, Yue S, 2011. Journal of the North Carolina Academy of Science, 127(2), 2011, pp 184-188.

Summary:
Along a coastal road on Bald Head Island, North Carolina, researchers used snake carcasses to investigate the rates at which they scavenged from the road.

Highlights:
Researchers discovered that habitat type did have an impact on the length of time that a snake carcass was removed.

Purpose:

Examining the timing, speed, and intensity of carcass removal is essential for studies attempting to understand road mortality rates as these factors can conceivably misrepresent the results.

Trail Time: July 20 – August 1, 2010
Trial Length: Ten trials happened over a separate 24 hour period
Study Site: 35 km of paved road on Bald Head Island, North Carolina. Road is two lanes often divided by a median of dune or maritime forest vegetation. Traffic on the road is restricted to electric golf carts, and the occasional gas-powered emergency and contractor vehicles.
Speed Limit: Does not exceed 29 km/h
Snake Species: Rough green snake and Black racer snake were the species used in early afternoon; Yellow rat snake and Scarlet snake were the species used at sundown.
Snake Carcass: Collected road-killed snake species during May 1 – June 29, 2010. All snake species were kept frozen and thawed before using in the study. Snake carcasses with open wounds were not used in the study. All snake carcasses were identified and measured; and carcasses of similar sizes were placed together on the road.
Placement: Two snake species were randomly placed at the side of the road along a 2km stretch of the forest section of the road, and along a 2km stretch of the dune section of the road.

Study:

- Snake carcasses were checked every hour for the first three hours after placed on the side of the road
- Then snake carcasses were checked every four hours afterwards for a 24 hour period.
- After the 24 hour period, all remaining snake carcasses were removed

Results:
In this study the snake carcasses placed in the forest section of the road were scavenged more quickly and frequently than those carcasses placed in the dune section of the road. Red fox and sow bugs were the scavengers of the carcasses identified by the researchers. Half of the snake carcasses were removed within the first 8 hours of being placed on the road, and all were removed at night. Removal of carcasses can be influenced by time of day, weather, temperature, species and condition of carcass, traffic density, topography season, and species of predators (Bumann and Stauffer 2002; Slater 2002). A scavenging analysis piece must be part of any road ecology and road mortality study to truly reflect the carcass removal in the area.

Effects of Road Networks on Bird Populations. Kociolek AV, Clevenger AP, St. Clair CC, Proppe DS, 2010. Conservation Biology, Vol 25, No. 2, 2011, pp 241-249.

Summary: In North America the abundances of at least 20 species previously categorized as common have declined more than 50% in the last 40 years. One likely contributor is the expansion of paved roads, mostly in terms of widening, and corresponding increases in the speed and volume of vehicles on those roads. Many of the negative effects of roads on other vertebrates (e.g., mortality, habitat fragmentation, and audiovisual disturbance, chemical pollution) also apply to birds.

Highlights: It is difficult to measure the true extent of vehicle induced mortality because estimates are typically far lower than the actual number of birds killed; estimation accuracy is reduced by variation in researcher efficiency, scavenger bias, and incorrect attribution of cause of death.

Purpose: Examining the direct and indirect threats posed to birds by roads and traffic.

Results:

- Birds are more likely to collide with vehicles if they forage, roost, or nest near roads
- Collisions with birds are more likely to occur at lower elevations and in open areas than in forests

