

**The State of Amphibian Biodiversity on the Trent University Symons Campus**

Includes:

Final Report

By: Riley Bowman and Olivia Gaetz

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Supervising Professor: Kaitlyn Fleming and Thomas Hossie

Trent Community Research Centre Project Coordinator: Brittany Finigan

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Suite 3.10, Trent University Student Centre

1600 West Bank Drive

Peterborough, ON K9L 0G2

Phone: [\(705\) 748-1093](tel:(705)748-1093)

Email: [tcrc@trentu.ca](mailto:tcrc@trentu.ca)

Website: [trentu.ca/tcrc](http://trentu.ca/tcrc)

Acknowledgements.....	3
Executive Summary .....	4
Introduction.....	5
Motivation.....	5
Goals.....	5
Background Information.....	6
The Trent Lands Plan and Trent Nature Areas .....	6
Promise Rock Nature Area (PRNA).....	7
Otonabee College Wetland Nature Area (OCWNA) .....	8
Archaeology Centre Wetland Nature Area (ACWNA).....	8
Wetland Complex Nature Area (WCNA) .....	9
General Requirements of Reptiles on Campus .....	9
Snakes.....	9
Turtles.....	11
General Requirements of Amphibians on Campus.....	12
American Water Frogs.....	12
Chorus Frogs.....	12
Holarctic Treefrogs.....	13
North American Toads .....	13
Mole Salamanders .....	14
Woodland Salamanders .....	14
Methodology.....	15
Field Surveys.....	15
Citizen Science.....	16
Safety Considerations and Training .....	16
Survey Protocols .....	17
Turtle Basking Survey Protocol .....	17
Road Mortality Survey Protocol.....	19
Opportunistic Survey Protocol .....	20
Results.....	22
Survey Results.....	22

Road Mortality Survey Results.....	22
Turtle Basking Survey Results .....	23
Opportunistic Survey Results .....	24
Citizen Science Results .....	25
Summary Tables.....	35
Discussion.....	37
Reptiles.....	37
Snakes.....	37
Turtles.....	38
Amphibians .....	39
Recommendations.....	41
Road Mortality Mitigation .....	41
Supporting Herptile Biodiversity .....	42
Future Research.....	48
Appendix.....	49
References.....	55

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## Executive Summary

This community-based research (CBR) project aimed to investigate the state of herpetofauna (reptile and amphibian) biodiversity within the Trent University Symon's Campus Nature Areas. A combinations of road mortality field surveys, turtle basking surveys, and opportunistic surveys were performed to collect observations of herptiles on campus. Field surveys were focused on locations of interest outlined by the Trent Land Use Committee and included Promise Rock Nature Area (PRNA), Wetland Complex Nature Area (WCNA), Otonabee College Wetland Nature Area (OCWNA) and the Archaeology Centre Wetland Nature Area (ACWNA). In addition to field surveys, researchers compiled existing observations from iNaturalist and provincially significant species tracked by the Ontario Natural Heritage Information Centre (NHIC).

Species of specific concern observed within the Trent Nature Areas include the eastern milk snake (*Lampropeltis triangulum triangulum*), midland painted turtle (*Chrysemys picta marginata*), common snapping turtle (*Chelydra serpentina*), and mole salamander populations (*Ambystoma spp.*). These species are considered due to either their provincial significance, sensitivity or local abundance unique to the Trent University Campus. Further studies and monitoring of herpetofauna biodiversity on campus is recommended to further strengthen the understanding of these species on campus.

Based on the findings of this CBR project, the following road mortality mitigation strategies are recommended:

- a. Seasonal amphibian crossing signs installed on Woodland Drive
- b. The extension of the Gzowski Way curb modification through East Bank Drive

- c. Collaboration with community stakeholders to campaign for the seasonal closure of Woodland Drive during amphibian migration periods

Based on the findings of this CBR project, the following strategies are recommended to better support herpetofauna biodiversity:

- a. Preservation of significant wildlife habitat pertaining to reptiles and amphibians (ACWNA, WCNA, and WSNA)
- b. Construction of artificial hibernaculum
- c. Implementation of artificial turtle basking sites
- d. Educational outreach to inform the Trent community about the biodiversity supported by the Trent Nature Areas and citizen science best practices

## Introduction

### Motivation

Considerations for a community-based research (CBR) project pertaining to campus herpetofauna started in early 2023 following the successful mitigation of the Gzowski Way curb, which was conducted by both the facilitators of this project and the researchers.

### Goals

The primary goal of this project was to fill historical knowledge gaps on the distribution of herpetofauna species within the Trent University Symon's campus. This was done to provide an understanding of potentially significant habitats for herpetofauna on campus and to provide mitigation strategies and further research to deepen understanding. It also is important to lay the framework for future research and studies by creating survey protocols, animal care protocols

and recommendations regarding field surveys. There were three main research objectives when creating this project.

- 1) Compile existing herpetofauna observations on Trent University's Symons Campus and collect new reptile and amphibian field data from historically under surveyed areas. This will inform future land-use management practices to facilitate the protection and conservation of herpetofauna biodiversity.
- 2) Identify threats to the herpetofauna biodiversity across campus, with a special focus on road mortality, and identify appropriate mitigation solutions. The main goal is to identify locations on campus with high herpetofauna road mortality with the goal of suggesting possible strategies that could be employed in each case to mitigate future road mortality and enhance the ecological connectivity of nature areas across campus. Any other possible threats to biodiversity will be noted and case-specific strategies to mitigate will be thoroughly researched.
- 3) Identify key habitat for the herpetofauna species existing on Trent University's Symons campus, with a focus on species-at-risk habitat, hibernacula locations, amphibian movement corridors, and overwintering sites for amphibians and turtles.

## Background Information

### The Trent Lands Plan and Trent Nature Areas

The Trent University Symons Campus, located in Peterborough, Ontario, is home to 1,400 acres of land which makes up 11 distinct nature areas. The Trent Nature Areas (TNAs) include many significant ecosystems, including forests, woodlands, drumlins, meadows, and wetlands (Trent Lands, 2021). The TNAs provide learning and research opportunities for students and faculty of the university, along with recreational and cultural value to the greater

Trent community. The purposes of the TNAs are to preserve natural areas to maintain biodiversity, provide recreation for the Trent and Peterborough communities, provide learning opportunities and spaces for students, and provide a space for researchers to study the natural environment (Trent Lands, 2021). The Trent Lands Plan, published in 2021, serves as a guiding document to ensure an integrated and holistic approach to campus planning. The Trent Lands Plan aims to provide a clear vision for the TNAs' future and a framework for development and planning (Trent Lands, 2021).

This project provides an overview of herpetofauna biodiversity within the TNAs and aims to fill existing knowledge gaps about their distribution on campus. Based on input from the Trent University Lands Stewardship Coordinator, four nature areas were selected for opportunistic field surveys. These nature areas include Promise Rock Nature Area, Otonabee College Wetland Nature Area, Archeology Centre Wetland Nature Area, and Wetland Complex Nature Area.

### **Promise Rock Nature Area (PRNA)**

The Promise Rock Nature Area (PRNA) is comprised of two distinct segments, separated by a drumlin. There is a western-facing lowland portion, and an eastern-facing upland portion. Deposits of glacial till are found throughout the nature area. PRNA is 13 acres of forests dominated by eastern white cedar and eastern white pine (Trent Lands, 2021). The higher elevation and well-drained soil of the upland portion acts as key overwintering habitat for several of the on-campus snake species. Glacial cobble deposits act as basking locations, and cover spots for species such as the eastern garter snake, northern red belly snake, and eastern milk snake. The western portion allows for connectivity between overwintering and foraging sites in the

snake species. Additionally, this low-lying area of PRNA experiences seasonal flooding (Trent Lands, 2021).

### **Otonabee College Wetland Nature Area (OCWNA)**

The Otonabee College Wetland Nature Area (OCWNA) is predominantly active in the spring, when meltwaters flood the ephemeral wetland that composes much of the surface area. Tree species mainly consist of European buckthorn, and mixed wood deciduous trees (such as white ash, trembling aspen, meadow willow, and black locust). The OCWNA is part of the Nassau Wetland Complex, designated as a provincially significant wetland (PSW) (City of Peterborough, 2019). There is an upland scrub toward the north-western portion, mainly consisting of grasses, goldenrod species, and small herbaceous plants. Along with the Archaeology Centre Wetland Nature Area, the OCWNA is more likely to have impairment within the natural system, due to the construction of Cleantech Commons, and agricultural land toward the east. Both Pioneer Road and Gzowski Way Road/East Bank Drive border this nature area, with Pioneer Road at the southern point, and Gzowski Way Road/East Bank Drive in the west.

