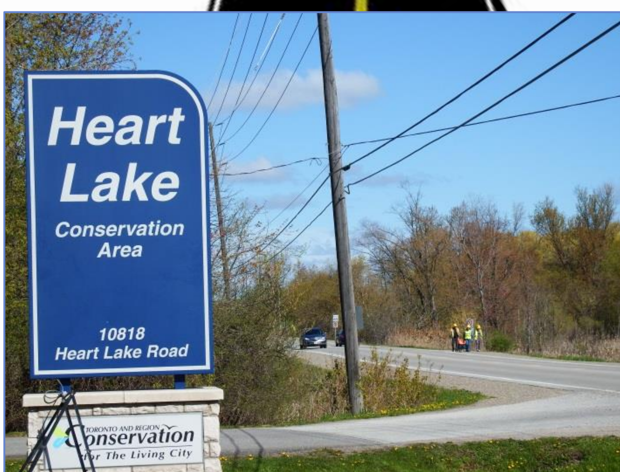
Wildlife Road Ecology Citizen Science Monitoring Study

Heart Lake Road Provincially Significant Wetlands
Brampton ON

2017



Toronto and Region Conservation for The Living City

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Table of Contents

List of Figures

Acknowledgements

Toronto and Region Conservation Authority (TRCA) acknowledges that the land on which the work and contributions for this project took place is traditional territory of the Haudenosaunee, Anishinabek, and most recently, the territory of Mississaugas of New Credit First Nation. Today, the meeting place of Brampton remains home to many Indigenous Peoples from across Turtle Island and gratitude is extended for the opportunity to work on this land.

Toronto and Region Conservation Authority (TRCA), City of Brampton (CoB), Ontario Road Ecology Group (OREG), and York University (YU) express sincere thanks to the dedicated volunteers and project partners who continue to participate in this road ecology study.

With dedicated citizen science volunteers, data continues to be collected at the designated Provincially Significant Wetlands along Heart Lake Road (HLR) to gain further knowledge on effects of roads to wildlife and fragmented habitat. These efforts assist in protecting wildlife and their habitat in this sensitive wetland.

The continued input of equipment, time, expertise, and valuable feedback from project partners has been critical to this project's ongoing success.

Executive Summary

Toronto and Region Conservation Authority (TRCA), in partnership with the City of Brampton (CoB), Ontario Road Ecology Group (OREG), York University, and local citizen scientists, delivered the Heart Lake Road Ecology Citizen Science Monitoring Project in 2017. The objective of the project is to better understand which species were being impacted by wildlife-vehicle collisions (WVCs) on Heart Lake Road, how many interactions were occurring, and to assess and suggest mitigation measures to protect local biodiversity in the provincially significant Heart Lake Road wetland complex.

In 2013, TRCA staff identified three hotspots along Heart Lake Rd, between Sandalwood Pkwy and Countryside Dr, where high numbers of WVCs had been identified with the support of citizen science volunteer monitoring efforts from 2011 to 2013. In 2016, Animex wildlife directional fencing and a dedicated wildlife passage were installed on Heart Lake Road, just south of Countryside Drive, as a mitigation measure to reduce the number of WVCs. Citizen science monitoring efforts in 2017 focused on assessing the effectiveness of the installed mitigation infrastructure relative to other areas without mitigation.

In 2017, monitoring of Heart Lake Road took place between May 1 and October 31. Data were collected by citizen science volunteers with the goal of observing and recording the location and species of WVCs, the number and location of turtle nests, as well as any notable live wildlife found along the road. A wildlife trail camera was mounted in the dedicated wildlife passage to discern wildlife usage from June 6, 2017 to November 19. 2017.

A total of 675 WVCs were documented in 2017. Of these 675 observations, 75 were turtles, 458 were frogs or toads, 17 were snakes, 65 were mammals, 52 were birds, and 8 were unknown. The number of WVCs that occur along this stretch of Heart Lake Rd is compelling, but the number of turtle mortalities is particularly concerning since turtles are especially sensitive to adult mortality due to the long maturation times of turtle species. Over a quarter of turtle WVCs recorded were snapping turtles, a species designated as Special Concern both federally and provincially. Of the 458 frog mortalities that occurred over the entire monitoring season, 109 mortalities occurred over the span of one day in early October when snow fencing was installed along Heart Lake Rd in an effort to prevent access to larger wildlife. It is uncertain if the disturbance of the snow fence installation contributed to this uncharacteristically high number of WVCs in that short time span.

The trail camera monitoring the dedicated wildlife passage captured numerous mammals, predominantly raccoons, frequenting the passage. In 2018, TRCA's goal is to improve upon the camera detection system by installing a second camera and introducing new camera angles to increase detection of herpetofauna that may be using the passage. TRCA staff and volunteers did observe herpetofauna activity at the entrances of the dedicated wildlife passage in 2017.

Overall, volunteers recorded a reduced number of turtle, snake, and frog WVCs in the mitigated area, suggesting that the wildlife directional fencing and dedicated wildlife passage are successful at reducing WVCs. Given this success, it is recommended to extend directional fencing to other WVC hotspots along Heart Lake Road. Without mitigation, the wildlife mortality levels on Heart Lake Road will remain unsustainable and may lead to local extirpation of some of the resident biodiversity.

Introduction

Toronto and Region Conservation Authority (TRCA), in partnership with City of Brampton (CoB), Ontario Road Ecology Group (OREG), York University, and local community volunteers, have been leading a series of studies examining the wildlife-vehicle collisions (WVCs) that occur along a stretch of Heart Lake Rd between Sandalwood Pkwy (43°45'09.3"N 79°48'11.2"W) and Mayfield Rd (43°45'09.2"N, 79°48'10.6"W) in Brampton, Ontario. The study, known as the Heart Lake Road Ecology Citizen Science Monitoring Project, was initiated in 2011 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.

Data collected in 2011 helped to identify the number and the species of wildlife impacted by WVCs along Heart Lake Rd. A report of findings is available online at: https://tinyurl.com/HLREMP2011. As a result, TRCA and CoB staff met in 2012 to assess the area, locate any existing drainage culverts, and begin examining mitigation options.

The study area was redefined in 2012, to focus survey efforts in areas with high instances of WVCs. Phase II of the project began in 2013, with the new survey area extending along Heart Lake Rd from Sandalwood Pkwy to Countryside Dr. Data sets were collected by citizen science volunteers and a report of findings is available online at: https://tinyurl.com/HLREMP2013.

A turtle population study was implemented by TRCA staff and professionally trained citizen science volunteers in 2014, as a component of wildlife fatality mitigation science. This study was put in place to gather demographic baseline information on the *in situ* turtle population, both before and after proposed mitigation measures are applied. Project partners agreed that it was essential to gain additional information on the local turtle population prior to the installation of any mitigation measures. A report on this study is available online at: https://tinyurl.com/HLREMP2014.

In 2015, the turtle population study continued, resulting in findings of a significant male-biased population. This supported the hypothesis that female turtles are at higher risk of WVCs due to increased movements along roads related to summertime nesting in roadside gravel. Report findings can be found at: https://tinyurl.com/HLREMP2015.

In 2016, TRCA, CoB and its partners moved forward with the project, installing Animex directional wildlife fencing and a dedicated wildlife passage under Heart Lake Rd, just south of Countryside Dr to prevent wildlife from accessing the road and help guide them to the passage. Preliminary monitoring efforts revealed fewer instances of WVCs within the mitigated area, however, attempts at monitoring usage of the wildlife passage with trail cameras were unsuccessful. As such, investigations into whether the fencing was truly redirecting wildlife to the dedicated wildlife passage and not just excluding wildlife from roads yielded promising, yet inconclusive results. Findings and further recommendations from the 2016 study are available online at: https://tinyurl.com/HLREMP2016.

Volunteers once again monitored Heart Lake Rd for WVCs and turtle nest locations from May to October in 2017, in an effort to assess the effectiveness of the mitigation infrastructure installed the previous year. A trail camera was mounted to the inside of the dedicated wildlife passage to assess how many animals walked through the passage, how often the passage was used, and what species were using it.

The following report outlines the results of this study during 2017.

Road Ecology in the Broader Context

Road ecology is the study of interactions between roads and the environment (Coffin 2007). Road ecology studies have demonstrated that wildlife populations are often negatively affected by the presence of a nearby road (Fahrig and Rytwinski 2009). One of the largest effects of roads is WVCs resulting in animal mortality. Roads directly affect wildlife, and as a result, visibly tarnish the image of protected areas (Farmer and Brooks 2012). Also worth noting is the possibility of human safety consequences, especially in the instances of large animal WVCs (Seiler 2005). Applying road ecology principles and practices is of increasing importance, as rural lands and wildlife habitats are decreasing due to development to accommodate an increasing human population.

WVCs have substantial negative impacts on the population dynamics of a variety of taxa, especially reptiles and amphibians (Steen et al. 2006, Row et al. 2007). In Ontario, many turtle populations are at risk. The federal and provincial government has designated seven out of the eight native turtle species as Species at Risk (SAR). Government, conservationists, and the public are making strides in the protection of turtle and other herpetofauna populations. Paramount in efforts to protect these species is mitigating threats of roads and traffic.

In order to mitigate the threats of roads on nearby wildlife, it is important to consider the risk factors for vertebrate mortality. A study by Farmer and Brooks (2012) identified posted road speed limit as the dominant predictor for wildlife mortality. As such, most mitigation measures against WVCs involve reducing speed limits on roads that are located in and around diverse habitats and wetlands. Examples include signage to warn drivers of animal crossing hotspots, seasonal speed reductions, and road closures. In areas where traffic control is minimal, alternative mitigation infrastructures, such as animal directional fencing and wildlife crossing passages, are critical in continued efforts of reducing instances of WVCs. Learned experiences dictate that multiple forms of mitigation infrastructure may be required to be successful (Rytwinski et al. 2016, Wang et al. 2017).

Mitigation infrastructure that protects biodiversity and SAR from the threats of roads has become more common across Ontario. Agencies such as Parks Canada, Ontario Parks, the Ministry of Transportation of Ontario (MTO) and municipalities are seeking solutions to reduce threats from roads, improve habitat connectivity, and allow wildlife safe passage across the landscape (Figs. 1 to 7).

Figure 1: Bruce Peninsula National Park ecopassage (Photo courtesy of Parks Canada)

Figure 2: Bruce Peninsula National Park grated ecopassage (Photo courtesy of Parks Canada)

Figure 3: Ontario Parks SAR snake road mitigation (Photo courtesy of Ontario Parks)

Figure 4: MTO wildlife overpass Hwy #69 (Photo courtesy of Ministry of Transportation Ontario)

Figure 5: Wildlife passage/fence, Terry Fox Dr, City of Ottawa (Photo courtesy of Dillon Consulting Ltd)

Figure 6: Turtle exclusion fence, City of Kingston (Photo courtesy of Mandy Karch)

Figure 7: Remote camera data, snapping turtle under road (Photo courtesy of Lake Simcoe Region CA)

Conservation Authorities (CAs) and local municipality partners across Ontario are actively protecting local biodiversity and SAR herpetofauna through road ecology planning policy and research and mitigation projects (Table 1). These projects have advanced conservation goals by contributing data, researching, implementing and monitoring a suite of mitigation measures (i.e. crossing signs, road closures, dedicated wildlife passage and fencing), and educating the public, thereby generating an invested community that endorses conservation initiatives.

Table 1. Examples of road ecology work accomplished by Conservation Authorities and Municipal Partners across Ontario

Conservation Authority (CA)	**Municipal Partners**	**Accomplishments**
Central Lake Ontario CA		• Wildlife Corridor Protection and Enhancement Plan 2015
Conservation Halton	• Town of Oakville • City of Burlington • Town of Milton	• Halton Region species at risk road mortality hotspot mapping • Evaluation of wildlife crossing structure opportunities • Planning policy updates (i.e. a Natural Heritage System with an emphasis on maintaining connectivity) • Town of Oakville Road Ecology Strategy • King Road, Burlington, road closure for seasonal salamander migration • Wildlife passage and fencing, Milton
Credit Valley CA	• City of Brampton • City of Mississauga • City of Oakville	• Fish and Wildlife Crossing Guidelines
Ganaraska CA	• City of Hamilton	• Turtle crossing signs
Hamilton CA	• City of Hamilton	• Collection of wildlife/vehicle collision data • Barrier fencing and turtle crossing sign to keep turtles off the road • Potential speed reductions at hotspots • Working with Royal Botanical Gardens to relocate Dundas Community Garden away from prime turtle nesting habitat
Lake Simcoe Region CA	• City of Barrie • Township of Oro-Medonte • Town of Bradford West Gwillimbury • Town of Innisfil	• Fencing and passage installation for turtles at five sites within region • Wildlife Passage Day workshop (2014) • Mapping potential road mortality hotspots for amphibians and reptiles in the Lake Simcoe watershed (2015) • Wildlife Safe Passage Pilot Project (2015)
Raisin Region CA		• Prioritization of locations where mitigation is most needed for turtles on roads in Raisin Region watershed • Monitoring and pre-mitigation assessment (Gunson and Schueler 2014)
South Nation CA		• Totally Turtles program (raises public awareness, builds nesting habitat, installs crossing signs and fencing)

Figure 8: Example of road mitigation at Tommy Thompson Park

In collaboration with municipal partners, TRCA has taken the lead on road ecology initiatives within its jurisdiction. Some of these initiatives include 'Brake for Snakes' signs (Fig. 8) and speed bumps at Tommy Thompson Park (TTP), intended to slow cyclists and encourage visitors to watch for snakes at TTP, basking habitat creation at King's Mill Park in the Humber River Watershed, and developing planning policies such as *The Crossings Guidelines for Valley and Stream Corridors.* These methods assist in working towards protecting sensitive ecosystems and wildlife within urban settings.

Road Ecology at Heart Lake Road

Heart Lake Rd is set amidst 99 hectares of a designated Provincially Significant Wetland complex in Brampton, Ontario. There are a variety of amphibians, reptiles, mammals, and birds within the wetlands. Most are common within this area, with certain species classed as special concern for local or provincial extirpation (Appendix A).

Wildlife road mortality is an important issue along Heart Lake Rd, as the road bisects the wetland complex. This road acts as a barrier to animal movements and therefore fragments the habitat. Aside from the direct habitat loss due to the road itself, and the associated mortality risk for animal species, Heart Lake Rd also increases noise, water, and air pollution, which contributes additional negative impacts to wildlife behaviours. Notably, adult female turtles residing in the wetlands often attempt to nest on the side of Heart Lake Rd, becoming more at risk to road mortality. These negative impacts of road networks have been observed in both the population and community levels of other animals (Fahrig and Rytwinksi 2009, Kociolek et al. 2011).

Farmer and Brooks (2012) developed a predictive model that determined the likelihood of vertebrate mortality on a road based on a number of integrated risk factors. Many of the risk factors identified by Farmer and Brooks apply to Heart Lake Rd, making it an ideal site for a road ecology study. The most effective WVC predictor was posted speed limit. At Heart Lake Road, the posted speed limit is 60 km/h, which is 10 km/h higher than the roads Farmer and Brooks surveyed during their study. Other predictors identified include traffic volume and proximity to wetlands, both of which are quite high at Heart Lake Rd.

The Heart Lake Road Ecology Citizen Science Monitoring Project would not exist without the dedicated concern and outcry from local residents, who reached out to TRCA and CoB after reporting numerous turtle fatalities on Heart Lake Road in 2010. As an immediate response, turtle crossing signs (Fig. 9) were installed alongside Heart Lake Rd in an effort to educate drivers and reduce traffic.

Figure 9: TRCA staff beside the wildlife crossing sign on Heart Lake Road

To better understand what was happening on Heart Lake Rd, TRCA, OREG, and CoB began Phase I of this study in 2011, to determine the type and amount of wildlife impacted by WVCs. Citizen science volunteers walked along Heart Lake Rd from Sandalwood Pkwy to Mayfield Rd, recording instances of WVCs. Data sets collected allowed project coordinators to identify and prioritize road mortality hotspots as potential mitigation sites.

Results identified three key hotspots between Sandalwood Pkwy and Countryside Rd. Committed biologists, project managers, engineers, and traffic services personnel collaborated and supported Phase II of HLREMP from 2013 to 2015, exploring mitigation options for the site. The locations of existing corrugated steel pipe culverts were located and examined to act as a potential dedicated wildlife passage. Options for directional fencing to guide wildlife toward the existing culverts were considered as part of the mitigation strategy.

In addition, a mock wildlife passage and wildlife directional fencing study was launched in 2013. This study did not produce successful results due to unusually high wetland water levels that submerged mitigation materials. Although unsuccessful that year, it allowed partners to strengthen their focus and lessons were learned in respect to installation methods and the variety of materials available for use in this type of mitigation.