- For many bird species, vehicle induced mortality increases during breeding and migration, but for other species it increases during winter
- Collisions can increase or decrease as roadside lighting increases
- Roadside trees, hedgerows, and other features that cause birds to fly higher across roads, typically decrease collision frequency, but they can also increase it
- Birds also vary in their responses to roads; some individuals appear to learn to avoid vehicles, whereas others do not
- Road salt is a common deicing agent that attracts birds; its ingestion can lead to death among birds
- Despite the ubiquity of road contaminants from vehicles and maintenance activities, toxic effects of roads appear to be rare, even in areas with high traffic volumes, and pollution appears to have fewer effects on birds than other road-related effects
- For birds, road avoidance appears to be associated with the physical barrier to movement roads present, noise, artificial light, and edge effects
- Noise likely causes reductions in population densities that have been reported for several bird species that are present near roads
- In grasslands the effects of noise appear to extend farther from roads than in forests, perhaps because grasslands have less vegetation to absorb sound
- Chronic industrial noise can reduce species richness, alter population age structure, and change avian predator–prey dynamics
- Several urban-dwelling songbird species appear to counteract the masking effects of traffic noise by singing at a higher pitch, increasing song amplitude, or singing during periods of low traffic noise
- Some lighting structures attract migrating bird species, which increases the probability they will be preyed on or collide with structures and often causes them to redirect flight paths and thus deplete energy stores
- Artificial lighting can also affect avian patterns of nestling development, singing, breeding, molting, and migration
- Changing roadway lighting may also benefit both birds and people through reductions in energy consumption and increases in safety
- The edge effects of roads may be particularly acute when introduced species, such as rats, prey on ground nesting birds or parasitic species, such as Brown-headed Cowbirds, target the nests of species of conservation concern
- The unvegetated area created by light-rail train tracks is more permeable to bird movement than roads of equivalent sizes, perhaps because they are quieter

Diet composition of common ravens across the urban-wildland interface of the West Mojave Desert
Kristan III WB, Boarman WI, Crayon JJ, 2004. Wildlife Society Bulletin 2004, 32(1), pp 244-253.

Summary: The importance of human-provided resources to raven population growth is supported by the observation that proximity to human developments, such as housing, landfills, sewage treatment ponds, and roads, augments raven reproductive success.

Highlights: Ravens are generalists in foraging ecology and diet and are capable of exploiting a variety of anthropogenic resources.

Purpose: Evaluate the effects of human developments on the relative composition of food items that can be detected in raven pellets

Results:

- The rapid increase in raven populations has become a management concern because large raven populations may harm species such as the threatened desert tortoise

- The primary study area was within the western half of Edwards Air Force Base (EAFB) and on lands immediately surrounding the base in the West Mojave Desert of California
- During springs 1999 and 2000 collected pellets from beneath known raven nests
- Nest locations were known from concomitant studies of raven breeding biology
- Nest searching was conducted each year from 1996 to 2000;by 1999 observed 261 nests (of which 150 exhibited some degree of breeding activity), and by 2000 observed 341 nests (of which 168 exhibited some degree of breeding activity)
- Nests were distributed throughout the study area
- Collected pellets opportunistically during reproductive monitoring, and made collections from 42 nests in 1999 and from 72 nests in 2000; because collections were made from some of the same nests in both years, made collections from 98 different nests over the 2 years, distributed throughout the study area
- The number of pellets from a nest ranged from 1–44, and analyzed 1,142 items from 560 pellets
- Identified plant and animal remains to species when possible
- Interpreted the presence of pieces of paper or plastic or other artificial, nonfood items in a pellet as consumption of trash
- Measured distance between each nest and the nearest paved road and nearest point subsidy using Geographic Information System (GIS) maps
- "Point subsidies" consisted of any potential source of food found on the study area that could be represented by a point or polygon on a map and included housing developments, landfills, and artificial water bodies (e.g., sewage ponds, artificial wetlands, permanent artificial ponds)
- Found mammals in 76.5% of pellets, arthropods at 81.6% of nests and in 37.4% of pellets. Trash was present at 57.1% of nests and in 24.2% of pellets
- Nests from which pellet collections were obtained were found up to 8 km from the nearest road and up to12 km from the nearest point subsidy
- Nests close to both subsidies and roads had more birds and amphibians
- Nests close to roads and far from subsidies had greater numbers of mammals and reptiles
- Pellets from nests far from both roads and subsidies had greater amounts of plant material and more arthropods
- Pairs with more anthropogenically enhanced diets fledged more chicks
- Known biases in pellet-based diet studies, since pellets contain indigestible components of food such as bone, feather, and fur, the highly digestible foods such as muscle tissue are underestimated by pellet analysis
- Reducing the availability of food subsidies to ravens may reduce predation pressure on the threatened desert tortoise population, thereby aiding in its recovery

Results: suggest that ravens forage opportunistically on foods available near their nests, and different kinds of human developments contribute different foods. Improved management of landfills and highway fencing to reduce road-kills may help slow the growth of raven populations in the Mojave.