### **Archaeology Centre Wetland Nature Area (ACWNA)**

The Archaeology Centre Wetland Nature Area (ACWNA) has an area of 14 acres. This nature area comprises three main vegetation communities: coniferous forests, woodlands, and wetlands. The meadow marsh, shallow marsh, and coniferous swamp present at this nature area are part of the Nassau wetland complex, which has been designated as provincially significant. These wetland sites are located along the eastern boundary of the ACWNA. The woodland area is at the northwestern corner, and the coniferous forest stretches along the western boundary of the nature area (Trent Lands, 2021). The proximity of terrestrial woodlands to shallow wetlands within the ACWNA provides significant breeding habitat for multiple amphibian species,

including *Ampystoma* spp, wood frogs, green frogs, northern leopard frogs, western chorus frogs, and gray treefrogs. Due to its central location, movement of herpetofauna between the ACWNA and OCWNA and WSNA is a significant source of road mortality. The ACWNA is bordered to the east by Gzowski Way. The nature area is also near East Bank Drive to the southeast and Pioneer Road to the south.

### **Wetland Complex Nature Area (WCNA)**

The wetland complex nature area (WCNA) is directly east of PRNA. The Rotary Greenway trail acts as a boundary between the two nature areas. This nature area is 3.5 acres, located within an agricultural landscape. It is a long, narrow, lowland plain. WCNA is downstream of the Ninth Line Nature Area (NLNA), from which WCNA receives intermittent drainage. Both the landscape and hydrology provide ecological connections between WCNA, PRNA, and NLNA which allows for plant and animal movement between the three (Trent Lands, 2021). This nature area contains three main wetland ecosystems, all connected to the provincially significant Nassau wetland complex. These include a semi-permeant thicket swamp, an ephemeral mixed swamp, and an ephemeral meadow marsh. These habitats provide breeding sites for *Ambystoma* spp., and other amphibian species.

### **General Requirements of Reptiles on Campus**

#### **Snakes**

There are five species of snake that have been sighted within the TNA. These species include the eastern garter snake (*Thamnophis sirtalis sirtalis*), the northern red belly snake (*Storeria occipitomaculata occipitomaculata*), the eastern milk snake (*Lampropeltis triangulum triangulum*), the Dekay's brown snake (*Storeria dekayi*), and the northern water snake (*Nerodia sipedon sipedon*). The most common snake species seen on campus are the eastern garter,

northern red bellied, and eastern milk. Dekay's brown snake has only been found in the South Drumlin Nature Area. However, they are a habitat generalist, thriving in both vacant lot and mixed woodland equally as successful (Rowell, 2012). This affinity for any habitat type leads one to believe that these species might have a much higher distribution on campus than what is perceived. Rather, their secretive nature has made it difficult to observe on campus (Rowell, 2012). A single northern water snake has been observed (deceased) within the boundaries of Promise Rock Nature Area. This species ranges both further north along the Otonabee (several observations in Lakefield, and personal observations at Trent-Severn Waterway Lock 24), and further south into Wallace Point. It is bizarre that it is not observed more frequently within the City of Peterborough, since they are also a habitat generalist (Rowell, 2012). The eastern milk snake is also a provincially tracked species with the Natural Heritage Information Centre (NHIC), and has a federal special concern designation (COSEWIC, 2014).

One of the project's main goals was to determine locations of possible critical habitat for the species on campus. Regarding snake species, there are three general habitat categories ranging from category 1 to category 3 (Crowley et. al. 2018). Category 1 habitat is classified as the most sensitive, showing minimal tolerance to changes and generally being less abundant than the other two categories (Crowley et. al. 2018). Examples of category 1 habitat include hibernacula, sites used for reproductive purposes (gestation and oviposition), and communal sites (both basking and shedding) (Crowley et. al. 2018). Category 2 habitat includes active habitat, where individuals thermoregulate or forage for food (Crowley et. al. 2018). It is more abundant than category 1, and more resistant to alterations (Crowley et. al. 2018). Category 3 habitat is the least sensitive to alterations and is classified as any area that the snake might use as a movement corridor (Crowley et. al. 2018).

The most important species to consider is the eastern milk snake, due to their federal designation. Eastern milk snakes have an affinity for edge habitats, where they hunt and consume a wide range of small vertebrates (Rowell, 2012). The most common hibernacula used by milk snakes are large rocky crevasses, although they have also been known to hibernate within older building foundations (Rowell, 2012). All species of snake found within the TNA are communal hibernators, meaning all species likely share similar or the same hibernacula (Rowell, 2012). This gives more significance to known milk snake hibernacula on campus, as other species also depend on these locations (Rowell, 2012). There is one significant known milk snake hibernacula on campus, found to the direct northeast of the parking lot within the Wildlife Sanctuary Nature Area. This nature area was outside of the boundaries of our survey effort, but it is significant, nonetheless.

## **Turtles**

There are two species of turtle that are confirmed to be present within the TNA. These species are the midland painted turtle (*Chrysemys picta marginata*) and the common snapping turtle (*Chelydra serpentina*). Both species require emergent structures in their respective water bodies for basking. Basking locations tend to be in shallower water near, but not directly besides, the shoreline (Munshower, 2019). Regarding turtles, critical habitat is classified as basking locations, nesting sites, and water bodies that can be overwintered in (ORAA, 2023). The most concentrated occurrences of both species are within the Trent-Severn Waterway lagoon that is to the western side of the Canal Nature Area. There have also been sightings of eastern musk turtles within this lagoon.

Some species that have either historic range in the TNA or could overlap in home range include the northern map turtle (*Graptemys geographica*), eastern musk turtle (*Sternotherus*

*odoratus*) and the Blanding's turtle (*Emydoidea blandingii*). Both the Blanding's and the northern map turtle are provincially tracked species by the NHIC. While not directly observed on campus, it is important to consider these occurrences since there could be the future potential of range overlap on campus. Trent-Severn Waterway Lock 23, about 2km upstream from campus, displays a high diversity of turtle species. The northern map, eastern musk, midland painted, and common snapping turtle have all been seen at this location. This gives the impression that some species could move further south downstream and start to occur on campus.

## General Requirements of Amphibians on Campus

### American Water Frogs

There are five species within the American Water Frog (*Lithobates*) genus that have been observed on the Trent University Symons campus. These species include the american bullfrog (*Lithobates catesbeianus*), the green frog (*Lithobates clamitans*), northern leopard frog (*Lithobates pipiens*), the mink frog (*Lithobates septentrionalis*), and the wood frog (*Lithobates sylvaticus*). These species all require aquatic habitats for breeding and overwintering. American bullfrogs, green frogs, and mink frogs require large, permanent waterbodies with abundant aquatic vegetation for breeding. Northern leopard frogs and wood frogs require ephemeral, fish-free wetlands with less than 1 meter water depth for breeding. Northern leopard frogs overwinter at the bottoms of well-oxygenated waterbodies. Wood frogs overwinter on land by burrowing beneath leaf litter (ORAA, 2023).

### Chorus Frogs

There have been two species within the chorus frog (*Pseudacris*) genus observed on the Trent Symons campus: spring peeper (*Pseudacris crucifer*), and western chorus frog (*Pseudacris*

*trisecriata*). Both species are freeze-tolerant and overwinter by burrowing beneath logs or leaf litter, or within natural cervices (ORAA, 2023). Western chorus frogs are the only at-risk amphibian species observed on the Trent campus, federally designated as threatened (COSEWIC, 2008). Western chorus frogs and spring peepers have been observed in the same locations across the Trent Nature Areas, but western chorus frogs are seen in much lower abundance than spring peepers. Observations of these species are clustered around the southeast corner of the Total Loss Farm Nature Area (TLFNA), the northeast corner of ACWNA, and between PRNA and WCNA.