To better understand *in situ* wildlife populations in and around the Heart Lake Rd wetlands, TRCA and partners agreed to conduct a study to determine turtle populations prior to installation of any mitigation and implemented a multi-year plan to track success and movement after installation. As a result, a turtle population study was conducted in 2014 and 2015. Baseline information of the turtle population, such as species richness, ratio of males to females, and age class distribution were collected. Results of the population study revealed a significant male-biased population, supporting the theory that female turtles are at a higher risk of fatalities related to nesting in gravel along roads. This information was used to help form mitigation recommendations for the site. In addition, signage and traffic calming measures were installed at both north and south boundaries of the study area to alert and educate motorists that they had entered a significant natural area.

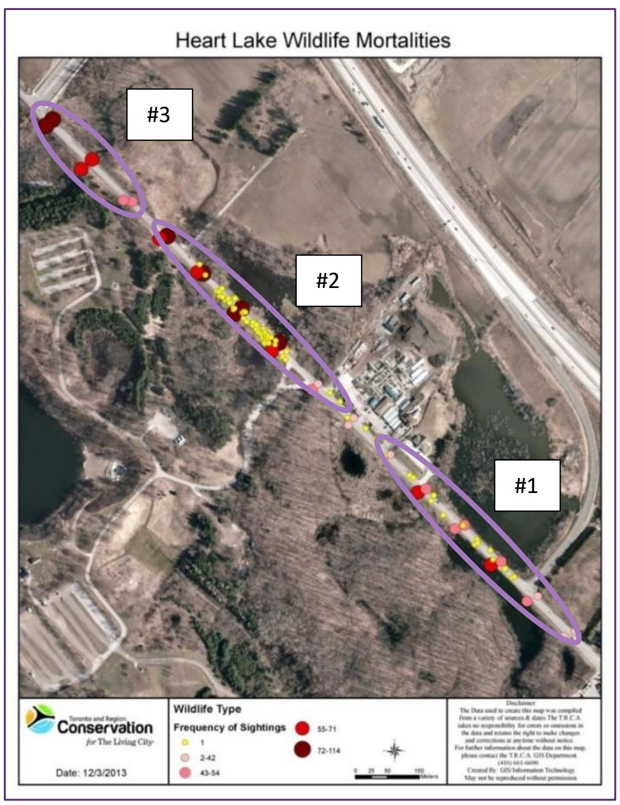

Figure 10: Hotspots identified from data collection in 2013

In 2016, a dedicated wildlife passage was installed under Heart Lake Rd at Hotspot #3, just south of Countryside Dr (Fig. 10). The passage is an oversized concrete box culvert, with approximately 300 metres of Animex wildlife fencing on either side to guide animals towards the passage. In addition to the wildlife passage and fencing, two turtle nesting beaches were constructed just north of the dedicated wildlife passage, one on the east side and one on the west side of Heart Lake Road, to help mitigate female turtle mortality as a result of nesting on the gravel roadside. Trail cameras were also mounted on the inside edge of the passage to monitor wildlife activity. Preliminary surveys revealed that less than 7% of the wildlife mortality on Heart Lake Rd occurred in the mitigated area. Due to technical issues and vandalism of the cameras, monitoring wildlife activity was unsuccessful.

With the installation of mitigation infrastructure complete, the study area was monitored during the spring and summer of 2017. This data, collected post-mitigation, will provide valuable input as to the effectiveness of mitigation. Areas of focus for 2017 include:

1. How has the mitigation infrastructure, specifically the dedicated wildlife passage and directional fencing, affected the frequency of WVCs and road mortality rates?
2. Is the wildlife passage being used by wildlife, and if so, by what species and how often?
3. What other steps can be taken to minimize the amount of WVCs on Heart Lake Rd?
4. Can these mitigation strategies be applied to other areas on Heart Lake Rd or other sites in TRCA's jurisdiction?
5. Assess condition of mitigation infrastructure and identify maintenance requirements.

The road ecology data collected by volunteers on Heart Lake Rd has fostered new partnerships, engaged members of the public and students from all levels of education, and generated new data points for a growing dataset (Table 2). This has laid the foundation of the Heart Lake Road Ecology Citizen Science Monitoring Program.

Table 2. Summary of HLREMP timeline and accomplishments leading up to 2017.

Year	Project	Partnerships	Results
2010	TRCA staff and local residents report fatalities of turtles to OREG	TRCA, OREG, COB	Turtle Crossing Signs
2011	HLREMP Phase I	TRCA, OREG, COB, Brampton Environmental and Planning Committee (BEPAC), Public	Wildlife/Road Interaction Dataset Identified and prioritized hotspots
2012	HLREMP Phase II initiated	TRCA, OREG, COB, BEPAC, ACO Wildlife Systems Ltd.	Located existing corrugated steel pipe culverts Refined study area to focus on hotspots identified in Phase I
2013	HLREMP Phase II	TRCA, OREG, COB, Toronto Zoo, Public	Augmented Wildlife/Road Interaction Dataset Mock wildlife passage and wildlife directional fencing study Nesting beach habitat creation for turtles Nest protectors implemented
2014	Turtle Population Study: Provincially Significant Wetland – Area 'C' (HLREMP)	TRCA, OREG, COB, selected expert volunteers from partner institutions	Added to baseline dataset of local turtle population presence prior to mitigation installation
2015	Road Ecology and Turtle Population Study	TRCA, OREG, COB, Public	Added to baseline dataset of local turtle population presence prior to mitigation installation Significant Natural Area signage
2016	Wildlife passage and Animex fencing installed	TRCA, OREG, COB, Public	Wildlife passage and Animex dedicated wildlife fencing installed at hotspot #3 Nesting beach habitat creation for turtles along Heart Lake Road

Mitigation Efforts at Heart Lake Road

The culmination of data and information over the past seven years has resulted in a multi-level approach to mitigating wildlife road mortality, comprised of installing wildlife area crossing signs, implementing traffic calming measures, creating nesting habitat, and installing directional wildlife fencing and a newly installed dedicated wildlife passage. These measures were selected to promote safe passage of local wildlife, including at-risk herpetofauna.

The Heart Lake Road Ecology Citizen Science Monitoring Program includes a follow up monitoring and maintenance plan to ensure long-term goals for protecting wildlife populations are successful. This mitigation strategy is reliant upon productive partnerships among government and non-government agencies, a supportive community, and dedicated citizen scientists.

Following the results of road ecology monitoring efforts and identification of herpetofauna road mortality hotspots, CoB approved a series of TRCA-recommended measures designed to curb incidences of WVCs.

Measures contemplated were:

i.	Pavement markings (optical speed bars)	Approved, implemented in 2016
ii.	Warning signage	Approved, implemented in 2010
iii.	Dedicated wildlife passage at identified hot spots	Approved, implemented in 2016
iv.	Installation of drift fencing	Approved, implemented in 2016
v.	Addition of turtle nesting beaches	Approved, implemented in 2016
vi.	Seasonal road closures	
	a) 24 hr/day	Rejected
	b) From 9:00 p.m. to 7:00 a.m.	Rejected
vii.	All-way stop at Countryside Dr and Heart Lake Rd	Rejected

1. Dedicated Wildlife Passage and Direction Fencing

In 2017, effectiveness of currently existing mitigation infrastructure was examined, and no new mitigation measures related to the dedicated wildlife passage or wildlife fencing were implemented.

Dedicated wildlife passages are intended to safely attract and allow wildlife to cross roads and access fragmented habitat for breeding, feeding, and migration. Wildlife passage design details, including construction materials, placement, entry features, lighting, moisture levels, and length, all interplay to determine if target wildlife species will successfully enter and pass through. Following a lengthy investigation process and consultation with project partners, in April of 2016, CoB and TRCA decided to install a concrete dedicated wildlife passage of suitable dimensions for local herpetofauna and mammals (Figs 11-16) at Hotspot #3.

Figure 11: Oversize culvert as wildlife passage

Figure 12: Dedicated wildlife passage and wildlife directional fencing

Figure 13: CoB road closed sign during installation

Figure 14: CoB digs trench at Heart Lake Road to install passage

Figure 15: Oversized concrete culvert sections at site

Figure 16: Soil/mulch substrate being "blown" into passage

Fencing is required to keep animals from accessing roads, guide animals to suitable, safe passageways, and reduce or eliminate mortality caused by wildlife/vehicle collisions (Cunnington et al. 2014). Maintaining fence integrity is critical, as any structural failure (i.e. holes, gaps, slack walls, overgrown vegetation, etc.) may compromise effectiveness of a mitigation strategy (Baxter-Gilbert et al. 2015).

The design details of exclusion and directional fencing should be specific to the landscape and target species. Fencing design, construction materials and installation methods are changing and improving as studies that monitor and report on *in situ* projects are conducted (Baxter-Gilbert et al. 2015, Ashpole et al. 2016). For this project, a total of 330 metres of Animex wildlife fencing (Fig. 17) was installed alongside the wildlife passage to exclude herpetofauna from the road in the mitigation area and encourage them to use the dedicated wildlife passage (Fig. 18).

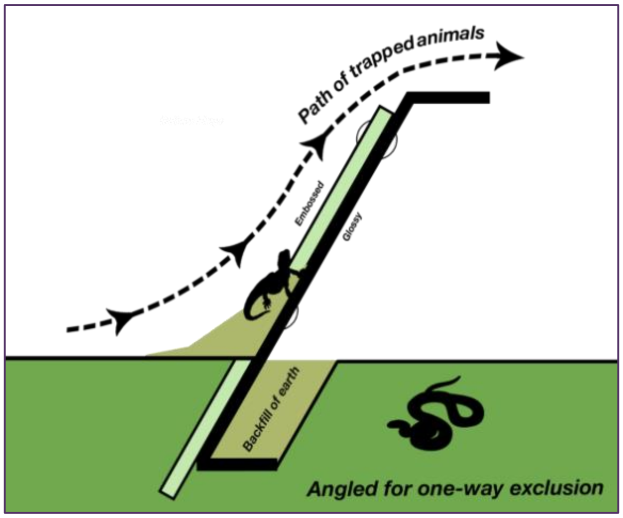

Figure 17: Animex wildlife fencing cross section (Photo courtesy of Animex)

Figure 18: Animex fencing banked with mulch leading to passage

2. Turtle Nesting Beaches

Creating safe, alternative habitat by installing turtle nesting beaches may reduce the number of turtles crossing roads and encourage nesting away from gravel shoulders. Nesting beaches have proven to be successful at attracting nesting female turtles (Buhlmann and Osborn 2011), incubating eggs, and producing viable hatchlings. Based on these findings, artificial nest mounds have been recognized as a valuable conservation tool and may be especially effective at sites with low nesting habitat availability (Paterson et al. 2013).

Figure 19: TRCA installation of turtle on nesting beach

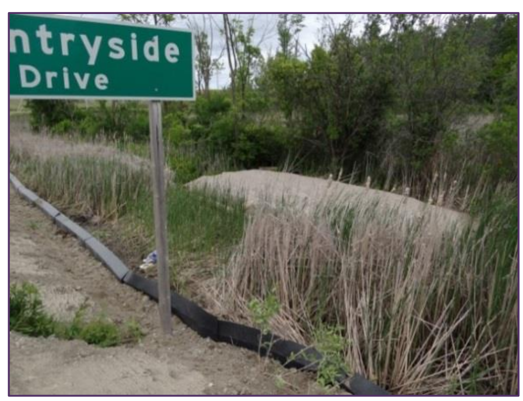

Figure 20: TRCA installed turtle nesting beach on east side of Heart Lake Road

Since mitigation restricted access for female turtles nesting on the gravel roadside, nesting mounds were installed by the TRCA (Figs. 19 and 20) on both sides of the mitigated areas on May 11 to 13, 2016. The mounds are located adjacent to the road but inside the wildlife fencing and act as an alternative to roadside nesting.

In 2017, cedar chip mulch was incorporated on the nesting mounds in order to provide variation in the digging substrate for gravid females (Fig. 21). This was in response to numerous observations by TRCA staff and volunteers of turtles nesting in mulch piles at Heart Lake Conservation Area.

Figure 21: Cedar chip mulch spread on top of Heart Lake Road turtle nesting beach

3. Roadside Watershed-Wide Cleanup Campaign

Litter, garbage, debris and illegal dumping poses significant risks to sensitive ecosystems and both wildlife and human health. Wildlife can experience decreased growth rates, depleted energy reserves, reduced reproductive output, and mortality by ingesting plastic, which is mistaken for food, or other toxic contaminants found in garbage (McCauley and Bjorndal 1999). Chemicals such as BPA or phthalates (salts or esters of phthalic acid used as plasticizers and in solvents), which are ingested by wildlife, can be passed on to predator wildlife, creating what is referred to as a “bottom-up” effect. From a road ecology perspective, the presence of garbage on or around roads has the potential of attracting scavenging wildlife (i.e. raccoons, opossums, some birds, etc.), placing them in a higher risk of fatality.

Over years of monitoring, citizen scientist volunteers have noted that Heart Lake Rd is subject to frequent illegal dumping. As part of the Watershed-Wide Cleanup Campaign, TRCA coordinates several activities throughout the year to remove trash, litter, and construction debris from areas bordering the wetlands. There were a total of seven clean up events along Heart Lake Rd in 2017, collecting approximately 3,887 total pounds of garbage (Fig. 22).

Figure 22: Watershed Wide Cleanup Campaign, Heart Lake Rd

4. Snow Fence Installation

On October 5, 2017, CoB road maintenance crews installed snow fencing on either side of Heart Lake Road, just south of the mitigated area until Sandalwood Parkway, in an effort to provide some wildlife protection in unmitigated areas. Fencing installation was in response to public pressure in respect to larger wildlife accessing the road (e.g. Trumpeter Swans).

5. Traffic, Speed Limits and Signage

Speeding and traffic volumes are an ongoing issue on Heart Lake Road. CoB Public Works Department provided in-kind traffic data collection for July 27, 2016 to August 1, 2016, at a location just north of the Highway 410 southbound off-ramp. Vehicle volume totals are listed below:

- **Total Average Daily Traffic:** (July 27, 2016 to August 1, 2016)
  Average Daily Traffic was 7,103 vehicles
- **Average Peak Hour Volume:** (5:00pm to 6:00pm)
  Average Peak Hour Volume was 527 vehicles
- **Speed:** 85% of vehicles were travelling at an estimated rate of speed of 79.8 km/h
  (posted speed limit; 60 km/h)

There were no new mitigation measures related to traffic, speed limits, and signage implemented in 2017.

In 2016, new signs were installed to raise awareness and alert public to potential small wildlife on roads (Figs. 23 and 24). An enhanced seasonal, motion activated (sensitive to approaching vehicles) wildlife crossing sign (Fig. 25) equipped with solar-powered amber flashing lights was chosen to help influence motorists' behaviour (i.e. proceed cautiously and watch for wildlife on the road). Use of this type of temporary passive sign with flashing lights has been shown to reduce motorist speed in some cases (Hedlund et al. 2003) but signage should not be used as a substitute for more permanent and effective mitigation (i.e. dedicated wildlife passage and exclusion fencing) where deemed necessary.

In an effort to modify motorist behaviour to reduce speed, CoB also installed/painted Optical Speed Bars (OSB) on Heart Lake Road (Fig. 26). These transverse stripes are spaced at gradually decreasing distances and cause a visual effect intended to reduce drivers' speed as they react to the spacing of painted lines (McGee and Hanscom 2006). The expectation is that the OSB will encourage slower driving speeds that facilitate motorists to watch for and react to wildlife on the road, thereby contributing to the overall goal of preventing WVCs.

Figure 23: Sign installed at north and south ends of Heart Lake Wetlands

Figure 24: CoB staff install wildlife crossing sign

Figure 25: CoB solar-powered. flashing seasonal wildlife crossing sign

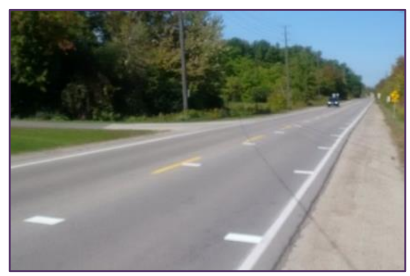

Figure 26: CoB install optical speed bars to slow traffic

Post Mitigation Monitoring

As a developing field, road ecology depends on monitoring to validate or inform adjustments to ensure mitigation dollars are effectively and efficiently spent. Any mitigation project should budget and/or make arrangements for post-installation monitoring. Methods could be remote (i.e. cameras, track boards, etc.) or on-the-ground surveys including wildlife/road interaction data collection conducted by trained officials, university students or members of the public.