How long do the dead survive on the road? Carcass Persistence Probability and Implications for Road-Kill Monitoring Surveys. Santos SM, Carvalho F, Mira A, 2011. PLoS One, Online Publication. Sep 2011, Vol. 6, Issue 9, e25383.

Summary: Daily surveys of road-killed vertebrates were conducted over one year along four road sections with different traffic volumes. Survival analysis was then used to i) describe carcass persistence timings for overall and for specific animal groups; ii) assess optimal sampling designs according to research objectives; and iii) model the influence of road, animal and weather factors on carcass persistence probabilities. Most animal carcasses persisted on the road for the first day only, with some groups disappearing at very high rates. The advisable periodicity of road monitoring that minimizes bias in road mortality estimates is daily monitoring for bats (in the

morning) and lizards (in the afternoon), daily monitoring for toads, small birds, small mammals, snakes, salamanders, and lagomorphs; 1 day-interval (alternate days) for large birds, birds of prey, hedgehogs, and freshwater turtles; and 2 day-interval for carnivores. Multiple factors influenced the persistence probabilities of vertebrate carcasses on the road. Overall, the persistence was much lower for small animals, on roads with lower traffic volumes, for carcasses located on road lanes, and during humid conditions and high temperatures during the wet season and dry seasons, respectively.

Highlights: The guidance given here on monitoring frequencies is particularly relevant to provide conservation and transportation agencies with accurate numbers of road-kills, realistic mitigation measures, and detailed designs for road monitoring programs.

Purpose: The study aims to describe and model carcass persistence variability on the road for different taxonomic groups under different environmental conditions throughout the year; and also to assess the effect of sampling frequency on the relative variation in road-kill estimates registered within a survey.

Results:

- Roads can exert severe impacts upon the long-term viability of animal populations, either through direct killings that decrease the number of individuals (road mortality), or through habitat loss and fragmentation, and barrier effects increasing isolation of populations
- Road mortality is one of the best known and visible impacts of roads on animal populations, with millions of individuals from a wide range of taxonomic groups being killed every year
- The need for effective mitigation measures to minimize impacts of existing and future roads on wildlife populations has thus lead to an increasing body of research relating the spatial patterns of road-kills with both ecological and road features
- Several factors have been referred to affect the accuracy of road mortality estimates, including the rate at which the carcasses decompose, the time interval between the occurrence of mortality and road monitoring, the number of vehicles that pass over the carcass, the visibility of carcasses, the abundance and diversity of scavengers, the weather, and the accuracy and precision of the search method
- Most animal carcasses on roads are quickly dismembered by passing vehicles, eaten or removed by scavengers and predators, or reduced to skeletons by ants and other decomposers
- In the present study, most carcasses remained on the road for the first day only, with some groups disappearing at high rates over this first day
- Animals that are covered by fur, spines or scales are more resistant to vehicles passing over them than amphibians, though some species of amphibian (e.g. Salamandra, salamandra) may remain longer on the road due to their tough skin and unpalatability
- A few situations during field work suggest that, occasionally, persons remove carcasses from the road: intact lagomorphs and partridges recently road-killed (for eating), and carnivores and birds of prey (for taxidermy and scientific studies)
- Suggest monitoring with 2-day intervals for carnivores; alternate days for large birds, birds of prey, hedgehogs, and freshwater turtles; and daily for all other groups
- There are several species that include carrion in their diet. The most common are corvids, birds of prey, and mammalian carnivores; but communities of invertebrate decomposers also are very relevant, due to their abundance and diversity; and hedgehogs and rats also are occasional consumers
- Carcass persistence is lower in summer months than in spring or autumn, due to increased temperatures and the diversity of insect communities, or scavenger activity
- Elevated temperatures during summer increase the formation of volatile and smelly chemicals that can attract scavengers and predators to the carcasses
- Predator and scavenging activity by vertebrates can increase during the dry season due to the greater energy needs of seasonal offspring and the later abundance of juveniles