### **Holarctic Treefrogs**

Gray treefrogs (*Hyla versicolor*) are the only species of the *Hyla* genus observed on the Trent University Symons campus. Like chorus frogs, the gray treefrog is freeze-tolerant and overwinters by burrowing beneath logs or leaf litter, or within natural cervices (ORAA, 2023). These frogs are highly arboreal, often found within open canopy forests. Gray treefrogs will utilize either permanent or ephemeral wetlands that are fish-free (ORAA, 2023). The majority of gray treefrog observations on the Trent campus are on the east bank, with a few contemporary observations on the west bank. Based on concentrated observations along University Road, it appears this species is utilizing habitats associated with the provincially significant Nassau wetland complex which spans across CNA and WSNA.

### **North American Toads**

American toads (*Anaxyrus americanus*) are habitat generalists and have been observed across the TNAs. These species use shallow, permanent or ephemeral waterbodies for breeding. Female american toads lay strands of eggs, woven among submerged aquatic vegetation. Outside of breeding season, these toads are typically found within terrestrial ecosystems (ORAA, 2023).

American toads have been observed contemporarily along Woodland Drive, and the surrounding nature areas (TLFNA, L22NA, and LEDNA). They have also been observed historically and contemporarily in ACWNA and WSNA, were mixed forests boarder wetlands.

### **Mole Salamanders**

The mole salamander (*Ambystoma*) genus includes the most abundantly observed salamanders on campus, including both the blue-spotted salamander (*Ambystoma laterale*) and the unisexual ambystoma complex (both referred to as *Ambystoma* spp for the purposes of this report). *Ambystoma* salamanders require shallow, fish-free, permanent wetlands, or vernal pools for breeding. Outside of breeding season, these salamanders inhabit mixed forests within a few hundred meters of their breeding ponds (Canadian Herpetological Society, 2024). On the Trent campus, *Ambystoma* spp have been observed in high concentrations along Woodland Drive. This pattern indicated movement between L22NA and LEDNA. L22NA is made up of mixed forests, swamps, and marshes, likely serving as a breeding location. LEDNA is made up of woodlands, mixed forests, and meadows, likely being utilized outside of breeding season.

### **Woodland Salamanders**

The genus woodland salamanders (*Plethodon*) include one species that has been observed on campus: the eastern red-backed salamander (*Plethodon cinereus*). Unlike other salamanders found on the Trent campus, eastern red-backed salamanders do not require a waterbody. Instead, they inhabit damp forest ecosystems with abundant leaf litter (ORAA, 2023). These salamanders have been observed historically within the south drumlin nature area (SDNA) and contemporarily within WCNA.

# Methodology

## Field Surveys

Field surveys were conducted to fill specific knowledge gaps within the Trent Nature Areas (TNAs) and collect observations relevant to the Trent Lands Stewardship Coordinator. Survey sites were chosen based on the information required by the Lands Stewardship Coordinator. To best address these requirements, the protocol for this project was designed by the research team based on available literature. The field protocol for this project includes three survey types: turtle basking surveys, road mortality surveys, and opportunistic surveys.

Turtle basking surveys were designed to observe turtles within ideal basking locations across four survey sites. These survey methods were designed based on *Turtles of Ontario: A Stewardship Guide* (2011). Turtles require undisturbed or relatively isolated basking areas to regulate temperature. These habitats must provide logs, rocks, or emergent vegetation that provide maximum exposure to the sun and protection from predators (Pickthorn, et al. 2011). These areas were identified within the survey sites and observed by researchers. Binoculars were used to observe basking turtles from afar, while minimizing disturbance. Turtle basking surveys took place during late-September to early-October, during sunny weather.

Road mortality surveys were designed to observe amphibians moving across roadways during their fall migration period. These survey methods were created based on the existing methods used by the Lands Stewardship Coordinator. These surveys aim to observe amphibians, specifically salamanders, moving from to their overwintering sites. Three roadways were selected based on their proximity to appropriate habitat. The Ontario Ministry of Natural Resources Significant Wildlife Habitat Mitigation Support Tool (2014) was used to identify

these potential habitats. Road mortality surveys were conducted from mid-October to mid-November, on rainy evenings with mild temperatures.

Opportunistic surveys aim to observe terrestrial frogs, salamanders, and snakes within specific nature areas. Areas of suitable habitat were identified by researchers, based on The Ontario Ministry of Natural Resources Significant Wildlife Habitat Mitigation Support Tool (2014) and existing information. The protocol for these surveys was designed based on the methods of the Ontario Ministry of Natural Resources and Forestry Survey Protocol for Ontario's Snake Species at Risk (2016), and The Toronto and Region Conservation Authority Wetland Amphibian Monitoring Protocol (2016). Areas of suitable herpetofauna habitat were surveyed from early-October to mid-November.

## Citizen Science

Researchers utilized citizen science databases to accompany the data collected during field surveys. Citizen science databases, including iNaturalist and the Ontario Natural Heritage Information Centre, were utilized to provide an overview of herpetofauna observed on campus. All herptile observations within the Trent University Symons Campus boundary were exported from iNaturalist. Observations of sensitive species were collected from the Ontario Natural Heritage Information Centre. Citizen science observations were analyzed by researchers based on the species, location, and year. This information was utilized to identify changes and trends in the distribution of herptiles on campus.

## Safety Considerations and Training

The data obtained from the Ontario Natural Heritage Information Centre (NHIC) pertains to sensitive and at-risk species. Before observations from the NHIC could be viewed or utilized

by researchers, they had to complete data sensitivity training. This training module was provided by the NHIC and was completed by researchers in October. To conduct research involving vertebrates on the Trent University Symons Campus, researchers were required to complete the Animal Care Committee training module. Following this training module, researchers were also required to submit the project protocol to the Animal Care Committee for ethics approval. The protocol was submitted to the Animal Care Committee in April 2023 and was approved (with revisions) in October 2023.

To ensure surveyor safety, the following directions were implemented to all survey protocols:

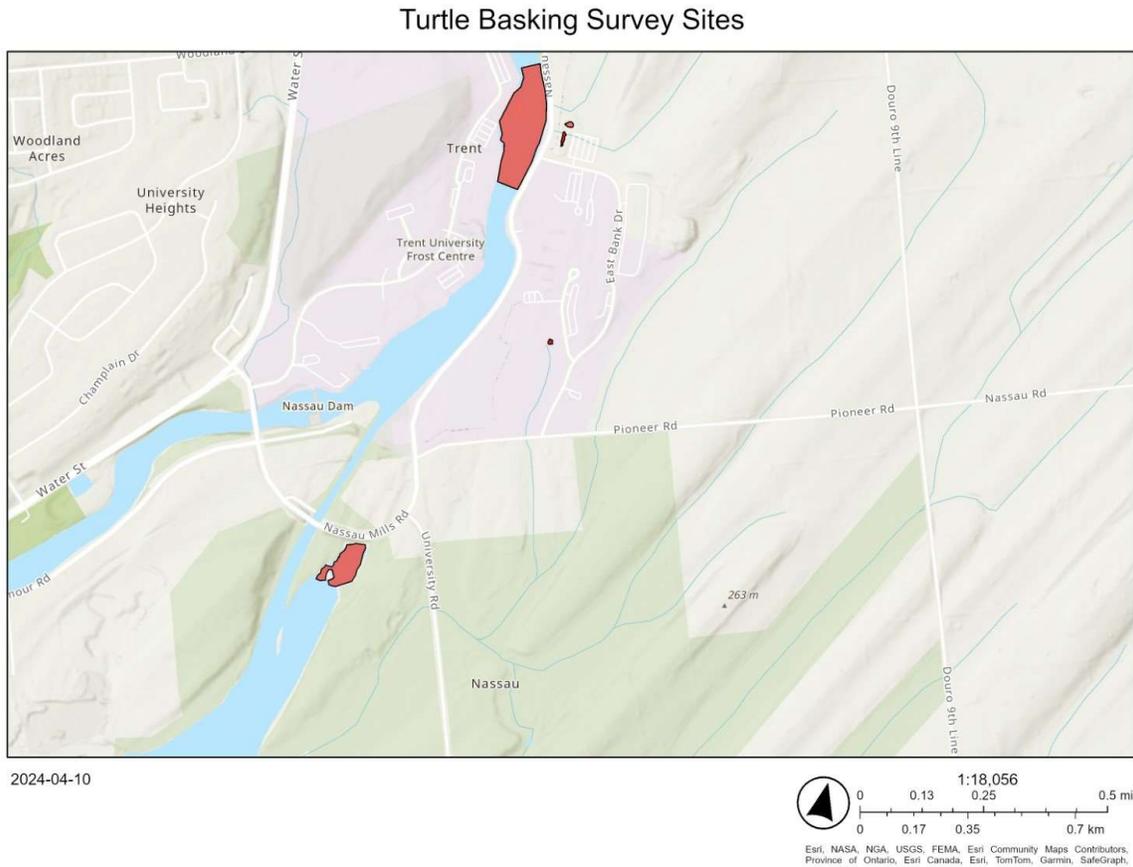
1. Two or more surveyors must be present during all field surveys
2. Project supervisors must be notified when surveyors begin and complete survey
3. Surveyors should utilize AllTrails and Google Earth for navigation during surveys
4. Surveyors must carry a cellphone and first aid kit during all field surveys
5. High-visibility vest must be worn when surveying near or on roadways
6. Sun and tick protection (bug spray, sunscreen, long pants, etc.) should be worn by surveyors