1. Road Ecology Monitoring

Once mitigation is in place, monitoring is critical to ascertain if the strategy is functioning as intended. One way to test mitigation measures is using the Before-After Control-Impact method. A Before-After

Control-Impact (BACI) study design involves pre and post monitoring of the site receiving remediation and of a control site nearby that receives no mitigation. As only one of the three hotspots along HLR was receiving mitigation (Hotspot #3), adjacent Hotspots #1 and #2 were used as control locations. All three hotspots have been monitored for many years.

If the dedicated wildlife passage and directional fencing is working as intended, fewer instances of WVCs in the mitigated area should be observed than in the control area. Specifically, the should be significantly fewer instances of snake and turtle mortality and fewer instances of frog mortality in the study area, as those are the target species of the Animex directional fencing. Monitoring efforts in 2017 focused on recording the frequency of WVCs that occurred between Sandalwood Parkway and Countryside Drive.

Also, it is important that connectivity between the wetlands of Heart Lake Road is still maintained, despite the presence of the road. There is potential for the Animex fencing to reduce connectivity, as it prevents certain taxa from accessing the road. The dedicated wildlife passage was installed to help maintain or restore any lost connectivity, allowing animals attempting to access the other wetland a safe passage to do so.

However, if a reduction in the number of fatalities in the mitigated area is observed, it does not necessarily mean that both the fencing and dedicated wildlife passage are functioning as intended. It is possible that the fencing is simply excluding wildlife access to the road, and therefore fragmenting the provincially significant wetland even further. Monitoring if and how the dedicated wildlife passage is being used is critical to understanding how mitigation efforts are impacting local wildlife populations.

2. Maintaining Mitigation Infrastructure

Evaluating mitigation infrastructure and addressing maintenance needs is an important part of a mitigation strategy. Passages require maintenance to remove debris or replenish substrate levels. Vegetation growth must be cut down around fencing to deter wildlife from breaching the fence. Checking fence integrity ensures that wildlife are not able to simply pass through and access the road, or get stuck in damaged sections of fence during the attempt.

Citizen science volunteers report any damage to the directional fencing back to TRCA in order to promptly address issues. In May 2017, TRCA staff replaced one damaged segment of the Animex fencing. Repairing the Animex fencing proved to be a simple process, as the fence is composed of numerous segments, allowing for easy replacement of damaged segments.

Additionally, in April 2017, TRCA staff line trimmed tall grasses within 1 metre of the Animex fencing. This was done in order to prevent animals climbing over the fence in the event the grasses fell or grew over the fencing.

3. Routine Maintenance Schedules

Roads require routine maintenance such as mowing, grading, ice control, etc. These practices may be altered in mitigation areas to help support conservation goals. For example, mowers and brush cutters used for shoulder maintenance may kill wildlife nesting, resting or hiding in grassy shoulders. Frequency of mowing, timing and mower blade height for different types of roadside vegetation can be adjusted to help avoid accidental deaths caused by this routine maintenance practice. Road shoulder grading also poses a threat for nesting females and their nests and hatchlings. Heavy machinery may kill nesting turtles and compacted road soils may cause nests to fail (i.e. not hatch).

4. Public Awareness

Effective road ecology projects require funding. Some projects use funds from a combination of public, private sector and fundraising sources. Typically, government or municipal funds (i.e. public tax dollars) constitute a portion of a project. Raising public awareness, engaging local residents and organizations and garnering support for local road mitigation projects facilitates the ease and pace with which projects may proceed. This may include ensuring local residents, community groups and businesses are aware about legislation (i.e. Endangered Species Act 2007) that mandates protection of SAR from primary threats such as roads. Once there is an understanding that mitigation is required, corporate compliance follows and opportunities for sponsorship of a road ecology project may be explored.

Other aspects of raising awareness can include seeking media outlets (i.e. local newspaper, television station, social media, public events, etc.) and inviting them to learn about the project to encourage promoting this message to the public, ultimately moving this initiative forward. The community's local newspaper, the Brampton Guardian, has been actively involved over the years, resulting in continuous promotion of road ecology on Heart Lake Road (Table 3).

Table 3. Public awareness of Road Ecology at Heart Lake Road

Source	Title	Date
Brampton Guardian	Corpse counters needed	March 22, 2011
Brampton Guardian	Residents wildlife about survey	April 16, 2011
Brampton Guardian	Friends of wetlands	May 17, 2011
Creek Time e-newsletter	Heart Lake Road Wildlife Monitoring	May, 2011
Creek Time e-newsletter	Heart Lake Road Wildlife Monitoring - Update	January, 2012
Brampton Guardian	Motorists kill 90 turtles on Heart Lake Road in 25 weeks	February 9, 2012
Royal Ontario Museum Blogs	Ontario Road Ecology Group – Protecting biodiversity from the threats of roads	June 6, 2013
	TRCA Family Fishing Day Event	July, 2013
	Evergreen Brick Works, Stewardship Event	August, 2013
Brampton Guardian	Thousands dying on Heart Lake Road every year	October 8, 2013
YouTube	Heart Lake Road Ecology Project www.youtube.com/watch?v=E186zpcX45s	January 16, 2015
TRCA News	Dedicated Wildlife Culvert Installed on Heart Lake Road	August 4, 2016
Brampton Guardian	Wildlife dying on Brampton road that bisects significant wetland	July 21, 2017
Brampton Guardian	VIDEO: Matilda back in Brampton pond, but rescuer fears for turtle's safety	September 13, 2017
Brampton Guardian	4 things you didn't know about the Heart Lake Road wetlands	September 14, 2017
Brampton Guardian	Snow fencing should cut down on Heart Lake Road deaths	October 14, 2017

Materials and Methods

1. Site Description

The wetlands bordering Heart Lake Road represent a 99 hectare designated Provincially Significantly Wetland complex, scoring in the top 10 most important evaluated wetlands in Ontario out of nearly 1,500 evaluated wetlands (Appendix B).

There are a variety of amphibians, reptiles, mammals and birds residing within the wetlands. Most of these species are common, but some are of special concern for local or provincial extirpation (Appendix A). Road mortality is an important issue at Heart Lake Road, as the road bisects this wetland complex. A dedicated wildlife passage is located just south of Countryside Drive with 330 metres of Animex directional wildlife fencing installed along the road adjacent to both sides of the passage.

2. Road Ecology Monitoring

i. 2011-2014

TRCA engaged in a community-led citizen science monitoring effort along HLR. This effort to document WVCs led to a series of reports and presentations to CoB council that culminated in the adoption of mitigation measures discussed in this current report.

Extensive monitoring conducted by TRCA and citizen scientists has documented many WVCs since 2011. In 2013, these observations identified three mortality hotspots (Fig. 10).

ii. 2016-2017 Survey Methods

In 2016, TRCA developed a citizen-science based road ecology monitoring program with implementation at various sites around the GTA, including Heart Lake Rd. Staff trained volunteers to record WVC incidents, upload data to a mobile tablet and subsequently into a central database. During the 2016 and 2017 spring and summer seasons, monitoring took place between 9:00 a.m. and 12:00 p.m. on staggered days. Volunteers monitored HLR between Sandalwood Parkway and Countryside Drive, a distance of approximately 1.3 kilometres on each side of the road. The stretch of Heart Lake Road located north of Countryside Drive to Mayfield Road was minimally monitored due to limited staff and volunteer time.

iii. Safety Protocol

Staff and volunteers adhered to strict safety protocols following guidance from the Ministry of Transportation. Teams of three or four people conducted monitoring during daylight hours and only in dry conditions (Appendix C - Road Safety Protocol).

iv. Data Collection Tablets

Volunteers were educated in identifying and cataloging (using an electronic tablet) fauna encountered while monitoring the SA. Fauna encountered were categorized by species, with accompanying photographs for reference (Appendix D – Survey123 Road Ecology Survey App). Locations were recorded using the built-in GPS function in the tablet.

3. Other Survey Methods Used in 2017

i. Visual Surveys for Nesting Turtles

TRCA staff and volunteers also monitored the study area for evidence of turtle nests, with nest sites recorded as part of the road ecology monitoring protocol. No artificial protection, such as wire cages, were installed to cover the nests. In the past, nest cages had proven ineffective due to a combination of poor installation and determined predators.

TRCA staff and volunteer citizen scientists continued visually monitoring nesting beaches for any signs of nesting activity. Inspection of turtle beaches occurred during regular road ecology monitoring days.

ii. Wildlife Camera and Sand-Trapping in the Dedicated Wildlife Passage

TRCA staff installed a wildlife camera at the midway point inside the passage on June 6, 2017. The camera was set to take a burst of three photos upon detection of wildlife movement. The camera was housed in a locked security box, secured on a four-legged stand, with leg bases sunk into the organic substrate lining the bottom of the passage. The lock-box was tethered to an aircraft cable anchored to the ladder inside the passage (Fig. 27).

Figure 27: Trail camera setup inside the wildlife passage

Figure 28: Striped Skunk walking through the installed sand trap

Shortly after installation, a sand trap was installed inside the passage within camera sight, in an effort to increase animal detection probability. Plastic trays were filled with sand substrate and laid end to end. Wooden barriers were erected to guide animals passing through towards the sand trap (Fig. 28). The sand trap was checked for new animal tracks whenever maintenance on the wildlife camera was required (i.e. changing the battery, switching out the memory card, adjusting the camera angle). During camera maintenance, oxygen and carbon monoxide levels were monitored from within the passage in accordance with safety protocol.

The camera was left mounted in the passage from June 6 to November 19, 2017. Due to technical difficulties with photo storage, there was a period of time between September 16 and October 24 where the camera was offline and not taking photos.

iii. Hydrology Monitoring of Wetlands

Hydrologists at TRCA previously installed piezometer monitoring wells at multiple locations throughout TRCA's jurisdiction. These wells housed water monitoring equipment recording water levels, water temperature, and water pressure over time.

There are three such piezometer wells located in the wetlands on Heart Lake Road. Due to significant changes in water levels within the wetlands since the summer drought in 2016, project staff was given access to these wells for data collected. Data were collected twice over the summer season from two of the three wells. Data from the third well was collected once, as vegetation growth in the wetland made it extremely difficult to locate.

Results and Discussion

1. Road Ecology Volunteer Efforts

When reporting on the results of a monitoring program, it is critical to also report on the amount of effort spent collecting the data (MacKenzie and Kendall 2002). Year-to-year variations in the number of WVCs may be a result in different sampling efforts rather than any actual changes in the number of WVCs due to mitigation.

Twenty hours in April was dedicated to a training session with all members of the public interested in volunteering for the project. Out of the twenty volunteers who attended the training session, only five volunteers continued monitoring for the duration of the monitoring season. These volunteers most often worked in groups of two or three. Monitoring began on May 1st, 2017, and ended on Oct 31st 2017, and took place three times a week on Tuesday, Wednesday, and Thursday mornings. Inclement weather during the monitoring period played a factor in the number of possible days for monitoring, as a few monitoring days were ultimately cancelled due to rain, according to safety protocols. Monitoring is not able to occur before sunrise or after sundown due to permit regulations.

On average, each monitoring session required approximately two to four hours to set up safety equipment, monitor the road and shoulder, record incidents and store safety equipment in an equipment box located on site. A total of 343 hours were spent monitoring Heart Lake Road, not including the 20 hours of training, over the course of 76 monitoring sessions. If each monitoring session took three hours, on average, to complete, then this means that Heart Lake Road was monitored during approximately 9.5% of the available time (available time being the total amount of daylight hours from May 1st to October 31st).

Doodle polls (Fig. 29) were used to manage the timetables and Track-it-Forward (Fig. 30) used to manage volunteer hours and awards.

Figure 29: Doodle poll schedule for citizen scientist participants

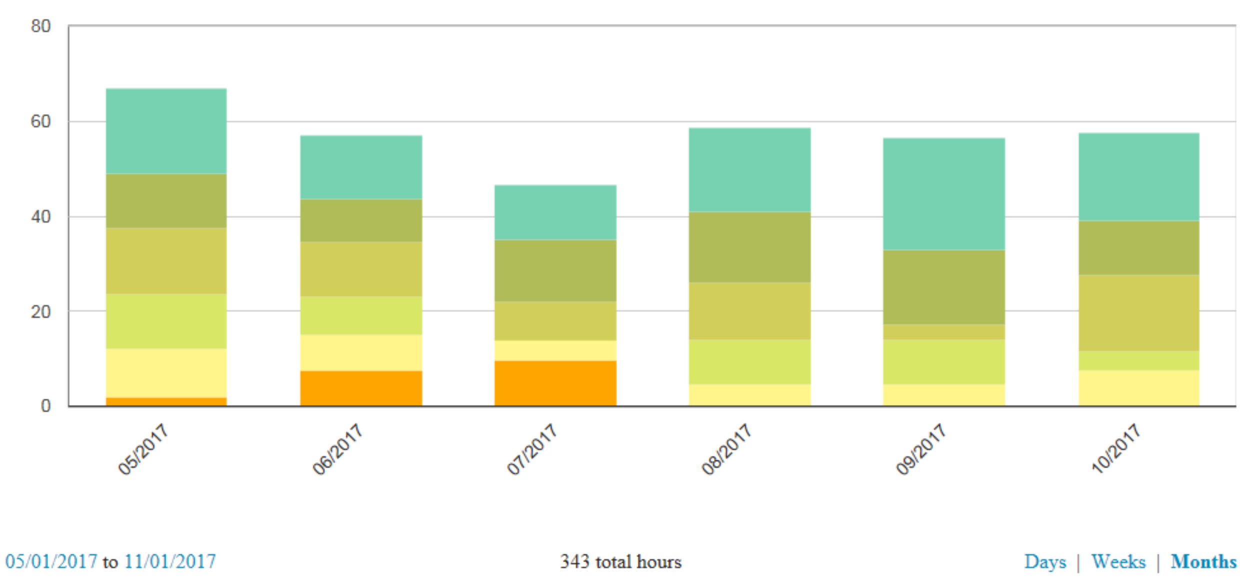

Figure 30: Track-it-Forward chart of citizen scientists' contributions during the monitoring season

2. Effectiveness of Mitigation Measures

In 2017, a total of 675 WVCs were recorded along the monitored stretch of HLR, as seen in the figure and table below (Fig. 33 and Table 4). For a gallery of photos, refer to Appendix E.

Generally, road mortality was highest along the identified unmitigated hot spots #1 and #2 near the wetland. The mitigated area (outlined in red) seems to have seen a reduction in the number of WVCs relative to the other hotspots (Fig. 33). However, the introduction of the new road ecology survey app and the field tablets led to considerable technical issues, specifically with the GPS locations of observation points. Therefore, some of the coordinates seen in the map figures (Figs. 33-39, 44) may be skewed or missing. This has resulted in some of the points on the figures being located a considerable distance from Heart Lake Road in areas not monitored.

i. Wildlife-Vehicle Collisions in 2017

An increase in bird fatalities were observed with 52 birds involved in WVCs in 2017, an increase from the 15 bird WVCs reported in 2016. One of the bird fatalities was a Trumpeter swan, a species that was once at risk of extirpation in North America but has since been recovered through human intervention. The Animex directional fencing was not designed to prevent birds from accessing the road, which explains why birds are still being hit by vehicles in the mitigated area (Fig. 34).

There was a significant increase in the number of frogs killed on the road in 2017, with 458 records collected in contrast with the 167 records collected in 2016. Most of this increase comes from increased numbers of leopard frogs found after the snow fencing installation event (235 leopard frogs reported this year compared to 28 reported last year). Anecdotally, it appears that most of the frog mortalities occurred outside of the mitigated area (Fig. 35), which suggests that the Animex exclusionary fencing is effective at preventing frogs from accessing the road. It is still unclear if the observed levels of frog mortalities seen outside of the mitigated area caused by road traffic have any long-term effect on population demographics.

This year included 65 WVCs involving mammals along Heart Lake Road. Based on the general spread of observations along the road (Fig. 36), it does not seem as if the Animex fencing has eliminated mammal mortality. The camera mounted to the inside of the passage captured considerable sightings of mammal movement, indicating possibly fewer mammals using the road to cross to adjacent wetlands.

There were 17 snake-related WVCs reported in 2017, almost all of which involved the Eastern gartersnake (Fig. 37). In the history of this study, snake WVCs have always been reported in low numbers relative to other taxa (7 snakes in 2016, 2 snakes in 2015, 37 snakes in 2013, 17 snakes in 2011). Local snake populations have not been studied, so it is uncertain if past accumulation of road mortality incidents have depleted the population.