- Other explanatory variables were: classes of traffic volume for each road section, mean body mass and length of each species, and average meteorological conditions during the period of carcass persistence (proportion of days with rainfall, amount of rainfall, mean daily temperature, minimum daily temperature and maximum daily temperature)
- The carcass removal by scavengers and predators should be studied further in different regions and landscape contexts because, besides differences in population abundances, scavengers and predators with different sizes, periods of activity or food preferences must affect differently the probabilities of carcass persistence

Road Ecology. Jaeger, J.A.G., 2012. Invited contribution to the Encyclopedia of Sustainability. Vol. 5; Ecosystem Management and Sustainability. Berkshire Publishing Group, Great Barrington MA, pp. 344-350.

Summary: Dr. Jaeger was invited to contribute a section on road ecology in a book publication of Ecosystem Management and Sustainability. It is an overview on roads and traffic effects on; biodiversity, wildlife fatalities, habitat isolation, wildlife genetics and ability to recolonize areas. It provides information for planners to consider impacts and long term effects on future development and improvements to existing roads.

Highlights: Along with being a threat to wildlife in respect to fatalities, roads also fragment and overtake habitat and create edge effects. This edge zone is explained as how far into the landscape do roads effect wildlife. It has been estimated that wildlife is affected from road edge, up to:

- 40 – 2,800 meters for birds
- 250 – 1,000 (+) for amphibians
- 17 km for mammals (Forman et al. 2003; Benitez-Lopez, Alkemade, Verweij, 2010)

Other research has indicated annual global wildlife fatalities number from 100 thousand to several 100 million in various countries. In Europe fatalities reached 500,000 of hoofed animals and more than 8 million birds in Sweden (Seiler, 2003). A theory of the high rate of avian fatalities is they are not able to reach clearance height from trees bordering roadways and are subsequently hit by passing vehicles.

Wildlife has the ability to adapt to changes however ongoing research is required to study long-term changes to population numbers and habitat (ie: food chain) in order to obtain a clear picture of effects. The term *extinction debt* has been applied by ecologists (Tilman et al. 1994) to help planners strategize road implementation and its effects to biodiversity. This includes assessing existing impacted areas and implementing mitigation plans for surrounding landscape development.

Mitigation involves taking advantage of existing land elevations and contours and includes overpasses, underpasses, fencing and raised roads. When considering these options in the capacity of species conservation, assessment of existing habitat is essential. It may not be possible to restore heavily fragmented areas.

APPENDIX F

City of Brampton Road Traffic Survey

MetroCount Traffic Executive
Weekly Vehicle Counts

WeeklyVehicle-460 -- English (ENC)

Datasets:

Site:	**[FQ37D7NE] MCSetup factory setup**
Direction:	1 - North bound, A hit first. **Lane:** 0
Survey Duration:	5:16 2013/06/07 => 3:55 2013/06/14
Zone:	
File:	FQ37D7NE14Jun2013Heart Lake Rd N of #410 Exit TURTLE NS.eco (Plus)
Identifier:	FQ37D7NE MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default (v3.21 - 15315)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**5:17 2013/06/07 => 3:55 2013/06/14**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Default Profile
Scheme:	Vehicle classification (Scheme F2)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 41613 / 41683 (99.83%)

Weekly Vehicle Counts

WeeklyVehicle **-460**
Site: FQ37D7NE.0.0N
Description: **MCSetup factory setup**
Filter time: **5:17 2013/06/07 => 3:55 2013/06/14**
Scheme: Vehicle classification (Scheme F2)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12 13) Dir(NESW) Sp(10,160) Headway(>0)