## Survey Protocols

### **Turtle Basking Survey Protocol**

Turtle basking surveys were conducted on sunny mornings, between 10:30am and 11:00am. Surveys were conducted during periods of minimal precipitation, when the air temperature was approximately 15<sup>0</sup>C. Turtle basking surveys were conducted at four locations: Otonabee River, Otonabee stormwater ponds, Archeology Wetland Complex permanent pond, and the Trent Canal lagoon (see Figure 1). Surveys were conducted three times at each survey site. Each

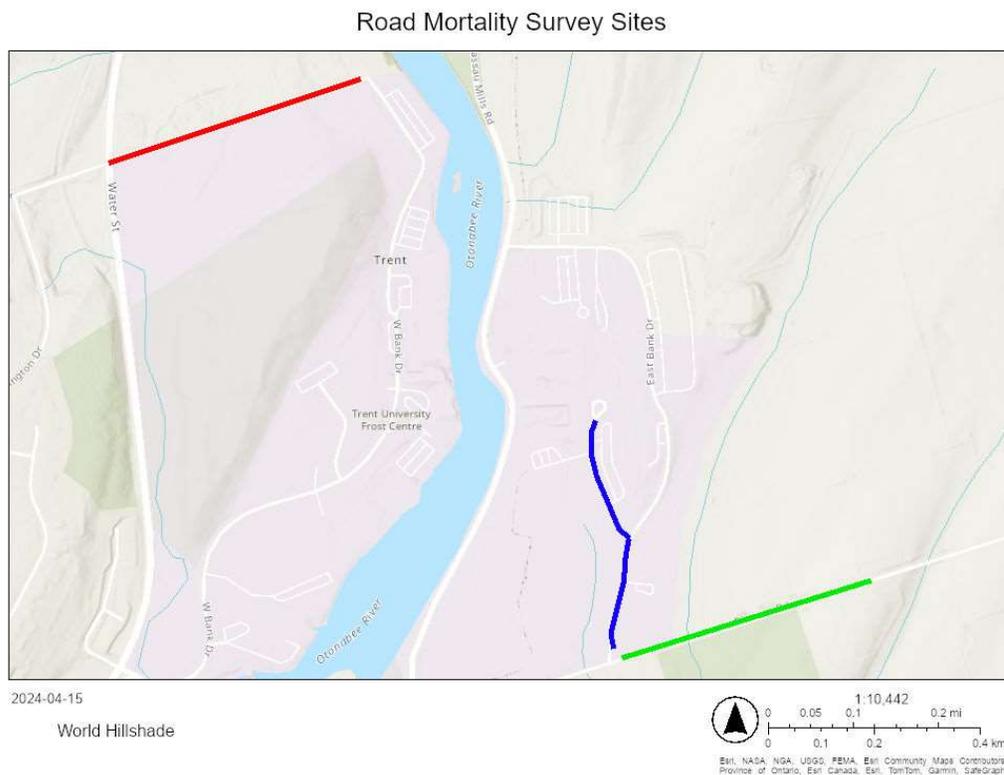
survey was a minimum of one-person hour effort. Surveyors used binoculars to observe and identify basking turtles from afar, while minimizing disturbance. Observations were recorded, along with the surrounding vegetation type, and weather data. A total of twelve turtle basking surveys were completed, across four water bodies/survey sites.



**Figure 1.** A map displaying the locations of the turtle basking surveys. The locations from top to bottom, left to right are as follows; Otonabee River, Otonabee College Stormwater Ponds, Archaeology Wetland Complex Permanent Pond, and the Trent-Severn Waterway.

## Road Mortality Survey Protocol

Road mortality surveys were conducted on rainy evenings, between 9:00pm and 11:30pm. Surveys were conducted when the air temperature was approximately 10°C. Road mortality surveys were conducted along 3 roadways/survey sites: Gzowski Way/East Bank Drive, Woodland Drive, and Pioneer Road (see Figure 2). Surveys were conducted three times per site. Surveyors walked two passes of each roadway, using headlights to look for amphibians moving across the roadway. Observations were photographed and recorded, along with the location, lane, and dead or alive. Weather data was also recorded. A total of nine road mortality surveys were conducted across three roadways.

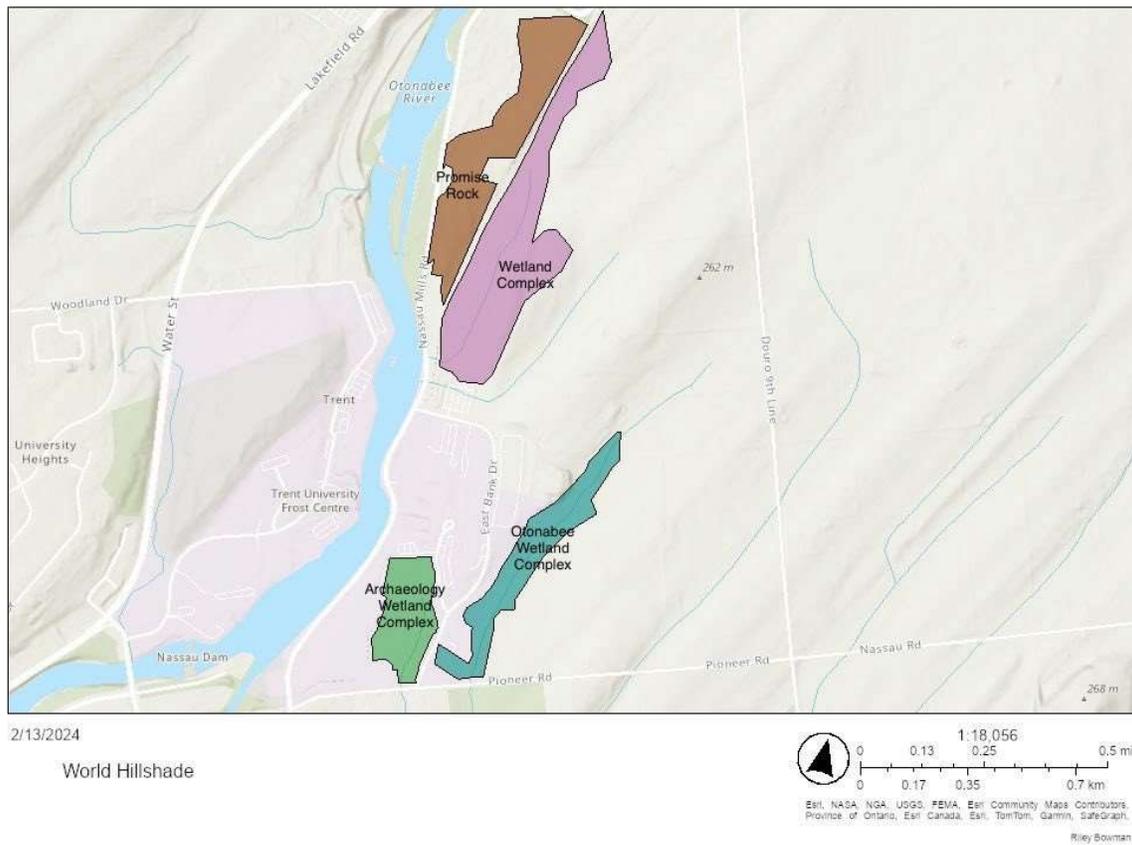


**Figure 2.** Map of Road mortality survey sites. Woodland drive shown in red, Gzowski Way/East Bank Drive shown in blue, and Pioneer Road shown in green.