The 75 turtle-related WVCs observed this year are most concerning (Fig. 38). The increase from 28 turtles found in 2016 to 75 turtles found this year may have been a result of the summer drought in 2016, leading to non-existent water levels in both east and west wetlands north of HLCA entrance. Turtles that migrated out of the dry wetlands in 2016 may have returned this year with replenished water levels, contributing to the increase in turtle WVCs. As of April 2018, the Committee on the Status of Endangered Species in Canada (COSEWIC) had designated all native Ontario turtles as at-risk populations.

Throughout the monitoring season, deceased turtles found relatively intact were scanned for pit tags from 2014 and 2015's turtle population study. A male midland painted turtle pit tagged with the ID# 985 1530 00342483 was found on May 29, 2017. All other turtles were sexed where feasible. Most turtles found during monitoring were hatchlings or juveniles, making them difficult to sex. All 22 snapping turtles found were hatchlings, with the exception of one juvenile and one that was impossible to identify due to extent of damage to remains. Most of the midland painted turtles were also difficult to age or sex due to the condition of the carcasses. Of the 56 reported, there were 2 hatchlings, 11 juveniles, 5 adult females, and 8 adult males definitively identified by photo review. These observations do not necessarily indicate that females are no longer most vulnerable to road mortality. The Heart Lake Road turtle population study did identify a significant male bias in the population (Dupuis-Désormeaux et al. 2017), which could explain why more male midland painted turtles were identified on the road in 2017.

The number of unknown WVCs (unknown group or species) was reduced from recent years to 8 (Fig. 33). Previous unidentified fatalities are; 21 in 2016, 56 in 2015, 28 in 2013, and 14 in 2011. This demonstrates an improvement in identifying animal types by road ecology volunteers, who tend to return in subsequent years to conduct monitoring.

As shown in Table 4, volunteers recorded 272 unknown (UNKN) where identification of animal group is established, but not the species (Fig. 31). As shown, the image is a snake fatality but was not able to be confirmed precisely as an eastern gartersnake or other species. Other recordings of UNKN are primarily blood stains or completely decimated and unrecognizable remains (Fig. 32). Overall, the number of unidentifiable remains speaks to the velocity of vehicles along Heart Lake Road.

Figure 31: Unknown snake species WVC

Figure 32: WVC evidenced by blood stains on the road

Volunteers discovered approximately 12 turtle nests along Heart Lake Rd, however this number might be incorrect due to discrepancies in how the nests were reported. Some volunteers may have reported multiple nests into one record, or reported the same nest twice after observing predation. Volunteers were instructed to flag potential nests on roadsides in an effort to reduce the chances of nests being recorded multiple times. Technical issues with GPS locations occurred in areas where larger numbers of nests were observed (west side of Heart Lake Road throughout hotspot #1), resulting in some nests recorded not being displayed on the map (Fig. 39).

The level of road mortality evidenced at Heart Lake Rd is unsustainable for species with longer life spans and slow reproducing rates such as turtles. This 2017 survey adds another year of data to a growing body of evidence in this study area and indicates high mortality rates for herpetofauna without implemented mitigation measures.

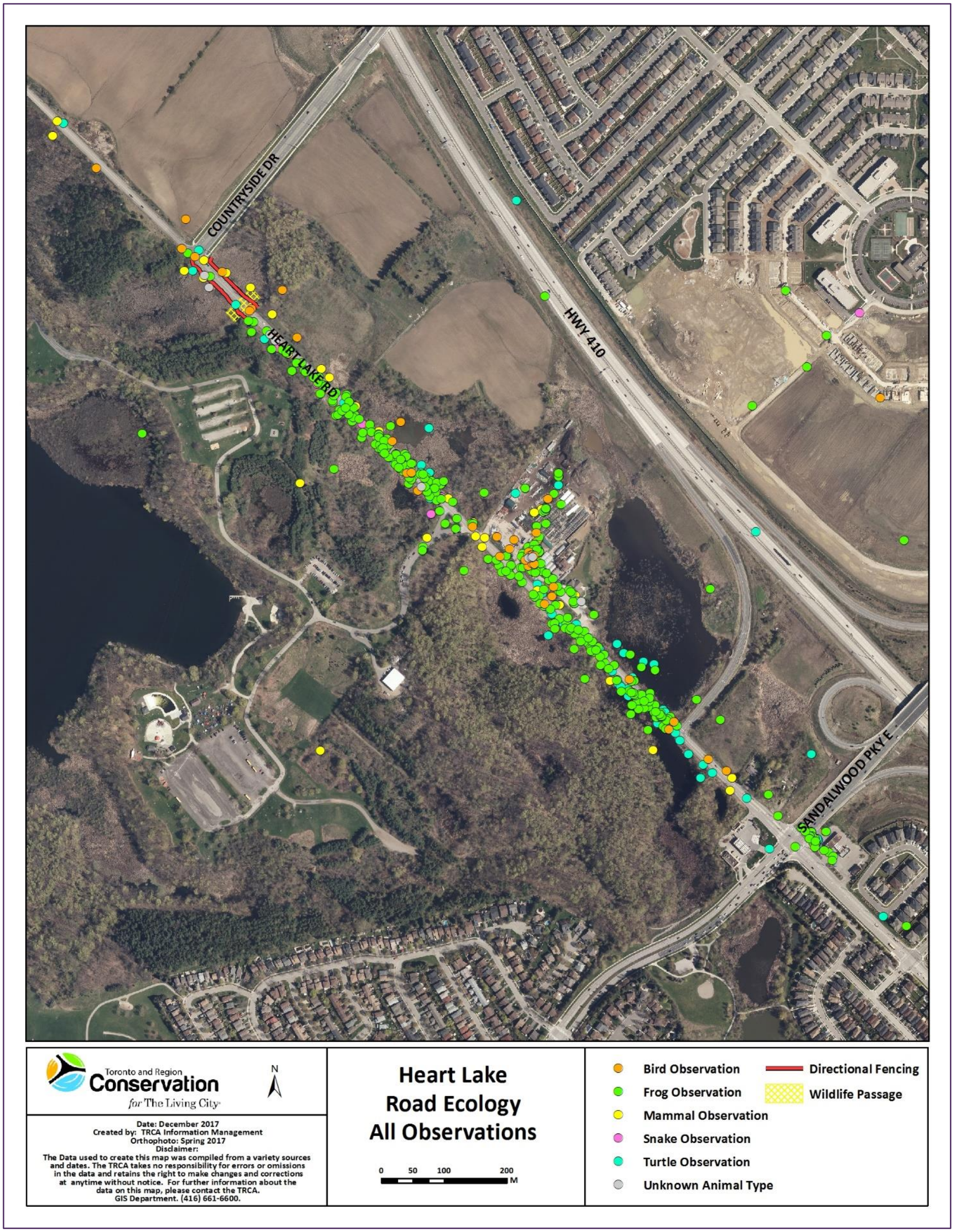

Figure 33: Map of all WVCs along Heart Lake Road

Figure 34: Map of all Bird WVCs along Heart Lake Road

Figure 35: Map of all Frog and Toad WVCs along Heart Lake Road

Figure 36: Map of all Mammal WVCs along Heart Lake Road

Figure 37: Map of all Snake WVCs along Heart Lake Road

Figure 38: Map of all Turtle WVCs along Heart Lake Road

Figure 39: Map of all turtle nests found along Heart Lake Road

Table 4. Record of 2017 wildlife fatalities along Heart Lake Road

Wildlife Type	Number	Species
Bird	52	AMGO(13), AMRO(5), DOWO (2), HOSP (1), REVI (1), RWBL (2), SAVS (1), TRUS (1), UNKN (24)
Frog/Toad	458	BUFR (1), TGTF (1), GRFR(26), LEFR(235), UNKN(194), WOFR (2)
Mammal	65	AMMI (1), DEMO (4), EACH(4), EACO (2), GRSQ(7), MEVO(2), MUSK(1), RACC(7), STSK (5), UNKN (27), VIOP (3), WTDE (2), WOOD (1)
Snake	17	EAGA (13), UNKN (4)
Turtle	75	MPTU (56), SNTU (22), UNKN (23)
Unknown	8	
TOTAL	675	

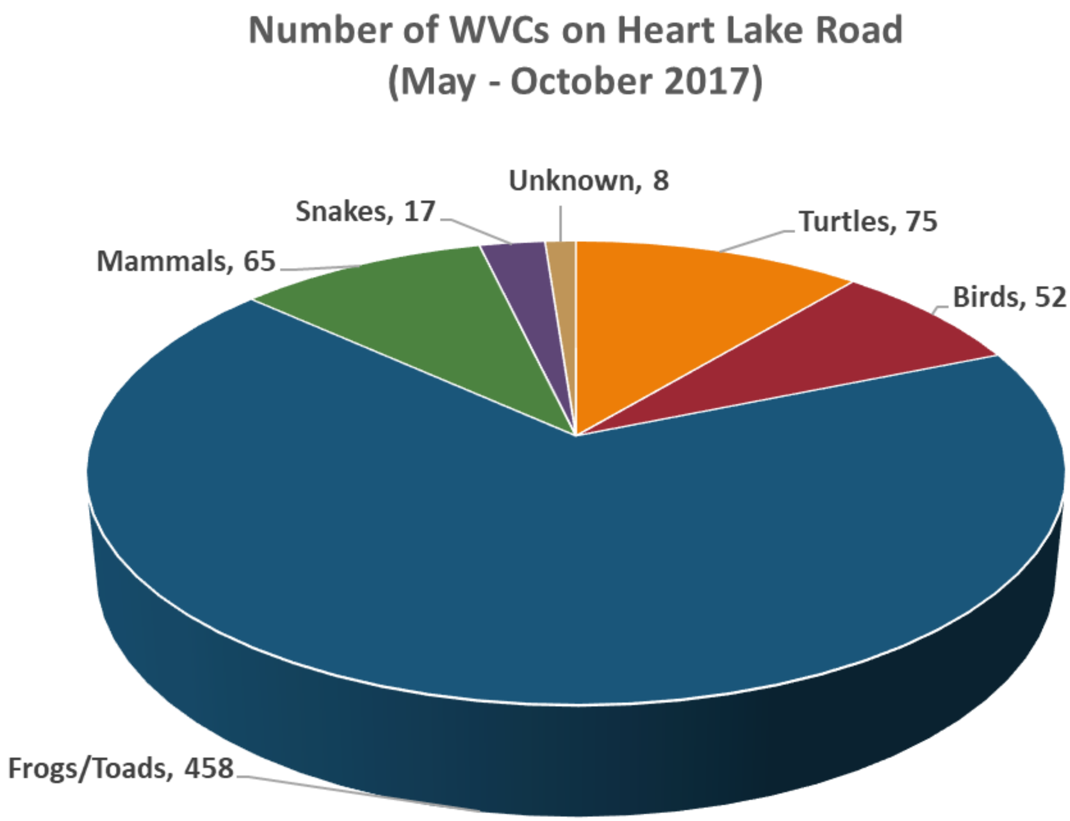

Figure 40: Heart Lake Road Fatalities 2017

ii. Year-to-Year Reporting and Monitoring Effort

The number of WVC incidents that occurred in and around the mitigated area was examined in an effort to investigate how effective the directional fencing and wildlife passage are at preventing road mortality. There appears to be a significant difference in the number of all WVCs in this area since mitigation occurred, suggesting a high level of effectiveness of the fencing and passage (Fig. 33).

Due to the unreliability of the location data, we must also consider other ways to estimate the effectiveness of mitigation measures. One way to do so is to examine the total number of WVCs recorded relative to the amount of monitoring time and effort over the years of the project (Fig. 41).

As seen below, there was a large dip in the number of WVCs in 2015, which coincides with a decrease in the number of weeks monitored and the percentage of available time that was monitored.

The number of WVCs recorded in 2017 was reduced, indicating installed mitigation measures are effective at reducing wildlife road mortality.

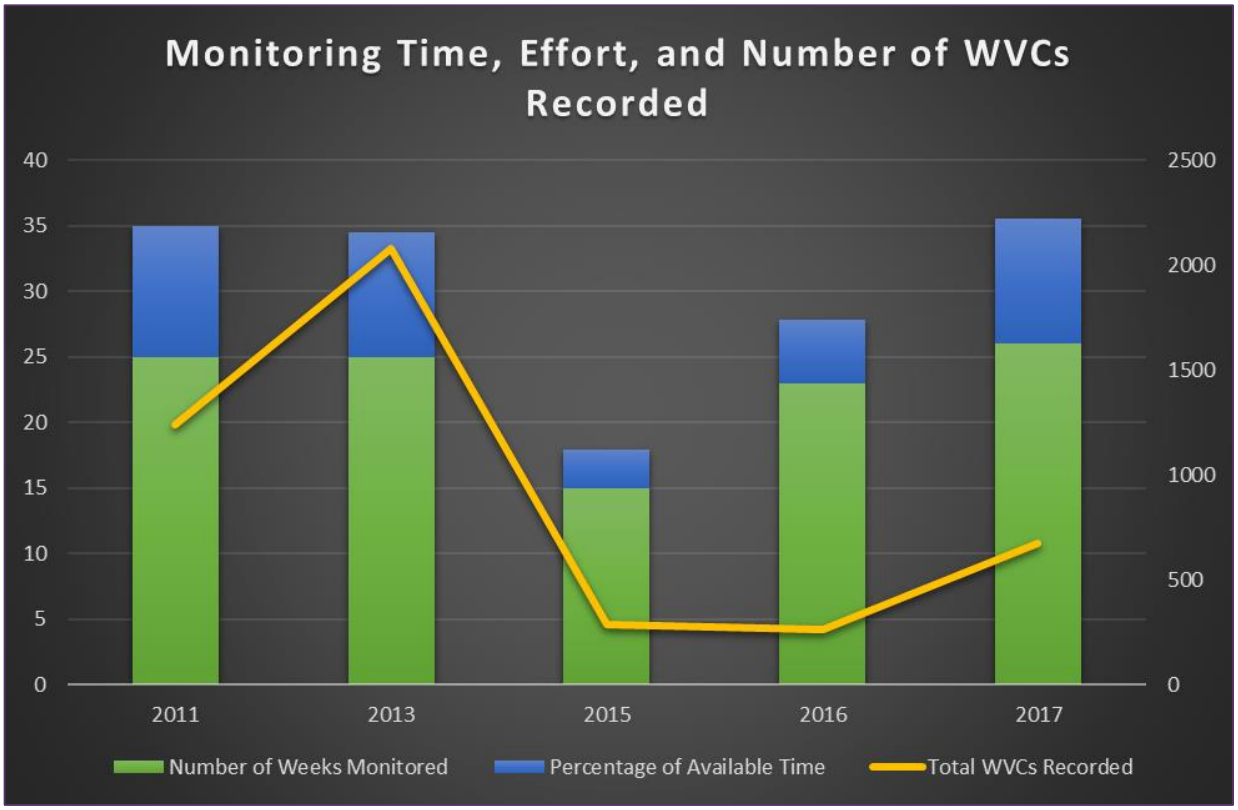

Figure 41: Annual comparison of monitoring time, effort, and relation to number of WVCs observed

Unfortunately, unless mitigation measures can be implemented along the entire stretch of road in the study area, temporal comparisons in the overall number of WVCs are unable to provide any significant answers. This sample size is still too small to make any significant statements about the effectiveness of the mitigation infrastructure. As such, there are a number of alternate explanations for this decrease in the number of WVCs along Heart Lake Road.

A decrease in the number of WVCs may be due to local wildlife population declines resulting from constant road mortality. As mentioned previously, female turtles are most at risk of road mortality given their seasonal movements back and forth between foraging and nesting sites (Dupuis-Désormeaux et al. 2017). Adult female turtles are the primary drivers of population recruitment and so any losses may result in significant population declines.

A drought in 2016, resulted in seven juvenile turtles being taken from the east wetlands north of HLCA entrance and moved apx 0.4 km to Heart Lake. It is possible given this significant drought some animals may have temporarily, or permanently, migrated to other wetlands.

Continued monitoring of Heart Lake Road with an emphasis on ensuring the same amount of monitoring time and effort is required in order to truly evaluate the effectiveness of the mitigation measures. This should be supplemented with additional wildlife population studies in the area to evaluate population health.

iii. Wildlife Passage Usage

Photos collected from inside the wildlife passage confirm that animals were using the passage as intended. As previously mentioned, the camera was set up to take a burst of three photos whenever the sensor detected movement. Over twenty weeks, a total of 455 photos captured animals using the dedicated wildlife passage. All photos taken were of mammals, with a majority capturing raccoons (Fig. 42). Species photographed included: raccoons, grey squirrels, striped skunks, eastern cottontails, Virginia opossums, and American minks.