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Averages	
	03 Jun	04 Jun	05 Jun	06 Jun	07 Jun	08 Jun	09 Jun	1 - 5	1 - 7
Hour									
0000-0100	*	*	*	*	*	73	52	*	62.5
0100-0200	*	*	*	*	*	37	26	*	31.5
0200-0300	*	*	*	*	*	22	22	*	22.0
0300-0400	*	*	*	*	*	17	9	*	13.0
0400-0500	*	*	*	*	*	17	7	*	12.0
0500-0600	*	*	*	*	44	29	16	44.0	29.7
0600-0700	*	*	*	*	183	89	34	183.0	102.0
0700-0800	*	*	*	*	366	132	86	366.0	194.7
0800-0900	*	*	*	*	349	241	199	349.0	263.0
0900-1000	*	*	*	*	239	307	318	239.0	288.0
1000-1100	*	*	*	*	270	401	447	270.0	372.7
1100-1200	*	*	*	*	274	**525<**	**540<**	274.0	**446.3<**
1200-1300	*	*	*	*	306	558	547	306.0	470.3
1300-1400	*	*	*	*	329	538	1108	329.0	658.3
1400-1500	*	*	*	*	344	512	**1275<**	344.0	**710.3<**
1500-1600	*	*	*	*	475	**628<**	871	475.0	658.0
1600-1700	*	*	*	*	**522<**	565	630	**522.0<**	572.3
1700-1800	*	*	*	*	479	454	519	479.0	484.0
1800-1900	*	*	*	*	424	375	360	424.0	386.3
1900-2000	*	*	*	*	387	266	274	387.0	309.0
2000-2100	*	*	*	*	254	188	235	254.0	225.7
2100-2200	*	*	*	*	201	147	141	201.0	163.0
2200-2300	*	*	*	*	151	93	89	151.0	111.0
2300-2400	*	*	*	*	85	77	49	85.0	70.3
Totals									
0700-1900	*	*	*	*	4377	5236	6900	4377.0	5504.3
0600-2200	*	*	*	*	5402	5926	7584	5402.0	6304.0
0600-0000	*	*	*	*	5638	6096	7722	5638.0	6485.3
0000-0000	*	*	*	*	*	6291	7854	*	6656.0
AM Peak	*	*	*	*	*	1100	1100		
	*	*	*	*	*	525	540		
PM Peak	*	*	*	*	1600	1500	1400		
	*	*	*	*	522	628	1275		

*** - No data.**

Weekly Vehicle Counts

WeeklyVehicle **-460**
Site: FQ37D7NE.0.0N
Description: **MCSetup factory setup**
Filter time: **5:17 2013/06/07 => 3:55 2013/06/14**
Scheme: Vehicle classification (Scheme F2)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12 13) Dir(NESW) Sp(10,160) Headway(>0)

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Averages	
	10 Jun	11 Jun	12 Jun	13 Jun	14 Jun	15 Jun	16 Jun	1 - 5	1 - 7
Hour									
0000-0100	27	19	40	32	1	*	*	23.8	23.8
0100-0200	9	8	11	18	0	*	*	9.2	9.2
0200-0300	9	7	8	5	0	*	*	5.8	5.8
0300-0400	9	7	6	6	0	*	*	5.6	5.6
0400-0500	17	17	18	25	*	*	*	19.3	19.3
0500-0600	77	72	80	72	*	*	*	75.3	75.3
0600-0700	205	198	215	215	*	*	*	208.3	208.3
0700-0800	407	**432<**	**400<**	411	*	*	*	**412.5<**	**412.5<**
0800-0900	**435<**	388	399	**417<**	*	*	*	409.8	409.8
0900-1000	295	250	263	263	*	*	*	267.8	267.8
1000-1100	205	232	261	245	*	*	*	235.8	235.8
1100-1200	230	248	311	259	*	*	*	262.0	262.0
1200-1300	250	256	335	303	*	*	*	286.0	286.0
1300-1400	275	304	323	310	*	*	*	303.0	303.0
1400-1500	326	358	351	355	*	*	*	347.5	347.5
1500-1600	329	360	401	373	*	*	*	365.8	365.8
1600-1700	343	477	458	428	*	*	*	426.5	426.5
1700-1800	**360<**	**503<**	**560<**	**474<**	*	*	*	**474.3<**	**474.3<**
1800-1900	304	469	471	438	*	*	*	420.5	420.5
1900-2000	225	351	364	316	*	*	*	314.0	314.0
2000-2100	163	279	230	299	*	*	*	242.8	242.8
2100-2200	98	178	206	214	*	*	*	174.0	174.0
2200-2300	49	108	89	109	*	*	*	88.8	88.8
2300-2400	46	53	69	62	*	*	*	57.5	57.5
Totals									
0700-1900	3759	4277	4533	4276	*	*	*	4211.3	4211.3
0600-2200	4450	5283	5548	5320	*	*	*	5150.3	5150.3
0600-0000	4545	5444	5706	5491	*	*	*	5296.5	5296.5
0000-0000	4693	5574	5869	5649	*	*	*	5435.4	5435.4
AM Peak	0800	0700	0700	0800	*	*	*		
	435	432	400	417	*	*	*		
PM Peak	1700	1700	1700	1700	*	*	*		
	360	503	560	474	*	*	*		