## **Opportunistic Survey Protocol**

Opportunistic surveys were conducted on sunny afternoons, when the air temperature was approximately 15°C. Surveys were conducted during the afternoon to observe herpetofauna when they are most likely to be active. Opportunistic surveys were conducted at four nature areas: Promise Rock, Otonabee Wetland, Wetland Complex and Archaeology Wetland (see Figure 3). Surveyors walked through the survey site, utilizing AllTrails to track location data. During opportunistic surveys, surveyors utilized personal experience, background knowledge, and iNaturalist observation patterns to identify and search suitable habitat. These surveys aim to observe snakes, frogs, toads, and salamanders. Suitable habitat historically under surveyed areas were prioritized by surveyors and searched by visual observation and natural cover flipping. Each survey was a minimum of one-person hour effort. Observations were recorded and photographed, along with weather data and location. Each nature area/survey site was surveyed twice, with a third replicate being performed if time permits. A total of eight opportunistic surveys were conducted across four nature areas.

### Opportunistic Survey Sites

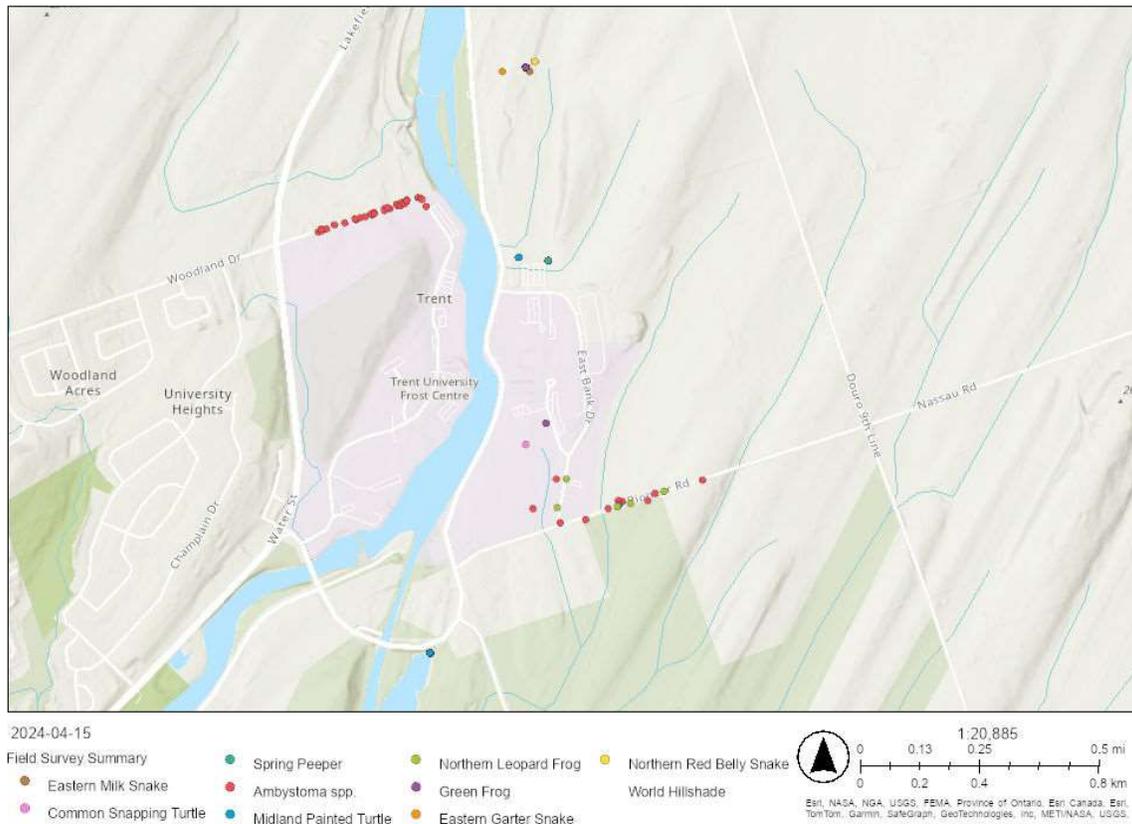


**Figure 3.** The four Trent Nature Areas surveyed during opportunistic surveys. The locations from top to bottom, left to right are as follows; Promise Rock Nature Area, Wetland Complex Nature area, Archaeology Wetland Complex Nature area, and Otonabee Wetland Complex Nature Area.

# Results

## Survey Results

Field Survey Summary Map



**Figure 4:** Summary of all field survey observations.

### Road Mortality Survey Results

The most observed species found during field surveys was *Ambystoma* spp, with 67 total observations. Most *Ambystoma* spp observations were found during road mortality surveys, with the greatest abundance found on Woodland Drive (see Figure 4). *Ambystoma* spp was also the only species observed on Woodland Drive. This indicates movement from Lock 22 Nature Area to Lady Eaton Drumlin Nature Area.

The greatest diversity of species was found on Pioneer Road, between East Bank Drive and Clean Tech Commons. Green frogs, northern leopard frogs, *Ambystoma* spp, and northern red-belly snake were all observed on Pioneer Road during road mortality surveys (see Table 1). Only one reptile was observed during road mortality surveys: a DOR (dead on road) northern red-belly snake found on Pioneer Road (see Table 1). This indicates movement from Otonabee College Wetland Nature Area and Archaeology Centre Wetland Nature Area to Wildlife Sanctuary Nature Area. Pioneer Road also had the greatest number of DOR observations. This site had 6 DOR observations and 6 AOR (alive on road) observations.

The low number of observations on Gzowski Way/East Bank Drive could indicate that this movement corridor is mainly utilized during the spring migration period when amphibians emerge from their overwintering sites and move to their breeding habitats. Further road mortality surveys should be conducted during April to better understand how this corridor is being used.

**Table 1:** Summary of road mortality survey observations.

Species	Woodland Dr.		Gzowski Way/East Bank Dr		Pioneer Rd.	
	AOR	DOR	AOR	DOR	AOR	DOR
<b>Ambystoma Spp.</b>	27	5		1	5	3
<b>Northern Leopard Frog</b>				2		3
<b>Green Frog</b>			1	1	1	
<b>Northern Red-Belly Snake</b>						1

### **Turtle Basking Survey Results**

Two species were observed during turtle basking surveys: common snapping turtle and midland painted turtle. Midland painted turtles were the most observed reptile species during field surveys, with 21 total observations. Most of these observations were found at the Trent

Canal (see Figure 4). Midland painted turtles were also observed, in lower concentrations, at the Otonabee College Stormwater Ponds (see Table 2). There was one identified observation at the Otonabee College Stormwater Ponds. Researchers believe this observation to be of a common snapping turtle, however the individual fled before identification could be confirmed. The only confirmed common snapping turtle observation was found at the Archaeology Centre Wetland (see Table 2).

The dense emergent vegetation present at the Otonabee College Stormwater Ponds and the Archaeology Centre Wetland created some challenges to observing and identifying basking turtles. No turtle basking observations were recorded at the Otonabee River. This could be due to a lack of suitable basking locations, and the shoreline construction taking place within the river. Further surveying should take place post shoreline construction to better understand how and if the Otonabee River is being utilized by basking turtles.

**Table 2:** Summary of turtle basking survey observations.

Species	Otonabee River	Archaeology Centre Wetland	Otonabee College Stormwater Ponds	Trent Canal
<b>Midland Painted Turtle</b>			3	18
<b>Common Snapping Turtle</b>		1		
<b>Unidentified</b>			1 (expected to be common snapping turtle)	

### **Opportunistic Survey Results**

Opportunistic surveys yielded the greatest diversity of species found. Reptiles observed include eastern garter snake, northern red-belly snake, and eastern milksnake. Amphibians observed include *Ambystoma* spp, green frog, and spring peeper (see Table 3). PRNA yielded

the greatest abundance of observations and diversity of species (see Figure 4). This indicates the likely presence of an overwintering site. The pattern of observations indicates that snakes and *Ambystoma* spp are likely utilizing the rock pile, located adjacent to the intersection of the Rotary Trail and the trail connecting to Nassau Mills/Lock 22, as an overwintering site.