Figure 42: Family of raccoons walking through the wildlife passage


Figure 43: Grey tree frog found in the wildlife passage on August 17, 2017

Despite a lack of photographic evidence, herpetofauna are still using the passage, and may not be getting detected on the camera due to size. While performing routine maintenance on the trail camera in mid-August, TRCA staff noticed a grey tree frog in the middle of the passage that was too small to have been detected on the camera, or to have made an imprint in the sand trap (Fig. 43). Volunteers and staff have noted a number of leopard frogs at the entrance of the passage on several occasions. Other detection strategies (i.e. photos taken at constant intervals or video surveillance, etc.) will need to be implemented next season to ensure wildlife presence in the passage is better represented.

iv. Snow Fence Installation Event

During and shortly after the installation of the fence, 109 different observations of wildlife road mortality were reported (Fig. 44). A large majority of these reports (approximately 81%) were Northern Leopard Frog, *Lithobates* pipiens. This frog species utilizes both aquatic and terrestrial environments for breeding, foraging, and overwintering activities and are most likely found in the riparian zone of the Heart Lake Wetlands closest to the road. It is possible that the disturbance related to the snow fence installation contributed to the number of frog fatalities observed after this event. Working with CoB, safer maintenance practices and schedules should be determined to reduce the consequences of extraordinary roadside measures and augment mitigation efforts.

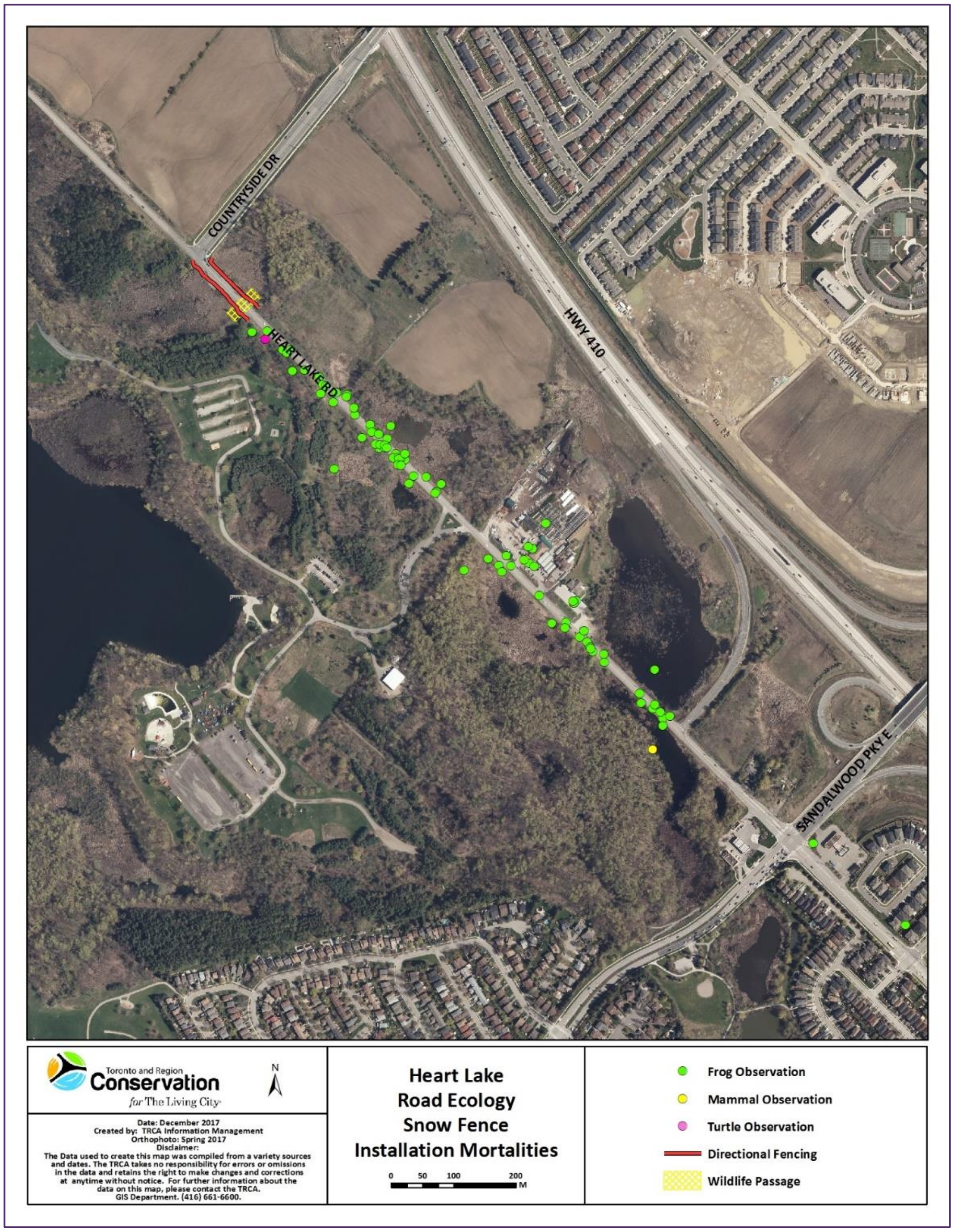

Figure 44: Map of all mortalities observed along Heart Lake Road immediately after snow fence installation on October 5, 2017

3. Weather

According to Weather Statistics Canada, 2016 had an extremely dry spring and summer, with only 307.0 total millimetres of precipitation in Toronto; the driest on record since 2007 (279.2 millimetres). It was also the second hottest summer on record, with 36 days above 30 degrees

Celsius. These extremely dry conditions, especially during the active season for herpetofauna, may have contributed to adverse effects for this provincially significant wetland and wildlife. The wetland in the mitigated area was completely devoid of water by the end of June 2016. Turtles were not evident and rescue efforts by TRCA staff in late July 2016, netted six juvenile turtles being relocated to nearby Heart Lake.

In 2017, considerably more precipitation in the spring and summer months were recorded, with 539.0 millimetres of precipitation (Fig. 45). This significant change in precipitation levels has seemingly altered the vegetation composition of the wetlands, resulting in increased areas of grasses, sedges and cattails (Fig. 46). These significant vegetation growths may have acted as a barrier to movement for resident turtles, preventing them from successfully using the wildlife passage. It is important to note that most of the vegetation present were Common Cattail, as CoB conducted control methods of phragmites within Heart Lake Road wetlands for the past two years.

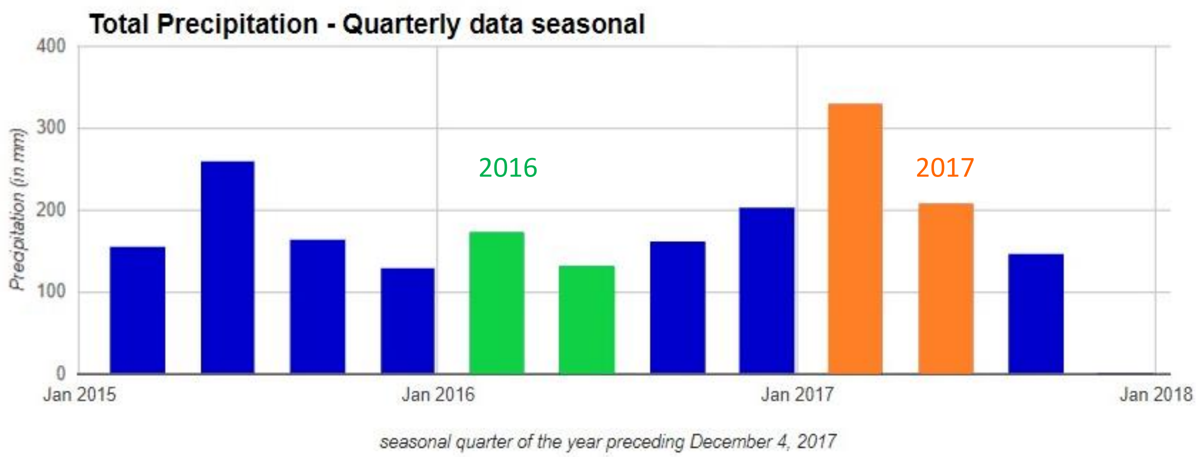

Figure 45: Seasonal precipitation data over the last three years, as of December 4, 2017 (Courtesy of Weather Stats Canada)

Figure 46: Heart Lake Road wetland vegetation, June 2017

4. Hydrology Data

Results downloaded from hydrology monitoring wells at Heart Lake Road had abnormalities requiring attention for 2018. One of the hydrology wells monitored (HLR-2) had poor air circulation. This resulted in pressure not being equalized between the inside and the outside of the well. Water level data, the primary metric and reason to monitor, was unreliable.

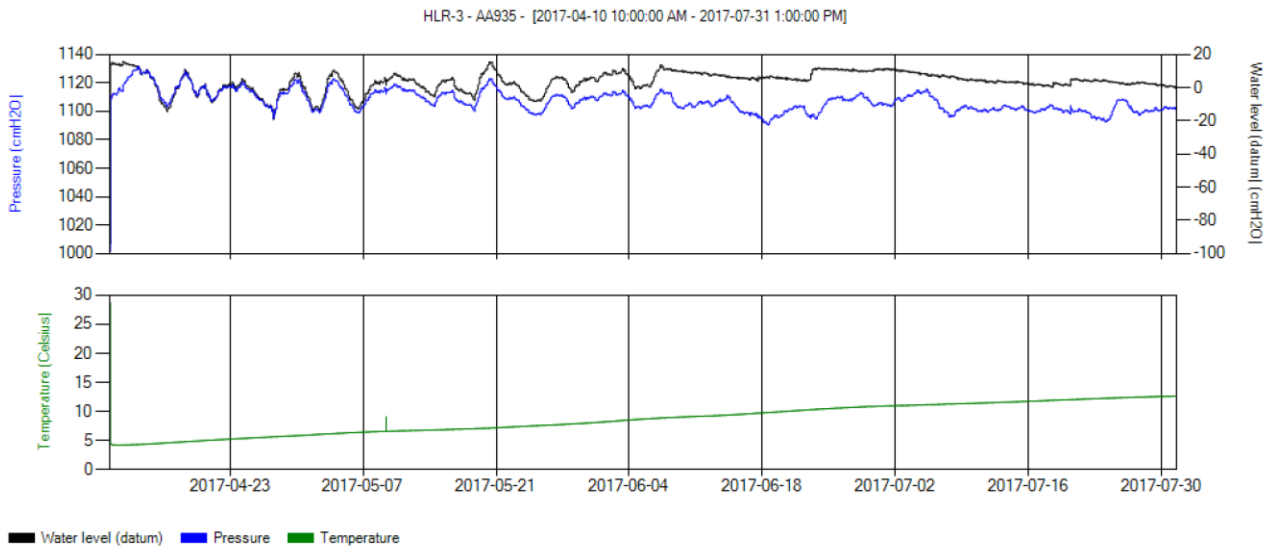

Figure 47: Heart Lake Road wetland vegetation, June 2017

Hydrology well (HLR-3) displayed water level readings that slowly increased over the summer, until it plateaued, with only slight variations in mid-June (Fig. 47). This well was located within ten metres of the entrance to the wildlife passage and these readings suggest possible water flow through this area.

Over the spring and summer, temperatures rose gradually as expected (Fig 47). However, the water temperature did not seem to be influenced by rain events, which occurred multiple times over the spring and summer. This suggests that Heart Lake Road wetlands being fed by groundwater rather than surface water. The temperature measurements from HLR-2, which were unaffected by the imbalance in pressure, also followed the same trend.

Lessons Learned and Key Recommendations

- What went right: Passage and fencing design
- What went wrong: Snow fence installation, data collection tablet technical issues, hydrology monitoring
- Variables: Rainy summer, significant vegetation growth in the wetland

1. Directional Fencing

An integral part of a wildlife passage solution is directional fencing specialized to the particular class of animal targeted (McCollister and Van Manen 2010, Pagnucco et al. 2012). Directional fencing has proven to be very effective in keeping herpetofauna from roads (Dodd Jr. et al. 2004, Aresco 2005). However, fencing on its own can lead to habitat fragmentation, long-term instability, and lack of resilience within fenced populations (Jaeger and Fahrig 2004). Due to this deficiency, fencing solutions are usually paired with wildlife passages.

Based on the very limited number of turtles, frogs and snakes recorded in the mitigated area, it would seem that fencing is restricting access to the road for targeted species and not diverting movement to fencing edges. The small number of incidents at fencing edges may be from animals following the fencing, escaping the 180-degree turn-back and finding their way to the road.

i. Extending Fencing to Other Hotspots

Given the success of exclusionary fencing installed, it is highly recommended to extend the treatment further south to encompass Hotspot #2, where the majority of WVCs were observed in 2016 and 2017. Fencing should also be considered for areas surrounding Hotspot #1. If exclusionary fencing is contemplated for the two other hotspot locations, then alternative nesting grounds should be provided.

ii. Seasonal Wildlife Directional Fencing as an Option

One type of mitigation measure that may be beneficial in certain cases is seasonal wildlife directional fencing. Seasonal fencing is a temporary measure whereby costs can be saved by putting up fencing that is durable enough to only last one season, and then replacing it annually. In this case, fencing would be in place when seasonal migrations of target species occur. It is a viable option in cases where purchasing permanent fencing, such as the Animex fencing used at Heart Lake Road, is too costly and not a desirable expenditure. However, road ecologists have recommended that more permanent mitigation measures should be prioritized over temporary mitigation (Garriga et al. 2017).

If seasonal wildlife directional fencing is being seriously deliberated at a site, a number of important factors should be considered. First, the type of temporary fencing installed must cater to the target species. Wood slat snow fencing, while cost-effective, may only be successful at ensuring large mammals and bird species do not have access to the road. Smaller herpetofauna, like frogs, toads, and snakes, and climbing species, like turtles or smaller mammals, could still possibly pass through a snow fence barrier. Certain modifications along the base of the fence should be implemented to prevent smaller animals from getting through the slats.

Secondly, timing of installation for temporary fencing must be carefully considered. During the season, wildlife sightings, in particular snakes and leopard frogs, are abundant along the gravel shoulder and vegetated area adjacent to the road. The wood slat temporary fencing installed in 2017 required the use of machinery to install posts. The noise and vibration caused by this machinery resulted in the animals seeking safety which unfortunately included the road. The ecology and seasonal behavior of target species must be determined and installation must occur outside that time frame (i.e. prior to spring emergence to avoid significant frog mortalities). As in most road ecology applications, numerous species from a variety of groups are targeted, and as such, installation windows might be quite limited if seasonal migration events or movement behaviours do not overlap amongst taxa. If seasonal fencing is considered as an option, consultation with wildlife behavioural experts should occur prior to installation and removal.

Finally, the cost of labour for installation of seasonal fencing should be explored to ensure costs justify financial savings of purchasing permanent fencing solutions. It may be that permanent directional fencing might be more cost-effective in the long run. At Heart Lake Road, the installation and removal of seasonal fencing took three to four days, whereas installation of the Animex fencing in 2016 took approximately 10 days. The total amount of labour spent installing and removing seasonal fencing year after year would easily exceed that of installing permanent fencing.

iii. Maintenance Regime

Success of any exclusionary fencing system depends on keeping the system in working fashion (Baxter-Gilbert et al. 2015). Breaches in fences can occur due to material stress, weather, vegetation overgrowth, debris, etc. A regular maintenance schedule is crucial to ensuring fences are functioning properly. The dedicated wildlife passage needs to be kept clear of debris at entrances and continued regular inspections of substrate is recommended to keep the passage appealing to wildlife.

2. Citizen Science Program and Public Outreach

The concern and engagement of local residents has been a key component in the success of this project. TRCA and CoB look forward to continued partnership with community members and engaging local residents who drive along Heart Lake Road. As a strong proponent of citizen science initiatives, TRCA hopes to grow and advance all citizen science projects, encourage public participation, and improve the quality of collected data sets.

i. Monitoring Effort

In 2017, there were five volunteers regularly monitoring Heart Lake Road throughout the season. In contrast, there were 17 volunteers at the beginning of this project in 2011. Despite this drop in number of participants, monitoring effort has remained relatively consistent (Fig. 41), which speaks to the dedication of this group of volunteers. TRCA staff would like to focus on recruiting more participants in an effort to ensure consistency continues or improves in 2018. Methods to achieve this goal include; participation in town hall meetings, community recreational events, other public outreach occasions, and through word of mouth via current and past citizen science volunteers.

ii. Volunteer Training

While volunteers are extremely well-trained in locating wildlife-vehicle collisions and identifying species based on remains, there are some discrepancies that will be addressed through training for the next monitoring season.

Some difficulties occurred in identifying non-native species found within the wetlands. The red-eared slider is a non-native turtle species, are most often the result of illegal pet release, and can be mistaken for a midland painted turtle. Species identification guides are provided at initial training sessions, are part of the equipment kit, and do include species native to Ontario along with non-native red-eared sliders. In future training sessions, additional non-native species will be added to further educate volunteers on species that may be present in wetlands as a result of illegal pet release.