*** - No data.**

APPENDIX G

Mock Culvert and Wildlife Directional Fencing Study

Studies are being undertaken globally to understand methods to address WVCs and implement mitigation. This mock culvert pilot study was undertaken to assist with addressing mitigation strategies at the Heart Lake Road Provincially Significant Wetland (PSW) complex and make an effort to reduce WVCs.

Following 2011 Phase I study, project partners agreed to pursue a project to determine suitable mitigation for SA. The pilot project location (Figure 1 and 2) is north of HLCA on the west side of Heart Lake Road. This area was chosen from data collected in 2011, examining existing historical wildlife data collected by TRCA and consultations with TRCA Ecology staff. To determine what type of mitigation would work best, TRCA and OREG chose three wildlife passage designs. Three pieces of culvert were chosen consisting of a DIMENSIONS corrugated steel pipe (CSP) , a DIMENSIONS concrete box culvert, a 500 mm ACO Amphibian Tunnel and ACO one-way wildlife directional fencing. CoB donated the CSP and box culvert, ACO Systems Ltd donated the ACO Amphibian Tunnel and TRCA purchased 80 meters of ACO wildlife directional fencing. ACO one-way fencing was chosen because of its permanent and durable features and inside curve design. This curved design along the inside allows wildlife (small mammals, reptiles and amphibians) to be directed towards a specific area of passage. In addition, the outside slope allows wildlife on the road access to wetland habitat.

Figure 1 –Pilot project location west side, Mar 25-13

Figure 2 - Pilot project location west side, Jun 18-13

On March 26, 2013, a crew of 2 field staff 5 days (total of 60 man-hours), began installing 80 meters of ACO one-way wildlife fence (Figure 3). Installation was targeted to ensure equipment was in place to monitor and assess early spring emerging amphibians moving to breeding areas. The edges of ACO fence curve inward (Figure 4) to guide target species towards three mock culverts, each two (2) metres in length. Any vegetation that facilitated wildlife from crossing over the inside portion of fencing was cut back. The pilot project site is an existing natural area with abundant existing vegetation, woody debris, wet areas and uneven ground which proved to be a challenge during installation. To properly anchor fencing, ground conditions must be relatively level for each section of fence to connect and prevent gaps along each section and lower edge of this product. Smaller wildlife are capable of navigating through very small areas therefore effectively sealing seams of fencing is essential for animals to reach passages. A large portion of man-hours were spent clearing vegetation, cutting woody debris and levelling the ground. Additional challenges were efforts made to collect vegetation and surrounding soils to create a “natural” ramp leading up the outside edge of fencing. This ramp would allow wildlife access to wetlands from the road (Figure 5 and 6).

As this is a sensitive area (PSW), staff were prohibited from using heavy machinery to clear debris, downed wood and level the ground. All work related to the 1m wide, 80m long fencing was accomplished using hand tools. In

sites where heavy equipment is used, installation time is considerably shorter (approximately 2 days). Examples of installing the same length of product with machinery in a newly constructed or level site with minimal vegetation would take considerably less time. Additional time would be required to create the ramp on the back side of fencing and time allotted would depend on source and location of materials being used. Although not experts with this ACO product, valuable lessons were learned throughout installation.