The low number of observations found at WCNA and ACWNA, as well as the lack of observations found at OCWNA (see Figure 4) could be attributed to the seasonality of the field surveys which took place in the fall. This likely indicates that these nature areas could be utilized by herpetofauna during the spring and summer months. Further opportunistic surveys of these nature areas should take place during May and July to September to better understand the distribution of herpetofauna within these areas and the habitats being utilized.

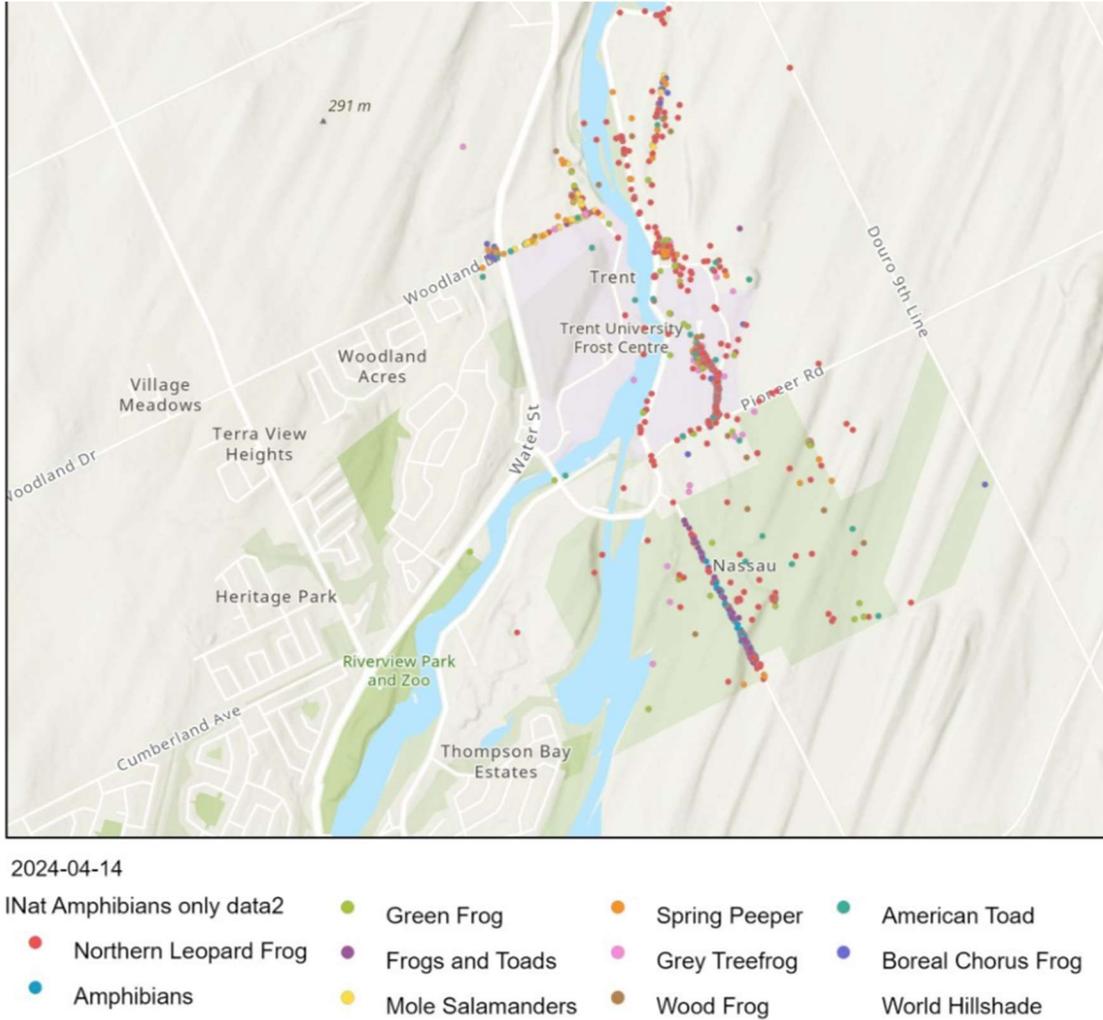
**Table 3:** Summary of opportunistic survey observations.

Species	WCNA	ACWNA	PRNA	OCWNA
<b>Ambystoma Spp.</b>	3		25	
<b>Green Frog</b>		1		
<b>Eastern Garter Snake</b>			2	
<b>Northern Red-belly Snake</b>			1	
<b>Eastern Milksnake</b>			1	
<b>Spring Peeper</b>	1			

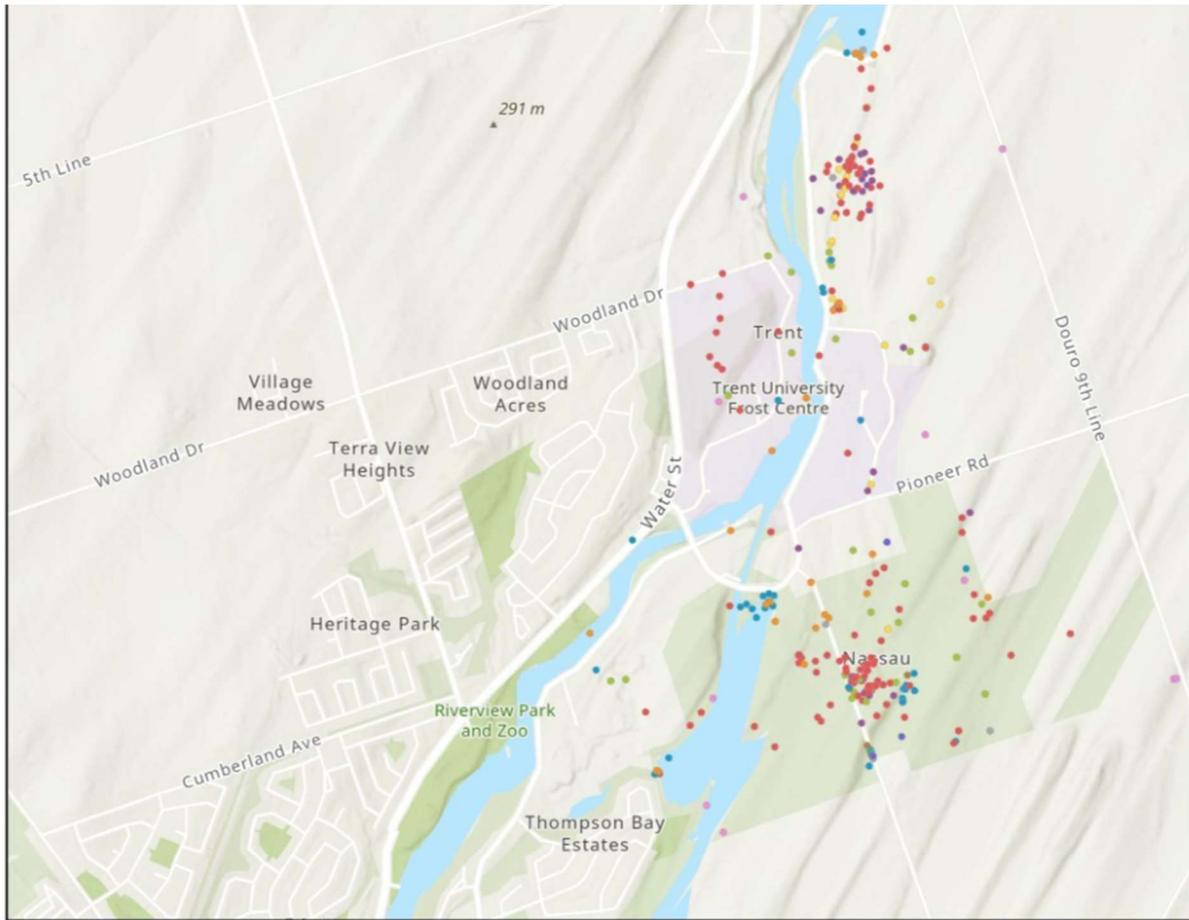
## Citizen Science Results

One of the most important aspects of this project was creating an inventory of species seen within the Trent Nature Areas' boundaries. This was done almost completely with data from iNaturalist. The data downloaded provided insights into where to survey, avoiding areas with high concentrations of observations to fill knowledge gaps. It also provided species accounts of

species not seen during surveys, and species that have limited knowledge of their on-campus distributions.