In 2017, discrepancies in identifying and reporting turtle nests resulted predation of eggs before nests could be protected with nest cages. Some nests reported by volunteers were actually small mammal tracks or damaged road shoulders. Oftentimes nests initially documented were recorded a second time. Once this issue was identified, survey flags were provided so volunteers could flag any located nests. Refined protocols will be revised and put in place to ensure a higher degree of accuracy is met when reporting nest locations for 2018.

iii. Data Collection Tablets

The implementation of electronic tablets and the Survey123 app for monitoring gave volunteers the opportunity to be more detailed in protocols with data collection. Volunteers were able to attach multiple photos for species ID verification, attach accurate GPS coordinates to each observation and add additional comments. Data sets were easier to read, more consistent and required no additional staff time for data input. Overall, electronic tablets improved the process of data collection for this project when compared to using paper data sheets.

One issue experienced with electronic tablets was learning steps of including data and becoming familiar with attaching photos and input all values required. This hurdle was corrected as volunteers became more familiar with Survey123. Training sessions in 2018 will include additional time practicing the app to allow volunteers to become familiar with each step prior to field use. Improvements to the user interface and functionality of the Survey123 app will be explored to allow ease of use.

The primary issue experienced with data collection tablets involved poor GPS accuracy. Opportunities to upgrade the tablets used for data collection or providing a cellular data plan for the current tablets should be explored in 2018 to ensure a higher accuracy in GPS readings.

iv. Public Outreach

Public outreach in 2017 resulted in numerous stories related to the project being published in City of Brampton's local newspaper, the Brampton Guardian. These stories garnered strong public support for reducing road mortality on Heart Lake Road, as evidenced by the installation of snow fence in October 2017. This support should motivate project partners to increase public outreach initiatives in 2018.

3. Dedicated Wildlife Passage

Oversize concrete culverts as wildlife passages and other ecopassage options are examples of mitigation measures allowing wildlife to cross roads safely (Baxter-Gilbert et al. 2015). It is important that installation be in tandem with directional wildlife fencing to act as a connection between fragmented habitats. The effectiveness of dedicated wildlife passages must be constantly reevaluated and maintained after installation to insure they continue to work as intended.

i. Temperature and Ectotherm Usage

Long-term studies of dedicated herpetofauna wildlife passages remain scarce. There is evidence that reptiles and amphibians have used other dedicated wildlife passages but effects on population numbers and demographics is almost non-existent (Lesbarrères and Fahrig 2012).

The wildlife camera mounted in the wildlife passage was unable to capture evidence of reptiles or amphibians passing through. At present, reasons are unknown as to why herpetofauna are not utilizing the passage but it is possible temperatures are not suitable for ectotherms, not enough light or the camera is not catching movement due to size of animal.

At the time images are taken, ambient temperatures are recorded. Temperature readings of the passage were consistently 10-15 degrees cooler than outside air temperature, possibly deterring herpetofauna from entering. These temperature readings may not be reflective of what herpetofauna might experience in the passage (i.e. cooler on the floor of the passage than at the ceiling), so temperature should be monitored in future to explore this possibility.

ii. Wildlife Passage Usage Sharing

Due to significant use of the passage by predator species (i.e. raccoons), it is possible that prey herpetofauna species may be actively avoiding the dedicated wildlife passage. According to Clevenger and Huijser (2011), low mobility of small and medium sized mammals and reptiles tend to use passages of a size that allow for movement but may limit movement of larger predators.

In the case of juvenile turtles and local snake species, which are amongst the target species for the dedicated wildlife passage at Heart Lake Road, raccoons are one of the most abundant predator species in the region and their usage of the passage is most likely a detracting factor. Clevenger and Huijser recommend meeting cover requirements of smaller fauna by placing pipes of varying diameter that span the entire length within the passage. Wildlife underpasses targeted towards large mammals have used organic materials (i.e. bushes and other types of vegetation) for cover as well. If continued monitoring of the passage does not result in observations of herpetofauna usage, methods that provide more cover from predator species within the passage should be considered.

iii. Wildlife Passage Monitoring

Without effective monitoring of the dedicated wildlife passage and wildlife directional fencing, it is difficult to say how many animals have used the passage versus how many animals have been dissuaded from crossing altogether.

It is also possible that more animals than observed are using the wildlife passage but are not detected by current methods. Staff conducting routine maintenance observed a grey tree frog in the passage despite there being no record on the trail camera. Motion detection currently used to monitor the passage may not be sensitive enough to detect smaller target species, like frogs, snakes or juvenile turtles.

Other studies monitoring dedicated wildlife passages for herpetofauna have discovered other methods to improve wildlife detection. Some have set up trail cameras to record photos at a specific time interval (Pagnucco et al. 2011, Colley et al. 2017). While this method increases the amount of time staff is required to screen and organize images taken, it may increase animal detection probability especially if the time interval between photos is short. Other monitoring projects done by TRCA have placed the camera closer to the study area in an effort to improve detection (S. Hayes, pers. comm.). Alternatively, installation of wooden ramps would guide animals closer to the camera's detection zone.

Another recommendation is purchasing a second trail camera to allow monitoring of both entrances of the passage to detect movement. Angling the camera towards the floor of the wildlife passage and away from light sources at entrances may improve contrast quality of photos taken. New mounting methods to accommodate these changes and securely fastening cameras to prevent vandalism and removal from the passage will be employed in 2018.

4. Turtle Nesting

Adult female turtles are most at-risk of road mortality relative to other sex and age classes of turtles and mitigation strategies are required to account for nesting behavior. Turtle nesting mounds installed away from roads are a viable option to attract females during egg laying. Nesting mounds are often used in road mortality mitigation strategies that list turtles as a target species.

i. Encouraging Turtle Beach Usage

Existing turtle nesting mounds resulted in no visible activity during the 2017 season. Both snapping and painted turtles are known to have high nest fidelity (Obbard and Brooks 1980, Rowe et al. 2005) and it is not surprising that turtles may continue to attempt to nest by the roadside until they are aware of nearby nest beaches. Take-up of the new artificial nesting mounds may take time, allowing for chance discovery of actively moving gravid turtles to the mounds to encourage nesting (Paterson et al. 2013). Gravid turtles may choose to nest on constructed mounds as long as they are located in close proximity to their usual nesting site (Buhlmann and Osborn 2011).

During the 2017 season, TRCA staff received multiple reports from Heart Lake Conservation Area staff and volunteers of nesting female snapping turtles observed in or around large piles of mulch. Staff also identified predated nests on a small pile of mulch approximately 10 metres south of the northwestern turtle nesting beach on Heart Lake Road. Based on these observations, in June 2017, mulch was lightly scattered over parts of the turtle nesting beaches at Heart Lake Road in an effort to attract nesting females. Mulch piles act as a soft substrate that constantly produces heat as decomposition takes place, but has not been investigated as a probable nesting site in scientific literature. A pilot project using mulch as a nesting site is being discussed and considered.

ii. Adding Beaches to Other Wetland Areas

Alternatively, installing additional turtle nesting mounds in the southern wetlands is a viable option to provide additional nesting areas throughout the wetlands. If exclusionary fencing is extended south towards Sandalwood Parkway, alternative nesting grounds should be provided to ensure acceptable nesting habitat is still accessible. These beaches would have to be floating beaches built within the wetland due to the high water levels in the southern wetlands.

In 2017, a number of turtle nests were observed and recorded on road shoulders adjacent to the south wetlands closer to Sandalwood Pkwy. Many of these nests had been predated shortly after initial observation and eggs that did survive resulted in significant hatchling road mortality. Turtle egg nests located on roadsides have a very low survival rate due to predation or roadside damage. Turtle beaches provide alternative nesting grounds for females and provide an area away from roads, assisting in reducing hatchling mortality.

iii. Nest Protection

Protecting identified nesting sites using wire-cages is a feasible method (Riley and Litzgus 2013) and practiced by TRCA staff and volunteers with varying degrees of success. Improvements in design of current wire cages is required to decrease predator ability to circumnavigate materials to affix the cage in place. Sweeping the surface of nesting sites does not effectively hide evidence of their location, and thus does not reduce predation (Geller 2015). Female turtles emit a scent during egg laying which predators easily detect. When observing a new nesting area, a method to assist in removing this scent and deter predators, is to apply water to the nest area, effectively washing away the scent. This scent will dissipate after a short period of time or with a rainfall.

5. Local Wildlife Population

There has been a reduction in the number of WVCs recorded in 2017, relative to observations pre-mitigation, but these lower numbers may not be as a direct result of mitigation without a clear understanding of the local wildlife populations. Declines in the abundance or richness of wildlife population can produce the same results as successful road ecology mitigation.

Wildlife population studies are key in understanding the nuances of changing wildlife populations and provide important insight on the success of mitigation measures. In the case of Heart Lake Road, the turtle and snake populations are two groups that would most benefit from a population study.

i. Turtle Population

While the Heart Lake Road Ecology Monitoring Project has conducted turtle population studies in the past, population dynamics of resident turtles are highly dependent on habitat characteristics of the Heart Lake Road wetland complex. This wetland complex has experienced significant changes over a short time period, given the drought in summer of 2016 and extreme vegetation growth observed in 2017.

Recruitment in turtle populations is also highly dependent on the number of adult females within the population (Paterson et al. 2013). Given the increased risk of adult female mortality due to the proximity of roads, it is important to evaluate turtle populations regularly as part of road ecology studies to ensure the population has not experienced significant declines.

Previous turtle population studies at Heart Lake Road involved turtle trapping and marking in an effort to create an inventory of the number of individuals residing in the wetland complex.

Future population studies should include a tracking component where locations and movement of the turtles are monitored via radiotelemetry. Understanding these movements and; when, where, and how often, turtles are crossing Heart Lake Road to access different water bodies will assist in implementing future mitigation strategies.

ii. Snake Population

There is minimal information on snake populations in the Heart Lake Road wetlands, as a study has not been formally undertaken. As previously mentioned, snake WVCs are low in relation to other taxa in the history of this study. However, in most other systems, snakes are at high risk of road mortality due to roads and roadsides being ideal basking sites. As such, it may be worth exploring to check if past accumulation of road mortality incidents have depleted the population.

6. Hydrology Monitoring

The first year of hydrology monitoring exposed a number of faults in methodology that can easily be addressed. Specifically, attention will be undertaken to ensure instrumentation is working optimally. Issues experienced with pressure imbalances are easily identified by conducting regular instrumentation checks and alleviated by drilling a hole into the well. Incorporating regular checks into a staff hydrology routine also allows an opportunity to recalibrate hydrology monitors by taking manual water depth measurements.

7. Traffic Calming Measures

Previous studies have identified traffic speed as one of the main factors contributing to wildlife fatalities (Farmer and Brooks 2012) and the number of wildlife road mortality events increase as traffic speeds increase. This is due to low detection probability and stopping time at higher speeds. The effect of traffic volume on road mortality is still not completely understood, though it is expected to predict a linear increase in WVC counts on secondary highways and smaller roads (Seiler 2005).

i. Reducing Traffic Speeds

In 2016, peripheral optical speed bars were implemented along HLR, north of Sandalwood Parkway and south of Countryside Drive. The impetus for peripheral pavement markings was to reduce average speeds of vehicles as they drove down Heart Lake Road. Research elsewhere into the effectiveness of optical speed bars has been mixed and at best can be considered marginal in its effectiveness, with multiple studies showing a decrease in speeds between 0 km/hr and 5 km/hr (Gates et al. 2008, Balde 2010, Balde and Dissanayake 2013).

A traffic survey was conducted by the CoB Public Works Department in 2013, prior to the implementation of the optical speed bars. In the time between June 7 and June 13, 2013, 85% of vehicles were travelling at an estimated speed of 78.1 km/h. Post-implementation of the optical speed bars in 2016, the average speed of travel had increased to 79.5 km/h. As such, it is unclear as to whether pavement markings have had any effect, positive or negative, on average speeds of vehicles using HLR.

Wildlife crossing signs were installed at select locations along Heart Lake Road, along with seasonal motion activated flashing lights in an effort to motivate motorists to slow down as they drive through the wetland. These types of signage have a very poor record of reducing WVCs and have been abandoned by many jurisdictions in the USA (Hammond and Wade 2004).

At this time, there is no evidence that signage implemented along HLR is effective, as no monitoring pre-post signage was in effect in 2016. Recent research on dynamic speed signage (where boards flash vehicle speeds to the driver when above the speed limit) is promising, with many papers showing a reduction in both average speed and in the number of speeders (Ardeshiri and Jeihani 2014, Gaca et al. 2016). Given the evidence provided from these and other cases, it might be worth implementing some additional, more effective types of signage on Heart Lake Road.

ii. Reducing Traffic Volume

Studies have shown that when roads have a large volume of cars they become nearly impassable to herpetofauna (Aresco 2005, Gibbs and Shriver 2005).

Traffic volume on Heart Lake Road is also of concern, as the number of vehicles that travel along this stretch on a daily basis has grown since the last traffic survey in 2013 (7,103 vehicles/day in 2016 vs. 5,903 vehicles/day in 2013). Previous studies have found a positive relationship between the traffic volume of a road and the number of WVCs on that road (Inbar and Mayer 1999, Mazerolle 2004, Coelho et al. 2008). Current assumption is that as housing developments around HLR continue to increase, there will be increased traffic volume. Based on the findings of this report, and what is known about how the local wildlife population interacts with Heart Lake Road, future developments would contribute to an increase in traffic volume in the area.

8. Wetland Improvements

Wetlands are the fastest disappearing habitat in urbanized areas, with scientific estimates showing that 64% of the world's wetlands have disappeared since 1900 (Davidson 2014). Generally, restored wetlands are of lesser quality than reference wetlands (natural wetland with high ecological integrity), and are on average 25% less functional (Moreno-Mateos et al. 2012, 2015).

Considering the loss of functionality of a restored wetland relative to reference wetlands and effects they can have on local wildlife populations, it is important to monitor and adaptively manage the health of wetlands to prevent the need for total ecosystem restoration.

i. Invasive Control

The quality of the wetland is especially important after severe weather events, like droughts or flooding. The drought of 2016 is one example of how climate can affect a wetland resulting in a complete change in vegetation composition, as observed in two of the wetlands along Heart Lake Rd. Vegetation composition, and microhabitats vegetation can create in an ecosystem, can influence wildlife population as well, directly affecting the ecology of nearby roads.

Invasive phragmites has historically been present within the Heart Lake Road wetlands, with stands shrinking or growing with environmental changes and invasive removal efforts. The City of Brampton has been actively involved in removing large stands of invasive phragmites from the Heart Lake Road wetland complex. Following the summer drought of 2016, when the entire wetland complex dried out, vegetation was given an opportunity to proliferate throughout the area. While phragmites was present in the wetland during 2017, common cattail was more abundant.

Phragmites removal is a long-term commitment, as the plant is highly aggressive and outcompetes native vegetation. It releases toxins into the soil through the roots, which can affect native plants. The best control method for phragmites is chemical application control however this method is regulated, follows strict guidelines, and requires special permits. The next most appropriate control method is a selective cut. Phragmites stalks are cut at their base as close to the substrate as possible and below the surface of the water. Seed heads are carefully cut and placed in plastic bags, in order to smother the seed heads and prevent seed dispersal during the removal process.

Complete eradication of phragmites stands can take two to three years and the site must be monitored annually to identify and control new growth. Smaller stands in early stages of growth are easier to eliminate than established ones. Project partners must continue to be vigilant and plan accordingly with the appearance of new phragmites within the wetland complex. The vegetation composition of the wetland must be closely monitored to identify additional plants that may be detrimental to the health of the ecosystem.

ii. Upcoming Developments on Heart Lake Road

There is a planned development bordering the wetlands on the southeast corner of Heart Lake Road and Countryside Drive consisting of residential, commercial and open space. Consideration should be given to this proposed development as it could potentially result in increased WVCs due to vehicle traffic through the study.

As of the writing of this report, the development is still in the stages of planning and approving site designs. This provides a unique opportunity for TRCA and project partners to approach developers and get involved in the planning process, which is critical when considering the impact development would have on the wetland and resident wildlife. By getting involved in this process, we can ensure that nearby green space is protected and that steps are taken to mitigate the predicted increase in traffic volume. Already there are plans to incorporate a public park and maintain some of the natural features of the area.

9. New Trends in Road Ecology

It is important to continuously monitor scientific literature for new trends in road ecology and road mitigation strategies.

Davey et al. (2017) propose incorporating an animal migration model into optimal road design during the planning process. They present a model that allows planners to find locations for roads that are able to maintain even small animal populations. Applying this model can be most cost-effective in the long run as it eliminates the need for extensive road ecology mitigation measures in the future.