Figure 3 –Staff installing ACO directional fence

Figure 4 – Inside edge of ACO directional fence

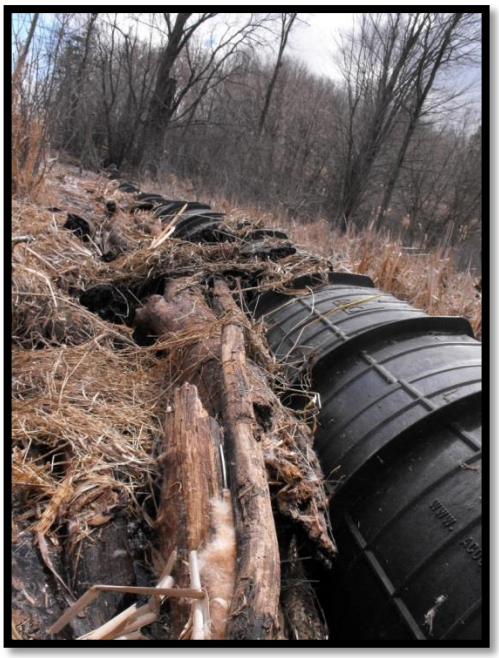


Figure 5 – ACO fence banked material

Figure 6 – ACO fence with banked natural material

All safety measures were in place and permits were obtained prior to installation and on March 29, 2013, three mock culverts were put into place via crane (Figure 7 and 8). They were placed at a central point of the two sections of fencing allowing species passage between wetlands in a west to east direction. Once in place, textile fencing was extended from the edge of the ACO fencing to the edge of the culverts to create a "landing area" to culvert entrances (Figure 9 and 10).

Figure 7 – Crane positioning culverts

Figure 8 – Culverts in place

Figure 9 Textile fabric extension

Figure 10 – Textile fabric at culverts

Additional fabric fencing was added to the far north and south ends of the ACO fencing extending into forested areas. This allowed additional guidance for wildlife from woodland areas to access mock-culverts. On April 5, 2013, pitfalls with drainage holes (Figure 11) and secure lids (Figure 12) were placed at each end of directional fencing (Figure 13), as well as exits of each culvert (Figure 14). These pitfalls allowed monitoring staff to safely transport wildlife across the road during breeding season. Lids were tightly secured and covered with woody debris to prevent wildlife entering between monitoring sessions.

Figure 11 – Pitfall with drainage

Figure 12 – Securing pitfall lid

Figure 13 – South pitfall

Figure 14 – Pitfall at culvert exit

Figure 15 – Mock culverts and ACO wildlife directional fencing in place

Although effective data related to wildlife passage was not able to be determined, valuable lessons were learned related to specific aspects of material used.

ACO directional wildlife fencing is most conducive to new construction sites with level ground, where the product can be installed with minimal chance of wildlife escaping through gaps in each section and where the base meets ground surface.

Challenges associated with installation and use of this product, in areas adjacent to Heart Lake Road includes:

- Non-level surface grade which created gaps in fence sections and base;
- insufficient natural debris available on site to create ramp on outside of fence;
- permits required to transport remote fill material into the PSW;
- amount of fill required to create ramp along entire stretch of directional fencing; and
- high water levels resulting in product shifting

Precipitation and high water levels of the wetland throughout the season of 2013, created additional challenges associated with initiating monitoring such as:

- culvert water levels allowed species to swim through;
- pitfalls were below water level and ineffective;
- water levels extended beyond culvert exits;
- wildlife cameras were unable to be installed at entrance and exit areas; and
- sections of fencing became submersed.

Following outcomes of 2013 pilot study efforts TRCA staff and project partners are considering several options to address challenges encountered during this study. TRCA has outreached to engage a graduate student to assist with leading monitoring studies related to this project. It is intended to readdress dynamics of the location of culverts and associated factors to ensure a non-biased study can be conducted. Consideration will be given to relocate the culverts to higher ground providing a buffer from potentially high water levels. Additionally staff will conduct further research to reduce bias associated with the study.

It is the intention of TRCA and partners to move forward in 2014, pending on adequate staff and funding to support completion of the study and share results with CoB to better inform them for future mitigation.