**Figure 5.** All amphibian iNaturalist observations from the data download.



4/12/2024

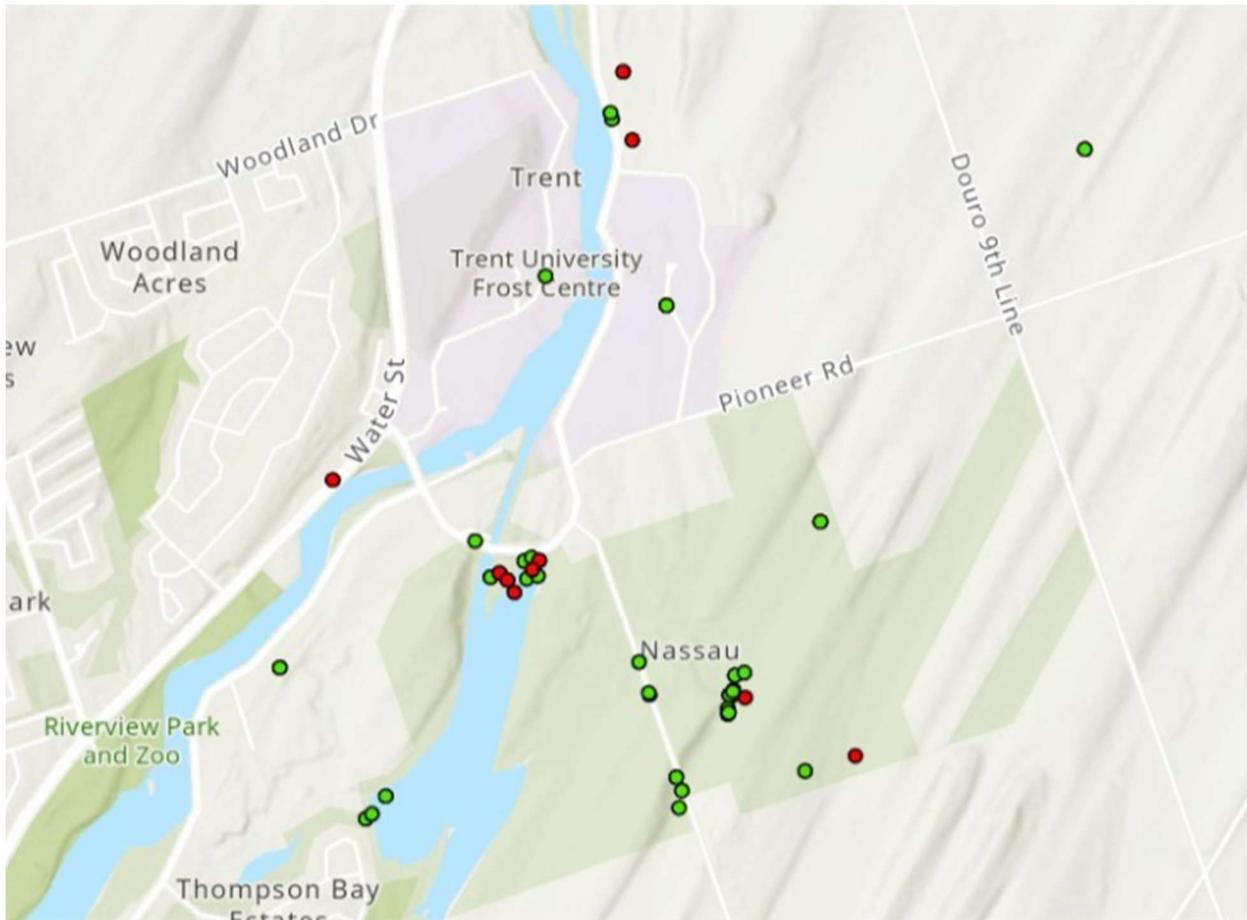
INat Reptile only data\_2

- |                          |                           |                         |                      |
|--------------------------|---------------------------|-------------------------|----------------------|
| ● Eastern Garter Snake   | ● Northern Redbelly Snake | ● Common Garter Snake   | ● DeKay's Brownsnake |
| ● Midland Painted Turtle | ● Common Snapping Turtle  | ● Painted Turtle        | ● Other              |
| ● Eastern Milksnake      | ● Red-bellied Snake       | ● Turtles and Tortoises | World Hillshade      |

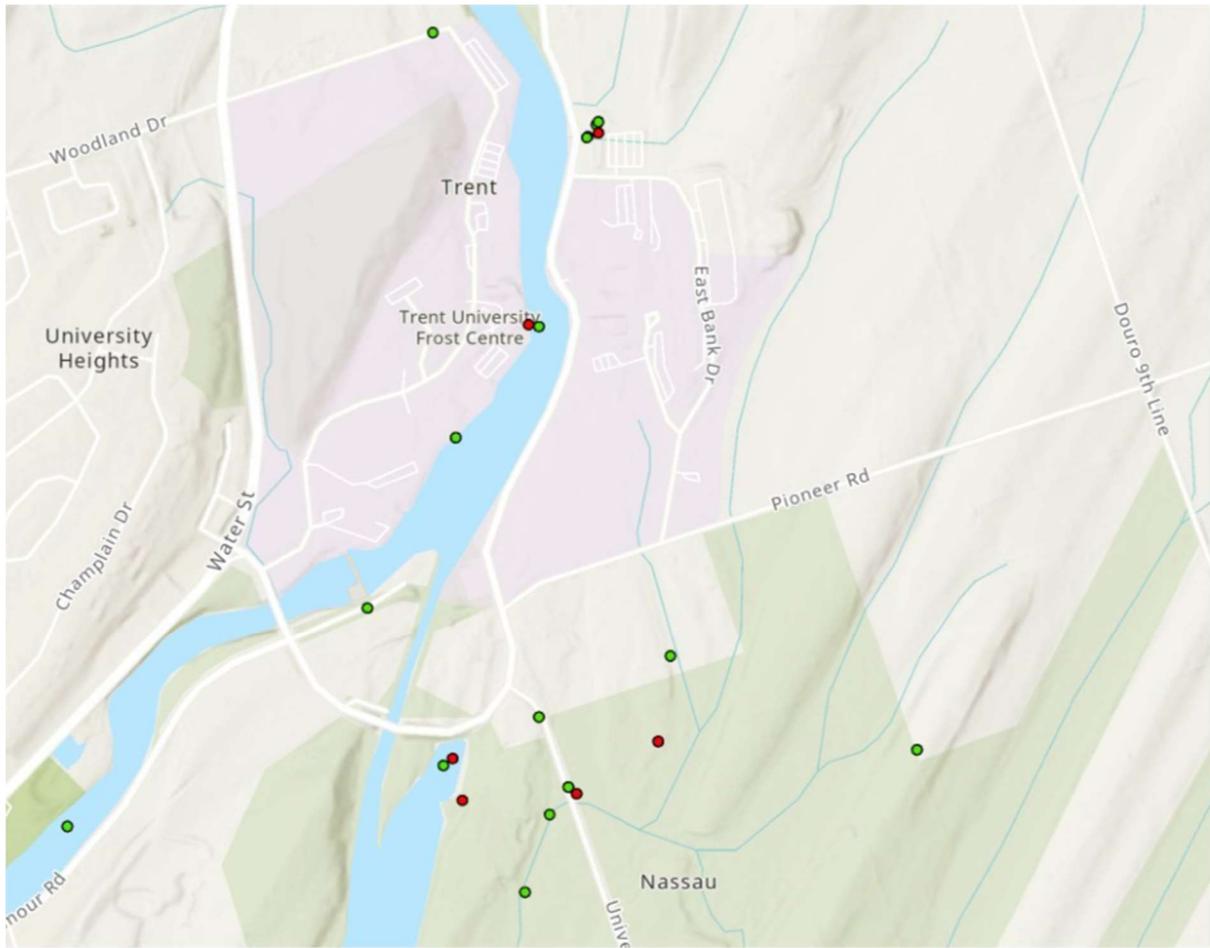
**Figure 6.** All reptile iNaturalist observations obtained from the data download.