One interesting concept that has recently emerged in the field of road ecology is the idea of using learning principles to create or extinguish aversive behaviours in animals living near roads. Proppe et al. (2017) propose using classical and operant conditions, which are well-documented techniques for altering animal behavior in response to novel cues and signals. Behavioural ecologists have used these conditioning techniques to mitigate human-wildlife conflicts, alter predator-prey interactions, and facilitate reintroduction efforts of at-risk populations. It is possible that learning techniques could be utilized to mitigate negative roadside behaviours in wildlife. While this is not a technique readily applicable at the Heart Lake Road study area, advancements in this concept as experimentation occurs should be closely followed in case it presents as a possible mitigation strategy in the future.

Conclusion

Since the installation of the directional fencing and dedicated wildlife passage in 2016, staff involved in the Heart Lake Road Ecology Project endeavored to answer a number of questions to evaluate the effectiveness of the mitigation infrastructure. Constant monitoring and revaluation allows adaptive management to reassess mitigation strategies to inform future decisions on additional mitigation steps for Heart Lake Road and other road ecology sites.

In 2017, staff and volunteers reported a reduction in the number of WVCs found within the mitigated area of Hotspot #3. In contrast, the unmitigated areas of Hotspots #1 and #2 are still experiencing similar levels of road mortality observed in years prior to the installation of mitigation infrastructure. In addition, trail cameras mounted to the inside of the wildlife passage were able to capture a number of mammals regularly using the passage to access wetlands. These observations demonstrate that mitigation strategies have been highly effective at decreasing frequency of WVCs and road mortality rates. Continued monitoring will occur in 2018 to strengthen these conclusions, make current datasets more robust, and deepen our understanding of effectiveness of the mitigation measures. Results from this study will be used to support future mitigation strategies considered for Heart Lake Rd and other candidate road ecology sites.

Based on the positive results observed to date with mitigation infrastructure installed in 2016, additional mitigation efforts are required to minimize road mortality on Heart Lake Road. Key recommendations include installing dedicated wildlife passages at Hotspots #1 and #2, extending Animex fencing around these Hotspots, and constructing additional turtle nesting beaches in these areas. Public outreach and growth of the citizen science aspect of the program, with an increased focus on volunteer recruitment, will be critical for the next monitoring season to ensure monitoring effort remains consistent with previous years. New electronic data collection applications will continue to be refined for use in 2018. Additional wildlife population studies within the study area are recommended focusing on populations of sensitive taxa.

Over the last few decades, challenges of urban conservation have grown critical due to rapid urbanization and the resulting growth and transformation of cities worldwide. Conserving biological diversity within urban environments is currently one of the most universally urgent and challenging natural heritage conservation issues. Heart Lake Road is only one example of how urbanization complicates wildlife conservation. The Heart Lake Road wetland complex is an important urban conservation challenge given that it is a designated Provincially Significant wetland in Brampton and adjacent to the biologically diverse Heart Lake Conservation Area.

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Appendix A

TRCA Fauna Species List – Heart Lake

Fauna Scores and Ranks, December, 2013.

Common Name	Scientific Name	Code	LO	PTn	PTt	AS	PIS	StD	HD	+	TS	L-Rank
Survey Species: species for which the TRCA protocol effectively surveys.												
Birds												
American redstart	*Setophaga ruticilla*	AMRE	0	3	2	3	1	4	2	0	15	L3
brown creeper	*Certhia americana*	BRCR	1	2	2	3	2	4	2	0	16	L3
common merganser	*Mergus merganser*	COME	5	3	2	3	2	2	2	0	19	L3
great blue heron	*Ardea herodias*	GBHE	3	2	2	3	1	4	2	0	17	L3
mourning warbler	*Geothlypis philadelphia*	MOWA	1	4	3	2	2	4	2	0	18	L3
pileated woodpecker	*Dryocopus pileatus*	PIWO	0	2	2	4	1	3	3	0	15	L3
Virginia rail	*Rallus limicola*	VIRA	1	2	2	2	3	4	3	0	17	L3
wild turkey	*Meleagris gallopavo*	WITU	0	1	0	4	3	3	4	0	15	L3
wood thrush	*Hylocichla mustelina*	WOTH	0	4	2	3	2	4	2	0	17	L3
yellow-billed cuckoo	*Coccyzus americanus*	YBCU	0	4	2	3	1	3	3	0	16	L3
belted kingfisher	*Ceryle alcyon*	BEKI	0	3	2	2	1	2	2	0	12	L4
blue-grey gnatcatcher	*Polioptila caerulea*	BGGN	0	1	1	3	1	3	1	0	10	L4
common yellowthroat	*Geothlypis trichas*	COYE	0	3	2	1	2	4	1	0	13	L4
Cooper's hawk	*Accipiter cooperii*	COHA	0	2	2	4	1	2	3	0	13	L4
eastern bluebird	*Sialia sialis*	EABL	2	1	1	2	1	2	2	0	11	L4
eastern wood-pewee	*Contopus virens*	EAWP	0	4	2	2	1	3	1	0	13	L4
great-crested flycatcher	*Myiarchus crinitus*	GCFL	0	2	2	3	1	2	2	0	12	L4
green heron	*Butorides virescens*	GRHE	0	3	2	2	1	4	2	0	14	L4
grey catbird	*Dumetella carolinensis*	GRCA	0	3	2	1	1	3	1	0	11	L4
hairy woodpecker	*Picoides villosus*	HAWO	0	2	2	3	1	2	2	0	12	L4
indigo bunting	*Passerina cyanea*	INBU	0	3	2	1	1	4	2	0	13	L4
northern flicker	*Colaptes auratus*	NOFL	0	4	2	1	1	3	2	0	13	L4
northern rough-winged swallow	*Stelgidopteryx serripennis*	NRWS	0	3	2	1	1	2	3	0	12	L4
pine warbler	*Setophaga pinus*	PIWA	0	1	2	4	1	3	3	0	14	L4
red-breasted nuthatch	*Sitta canadensis*	RBNU	0	1	2	3	1	2	1	0	10	L4
red-eyed vireo	*Vireo olivaceus*	REVI	0	1	2	2	1	3	1	0	10	L4
rose-breasted grosbeak	*Pheucticus ludovicianus*	RBGR	0	3	2	3	1	3	2	0	14	L4
ruby-throated hummingbird	*Archilochus colubris*	RTHU	0	2	2	1	1	2	2	0	10	L4
swamp sparrow	*Melospiza georgiana*	SWSP	0	1	2	1	2	5	1	1	13	L4
white-breasted nuthatch	*Sitta carolinensis*	WBNU	0	2	2	3	1	2	2	0	12	L4
wood duck	*Aix sponsa*	WODU	0	2	1	3	2	4	2	0	14	L4
American Crow	*Corvus brachyrhynchos*	AMCR	0	1	2	1	1	0	0	0	5	L5
American goldfinch	*Carduelis tristis*	AMGO	0	3	2	1	1	1	0	0	8	L5
Common Name	**Scientific Name**	**Code**	**LO**	**PTn**	**PTt**	**AS**	**PIS**	**StD**	**HD**	**+**	**TS**	**L-Rank**
American robin	*Turdus migratorius*	AMRO	0	1	2	1	1	1	0	0	6	L5
Baltimore oriole	*Icterus galbula*	BAOR	0	4	2	1	1	1	0	0	9	L5
black-capped chickadee	*Parus atricapillus*	BCCH	0	1	2	1	1	1	0	0	6	L5
blue jay	*Cyanocitta cristata*	BLJA	0	3	2	1	1	1	0	0	8	L5
brown-headed cowbird	*Molothrus ater*	BHCO	0	3	2	1	1	1	0	0	8	L5
Canada goose	*Branta canadensis*	CANG	0	0	2	1	2	0	1	0	6	L5
cedar waxwing	*Bombycilla cedrorum*	CEDW	0	1	2	1	1	1	0	0	6	L5
chipping sparrow	*Spizella passerina*	CHSP	0	3	2	1	1	2	0	0	9	L5
common grackle	*Quiscalus quiscula*	COGR	0	4	2	1	1	1	0	0	9	L5
downy woodpecker	*Picoides pubescens*	DOWO	0	1	2	1	1	1	1	0	7	L5
eastern phoebe	*Sayornis phoebe*	EAPH	0	1	2	1	1	1	2	0	8	L5
house wren	*Troglodytes aedon*	HOWR	0	1	2	1	2	1	1	0	8	L5
mallard	*Anas platyrhynchos*	MALL	0	1	2	1	2	1	0	0	7	L5
mourning dove	*Zenaida macroura*	MODO	0	3	2	1	1	0	0	0	7	L5
northern cardinal	*Cardinalis cardinalis*	NOCA	0	1	2	1	1	2	1	0	8	L5
red-tailed hawk	*Buteo jamaicensis*	RTHA	0	2	2	2	1	1	1	0	9	L5
red-winged blackbird	*Agelaius phoeniceus*	RWBL	0	3	2	1	1	2	0	0	9	L5
song sparrow	*Melospiza melodia*	SOSP	0	3	2	1	1	2	0	0	9	L5
warbling vireo	*Vireo gilvus*	WAVI	0	1	2	1	1	2	1	0	8	L5
yellow warbler	*Setophaga petechia*	YWAR	0	3	2	1	1	2	0	0	9	L5
European starling	*Sturnus vulgaris*	EUST		4								L+
house sparrow	*Passer domesticus*	HOSP		4								L+
trumpeter swan	*Cygnus buccinator*	TRUS										L+
Herpetofauna												
grey treefrog	*Hyla versicolor*	TGTF	1	3	2	3	4	5	2	1	21	L2
spring peeper	*Pseudacris crucifer crucifer*	SPPE	1	2	2	3	4	5	3	1	21	L2
wood frog	*Lithobates sylvatica*	WOFR	0	2	2	3	4	5	3	1	20	L2
eastern red-backed salamander	*Plethodon cinereus*	RBSA	0	2	2	1	4	4	3	0	16	L3
northern leopard frog	*Lithobates pipiens*	LEFR	0	3	2	1	4	5	2	1	18	L3
American toad	*Anaxyrus americanus*	AMTO	0	3	2	1	4	4	0	0	14	L4
green frog	*Lithobates clamitans*	GRFR	0	2	2	1	3	4	1	0	13	L4
Incidental Species: species that are reported on as incidental to the TRCA protocol.												

Appendix B

Evaluated Wetlands Spreadsheet

EVALUATED WETLAND NAME	EVALUATED WETLAND SIZE	EVALUATED WETLAND TYPE	BIOLOGICAL COMPONENT SCORE	SOCIAL COMPONENT SCORE	HYDROLOGICAL COMPONENT SCORE	SPECIAL FEATURES SCORE	OVERALL WETLAND SCORE
Luther Marsh	4031.6	Evaluated Wetland Complex	193	212	219	250	874
Nappan Island Complex		Evaluated Wetland Complex	233	192	191	250	866
Cranberry Oil Well Bog Wetland Complex	372.57	Evaluated Wetland Complex	187	195	222	250	854
Little Cataraqui Creek Complex	320.7	Evaluated Wetland Complex	161	224	219	250	854
South Dorchester Swamp (UT 23)		Evaluated Wetland Complex	185	181	236	250	852
Snelgrove Brook		Evaluated Wetland Complex	196	177	229	250	852
Heart Lake Wetland Complex	99	Evaluated Wetland Complex	174	183	243	250	850

Appendix C

Road Safety Protocol

This document includes the following:

1. **Volunteer Safety Protocol**
2. **Volunteer Injury Reporting Process**
3. **Volunteer Road Ecology Monitoring – Safe Work Procedure**
4. **Volunteer Road Ecology Monitoring Safe Work Procedures Competency Sign Off**
5. **Competency Checklist (to be completed by Supervisor at Field Training Session)**

1. Volunteer Safety Protocol

All volunteers must:

1. In case of emergency call 911.
2. In the case of an injury, follow the Volunteer Injury reporting process.
3. Attend one Field Training Session.
4. Sign "Volunteer Waiver" and submit to Project Coordinator.
5. Complete all mandatory AODA and TRCA orientation training online, review summary of TRCA's Harassment, Health and Safety, E-Communication Policies and Code of Conduct. Sign "Volunteer Intake Form" and submit to Project Coordinator.
6. Sign "Volunteer Letter of Offer" and submit to Project Coordinator.
7. Check in with Project Coordinator at the start and end of each shift using an agreed upon method (email, text message)

   Marc Dupuis-Desormeaux
   trcaroadecology@gmail.com
   cell: 647-221-1929

8. Not conduct surveys in rain, thunder or high winds, where weather conditions inhibit safety while on or near the roads.
9. Do a safe road assessment and follow the procedure to properly place two "Road Works" signs on the side of the roadway prior to the commencement of work. One at either extent of the study site and on the side of the road of oncoming traffic. When the work is done the signs must be dismantled and stored.
10. Work in groups of 3 and comply with the roles assigned as outlined in the "Safe Work Procedure".
11. Adhere to the "Safe Work Procedure" for Volunteer Road Ecology Monitoring.
12. Walk the shoulder of the road, facing on-coming traffic.

13. Wear Personal Protective Equipment that consists CSA approved safety boots, Class 2 high visibility safety vest, Type 1 hard hat, CSA approved eye protection. If carrying a backpack, the safety vest is to be worn over the backpack.

14. Park vehicles at designated locations as indicated on site fact sheets.

15. Carry a copy of the Road Occupancy Permit for your site at all times while on site.

16. Only remove wildlife (dead or alive) when there is a sufficient gap in traffic to do so as you are not authorized to stop or direct traffic.

17. Carry a charged cell phone (minimum 1 per group).

18. Not eat during surveys. Use the hand sanitizer at the end of the survey and before eating.

19. Avoid all visual and auditory distractions throughout shift such as wearing ear buds, texting, phone calls, etc. Adhere to duties as assigned.

20. Wear Nitrile Gloves. TRCA will supply.

21. Be prepared for the conditions with:
    a. Sunscreen
    b. Bug spray
    c. Extra clothing layers
    d. Extra drinking water

2. Volunteer Injury Reporting Process for the Volunteer:

1. Call 911 if necessary
2. Contact Project Coordinator

    Marc Dupuis-Desormeaux

    trcaroadecology@gmail.com

    cell: 647-221-1929

    Record information as outlined in the Visitor / Volunteer Injury Form in folder. Injury forms will be in the box on site.

3. Take photos of injury and scene.

3. Volunteer Road Ecology Monitoring – Safe Work Procedure

Background Information

This project involves collecting road/ wildlife interaction data from the roadside. This work necessitates compliance with Ontario Traffic Manuals - Book 7 and municipal requirements for road side works.

Equipment

All personal protective equipment must be inspected before use, to ensure it is in safe working condition. All equipment must be worn and used as per the manufacturer's recommendations and without modification.

Personal Protective Equipment Requirements:

1. CSA approved safety boot.
2. CSA approved eye protection
3. Type 1 hard hat
4. High visibility class 2 safety vest
5. Nitrile gloves
6. Hand sanitizer
7. First aid kit including tick removal kit
8. Working cell phone (1 amongst group of 3)
9. 2 'men at work' road signs
10. 5 28" pylons

Procedure

Volunteers must be given detailed instruction from a properly trained and competent person on all procedures and safe practices. No monitoring will take place without the presence of at least 3 volunteers. Roles and responsibilities shall be designated at the beginning of each shift. At any time volunteers are to communicate any potential hazards or concerns to the volunteer coordinator.

1. **Pre-monitoring set-up**
    a. Park vehicles at designated parking area identified on site fact sheets.
    b. Observe weather conditions. Refrain from monitoring if there is rain, thunder and/or high winds or where weather conditions inhibit safety while

on or near the roads.

c. Contact volunteer coordinator to indicate that monitoring is about to commence (via text or email).

d. Review all personal protective equipment and ensure that you have all items on the **Personal Protective Equipment Requirements list. Inspect all equipment to ensure that it is in good working order**

e. Review "Conditions that Affect Traffic Control Requirements" in the site fact sheet for the site being monitored and note any changes to conditions. If conditions have changed record on a new sheet and submit to Project Coordinator. Take special note of Emergency road repair, broken down vehicles, obstructions to traffic flow.

f. Observe site and identify emergency escape route.

g. Identify roles for the shift: Volunteer A, Volunteer B, Volunteer C

Role	Responsibility
A (Spotter and safety set up)	- Observes oncoming traffic in both directions at all times. - Observes oncoming traffic (work side) during removal. - Gives the 'All Clear to A for removal - Communicates potential hazards to team. - Shifts safety set-up as required. - Activates 911 if necessary.
B (Data Collection)	- Collects data - Observes for wildlife on roadway - Communicates potential hazards to team
C (Support)	- Observes for wildlife on shoulder - Observes oncoming traffic (opposite work side) during removal - Gives the 'All Clear' to A for removal - Assists with data collection at roadside - Communicates potential hazards to team

2. At work procedure

a. Set up 'men at work' roadside signs at designated locations identified in site fact sheets (set up will need to be moved once for each monitoring session

b. Walk on shoulder facing on-coming traffic, following the route identified in the site fact sheets.
c. When stopped to record data ensure that you are within a pylon set up as depicted in figure 1 below
d. Volunteer B (Data Collector) to only remove wildlife (dead or alive) when there is a sufficient gap in traffic to do so and when given the 'all clear' by volunteer A (Spotter and safety set up) and volunteer C (support). Volunteers are not authorized to stop or direct traffic.

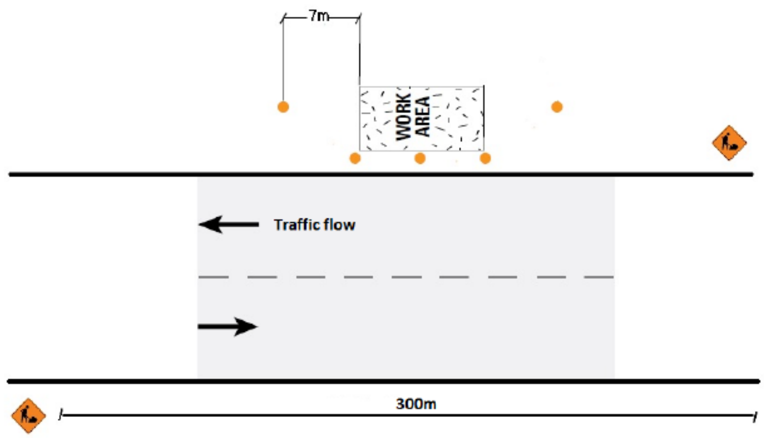


Figure 1: Work Area Set Up

3. Close out procedure

a. When the work is done the signs must be put back inside the storage box stored onsite. Contact volunteer coordinator to inform that the shift is complete (via text or email).
b. Upload data at secure wifi location.
c. Record volunteer hours worked at http://www.trackitforward.com/site/trca

Important Contact Information:
Volunteer Coordinator
Marc Dupuis-Desormeaux
trcaroadecology@gmail.com
Cell: 647-221-1929

4. Volunteer Road Ecology Monitoring Safe Work Procedures - Competency Sign Off

I have reviewed the "Volunteer Road Ecology Monitoring Safe Work Procedures" document and have demonstrated the following tasks to a competent supervisor.

- ☐ Pre-monitoring Procedure (Assigning roles and responsibilities, setting up signs, etc.)
- ☐ At Work Procedure (assessing traffic flows, traffic judgement, etc.)
- ☐ Close-out Procedure (Shift completion)

Name	Signature	Date

Competent Supervisor Name:

Competent Supervisor

Signature:

5. Competency Checklist

(to be completed by Supervisor at Field Training Session)

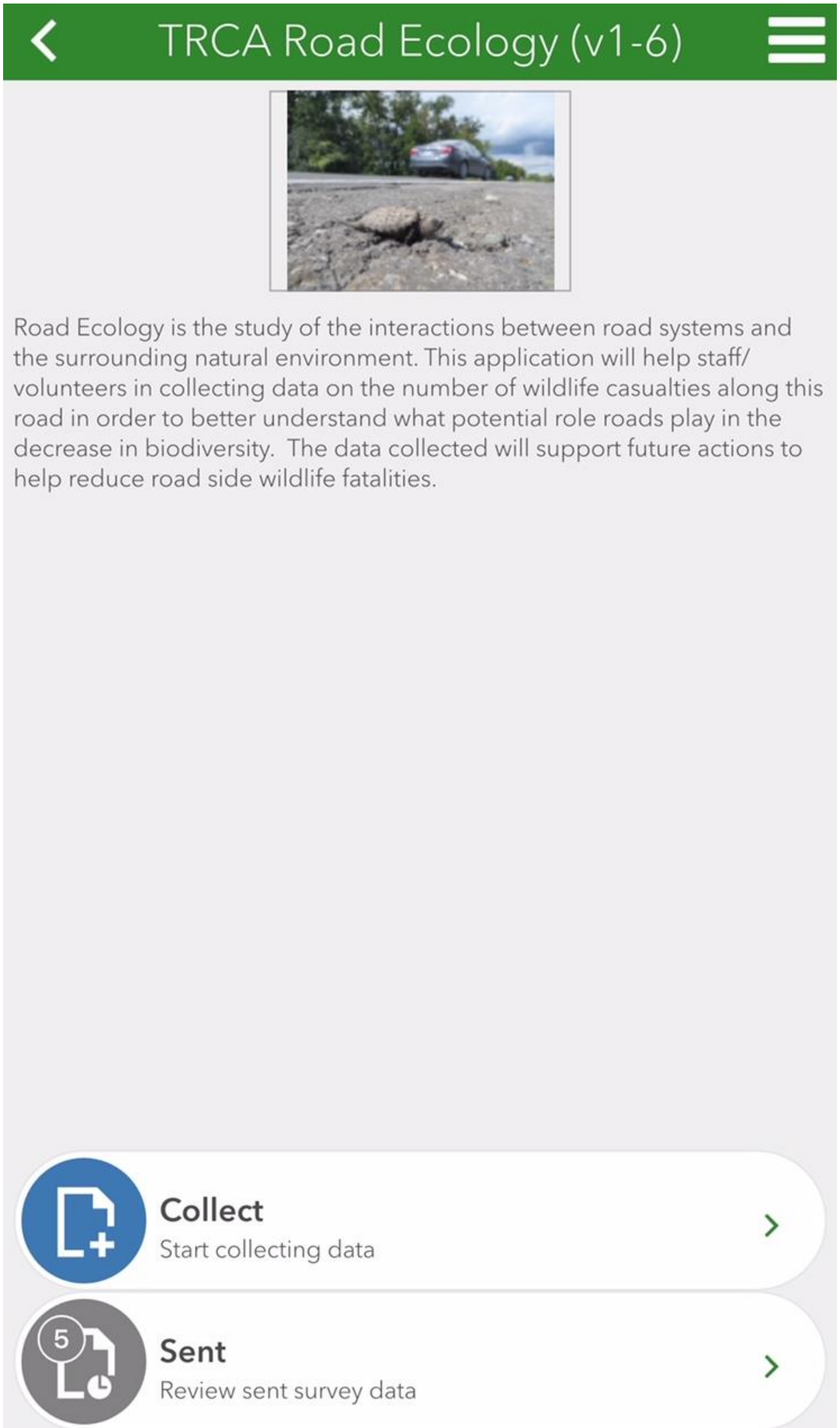
Competency Checklist *Volunteer Name:___*

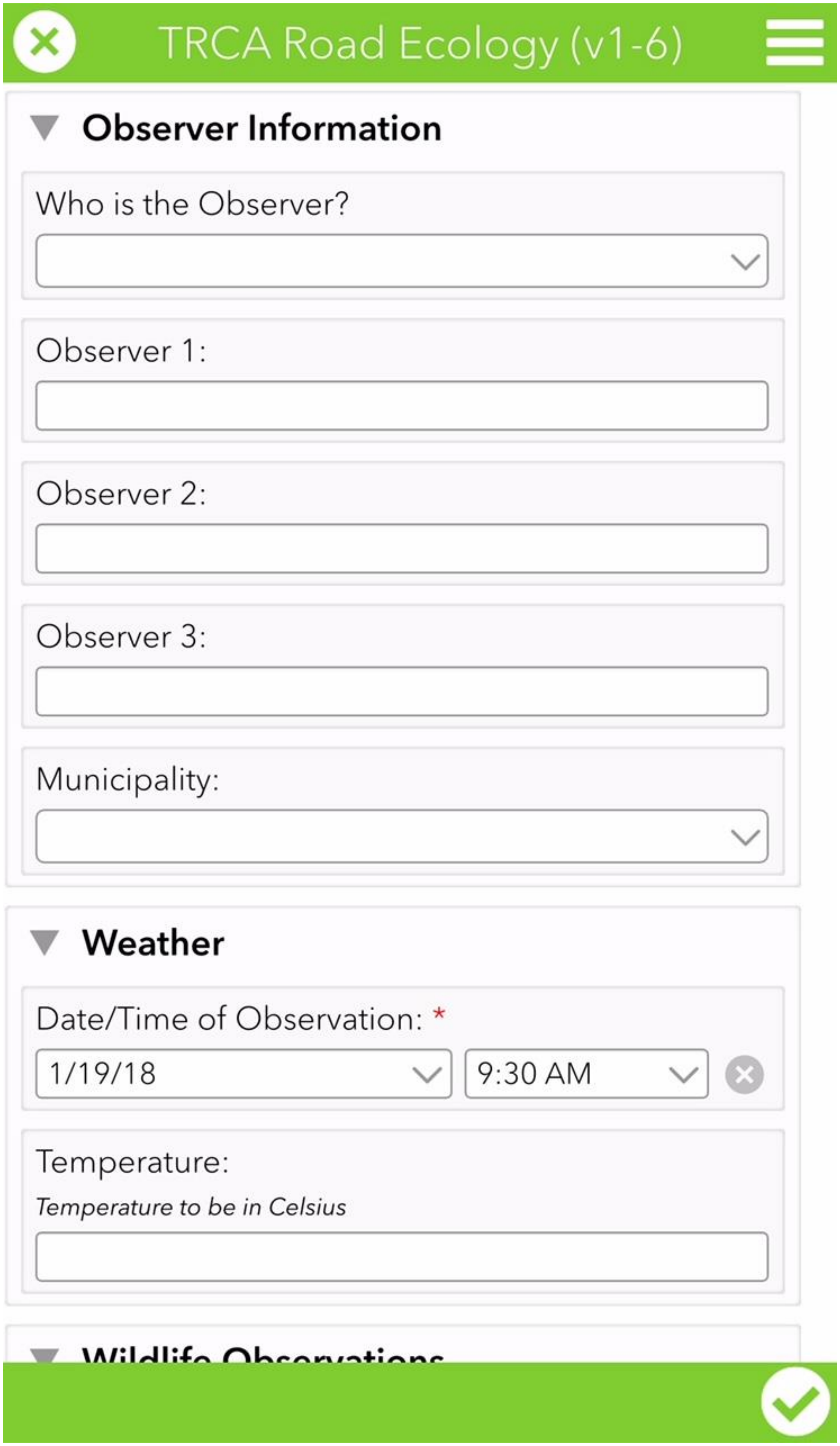
- □ Has gone through Safe Work procedures with supervisor and demonstrates a sound understanding of the outlined principles
- □ Demonstrates knowledge of required PPE
- □ Able to identify hazards during pre-monitoring and at work procedure
- □ Demonstrates knowledge of doing Pre-monitoring Procedure (Assigning roles and responsibilities, setting up signs, etc.)
- □ Demonstrates knowledge of doing At Work Procedure (assessing traffic flows, traffic judgement, etc.)
- □ Demonstrates knowledge of doing Close-out Procedure (Shift completion)

Supervisors Name: _____ Supervisors Signature: _____

Appendix D

Survey123 Application Interface





TRCA Road Ecology (v1-6)

Observer Information

Who is the Observer?

Observer 1:

Observer 2:

Observer 3:

Municipality:

Weather

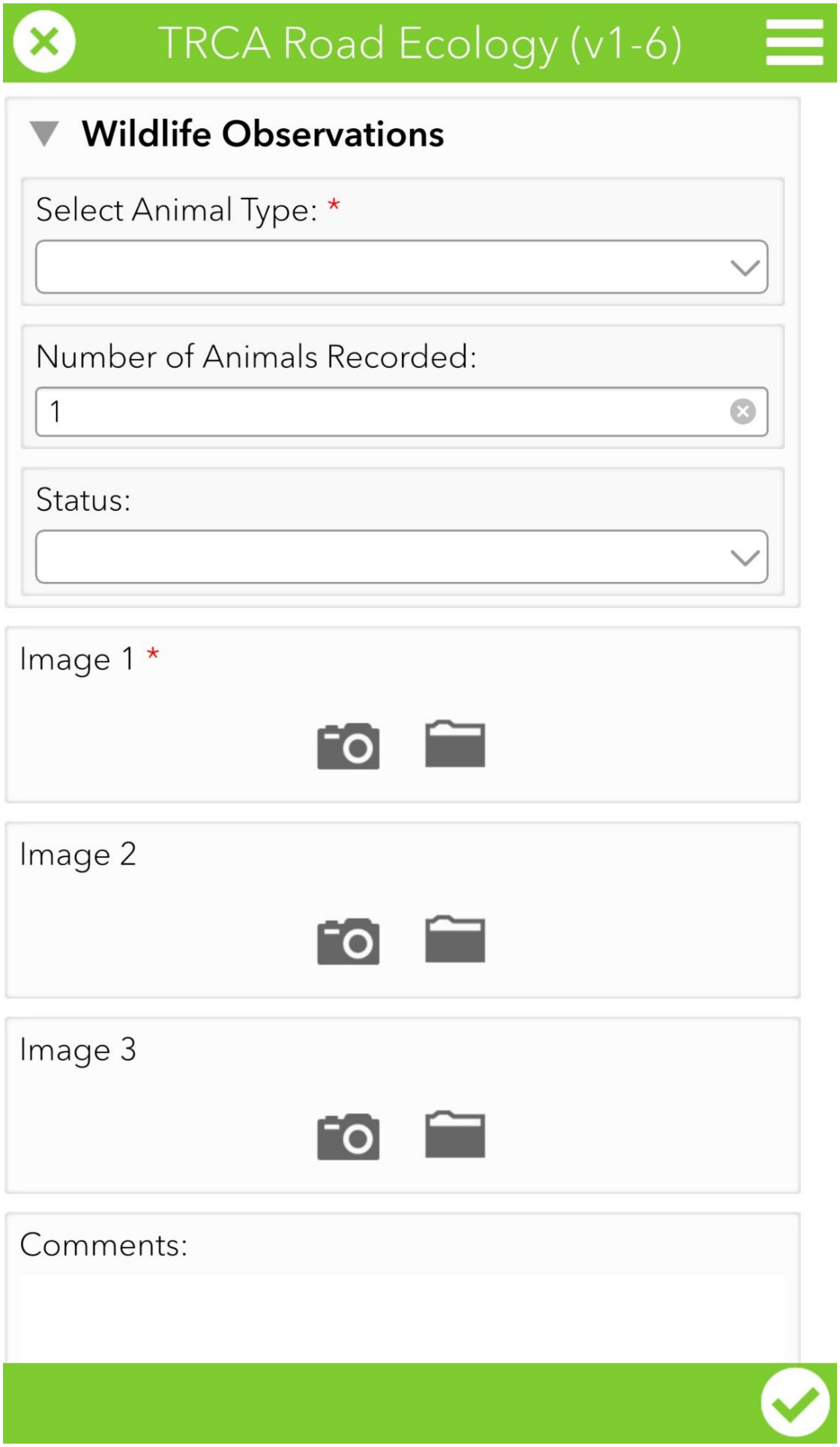
Date/Time of Observation: *

1/19/18 9:30 AM

Temperature:

Temperature to be in Celsius

Wildlife Observations

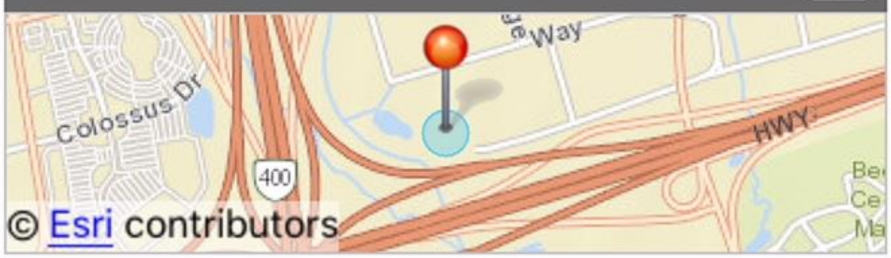

TRCA Road Ecology (v1-6)
Wildlife Observations
Select Animal Type: *
Number of Animals Recorded:
1
Status:
Image 1 *
Image 2
Image 3
Comments:

TRCA Road Ecology (v1-6)

Comments:

Location of Observation:

43°47'N 79°32'W ± 65 m



Location Description:

If GPS location is ±10m, please provide a detail description of the area (i.e. 2 ft west of road near bench)

This is the link to the Ontario Road Ecology Group: A Guide to Road Ecology in Ontario

Appendix E

Gallery of WVC Photos from 2017