**Figure 7.** The historic (prior to 2019, coloured in red) and current (after or during 2019, coloured in green) observations of eastern milk snakes observed on or near the Trent Nature Areas.



**Figure 8.** The historic (prior to 2019, coloured in red) and current (after or during 2019, coloured in green) observations of midland painted turtles observed on or near the Trent Nature Areas.



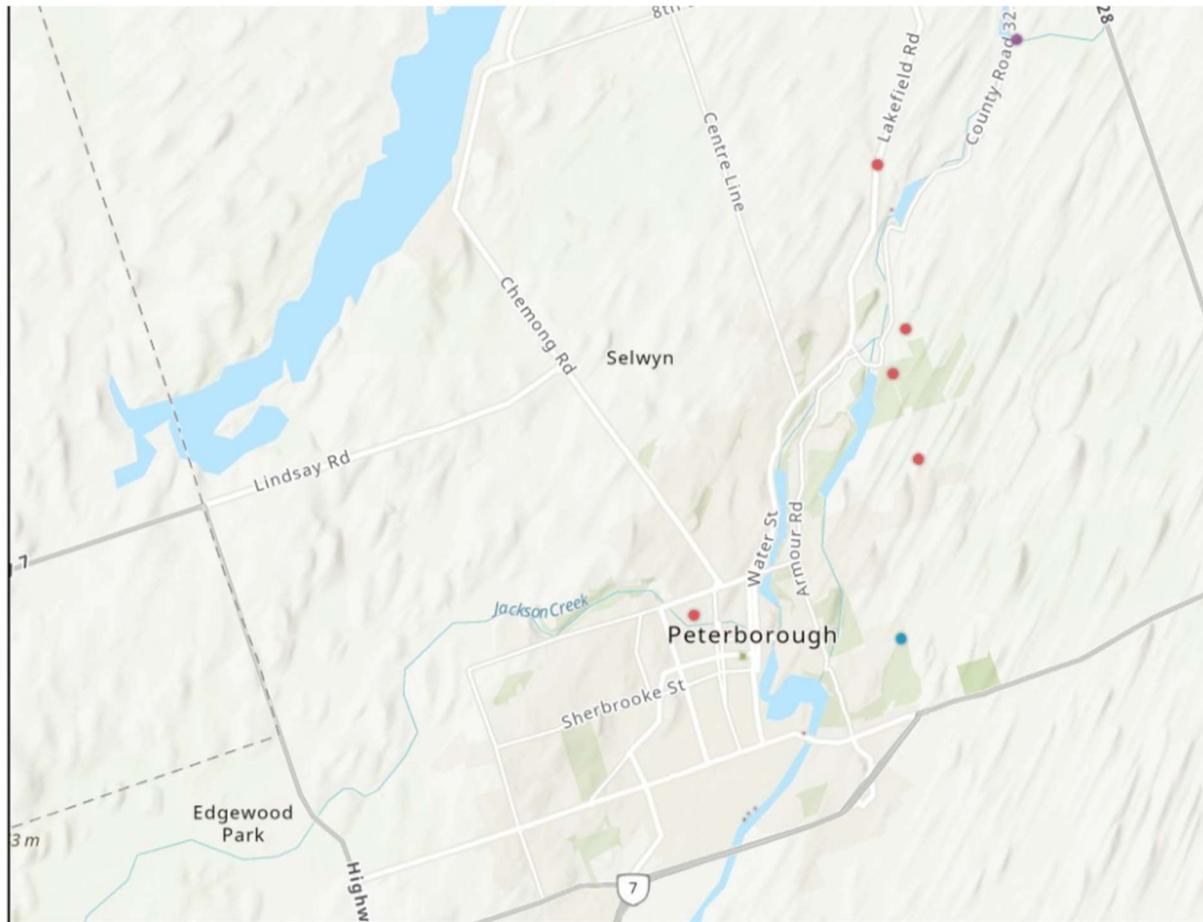
**Figure 9.** The historic (prior to 2019, coloured in red) and current (after or during 2019, coloured in green) observations of common snapping turtles observed on or near the Trent Nature Areas.



**Figure 10.** Observations of Dekay's Brownsnake (3) in the Trent Nature Areas, obtained from iNaturalist.

The iNaturalist data proved to be highly valuable, as it showed hotspots of herpetofauna observations, and gave insight into cryptic species that might not be seen during surveys (fig. 5). The historic and current observations were defined as historical occurring before the year 2019, and current either during 2019 or after 2019. These observations show a decrease in the range size of eastern milk snakes within the Wildlife Sanctuary Nature Area, with observations in the northern end comprising of historic data, and observations in the southern end current (fig. 6). It displayed that some common species, such as the Dekay's brownsnake utilize the Trent Nature Areas but have a limited distribution according to citizen science (fig. 9). This would warrant

further investigation since this species is a habitat generalist and would exploit many other areas on Trent ground than what is observed on iNaturalist.



**Figure 11.** A map that displays the element occurrence observations obtained from NHIC data. Note that only eastern milk snakes were observed on the Trent Campus, and that there is both Blanding's and northern map turtle observations in proximity (<10km) to the campus.

The results of the data obtained from NHIC yielded few individuals. Within the spatial boundaries of the Trent Nature Areas, only two datapoints came back; both were eastern milk snakes (fig. 9). Outside of the boundaries of the Trent Nature Areas, Blanding's turtles, northern map turtles, and even a historic population of five lined skink were all observed within the City of Peterborough (fig. 9). The implication of this is that although there are no historical observations of both Blanding's and map turtle on campus, they are present in the general vicinity of Peterborough and their presence should be considered. The nearest northern map turtle observation was 2km upstream of campus in the Otonabee River (Lock 23), which means campus is within the spatial boundaries of its home range (ORAA, 2023). The Blanding's turtle was observed approximately 8km away from campus toward the southeast (near Beavermead Park). This would be outside of this individual turtle's home range; however, the population could range into the southern nature areas such as Wildlife Sanctuary and Canal (ORAA, 2023).

Northern leopard frogs are the most abundantly observed amphibian species on the Trent University Symons campus, with over 450 iNaturalist observations. Northern leopard frogs have been observed both historically (prior to 2019) and contemporarily (2019 – 2023) within the boundaries of Promise Rock Nature Area (PRNA), Archeology Centre Wetland Nature Area (ACWNA), Canal Nature Area (CNA), and Wildlife Sanctuary Nature Area (WSNA). They have been observed contemporarily within the boundaries of Ninth Line Nature Area (NLNA), Wetland Complex Nature Area (WCNA), Otonabee College Nature Area (OCWNA), South Drumlin Nature Area (SDNA), and Lock 22 Nature Area (L22NA). High concentrations of northern leopard frogs have been observed along Gzowski Way/East Bank Drive, indicating movement between ACWNA and OCWNA. The marsh within ACWNA, and the swamp within OCWNA both serve as possible breeding and overwintering habitats for multiple species of the

Lithobates genus including northern leopard frogs, and green frogs. High numbers of northern leopard frogs and green frogs have been reported moving across Gzowski Way, East Bank Drive, and University Drive. Both species have also been observed, in lower abundance, on Pioneer Road. This pattern indicates that Lithobates species on campus are likely utilizing aquatic habitats within ACWNA, WLSNA, and OCWNA.

The cluster of western chorus frog and spring peeper observations in the southeast corner of TLFNA overlaps with a small marsh surrounded by woodlands. Based on this pattern of observations, it is possible that this marsh is being utilized as breeding habitat by Pseudacris species. The proximity of this small marsh to a woodland habitat makes it an ideal habitat for Pseudacris species. The same can be concluded about the cluster of observations between PRNA and WCNA. To the east of these observations is savannah habitat within PRNA, to the west is a swamp surrounded by marsh habitat within WCNA. Spring peepers and western chorus frogs have been observed historically and contemporarily in the northeast corner of ACWNA. These observations overlap with a small swamp which borders an area of coniferous forest. The proximity of these two ecosystem types likely serves as an ideal habitat for both spring peepers and western chorus frogs.

Although a very important tool, citizen science is not without pitfalls. Using iNaturalist presents a challenge, as your observations are open for anyone to comment on or see. This led to some individuals misunderstanding best practices for reporting *Ambystoma* species. There were instances of “correcting” our observations into both the unisexual mole salamander umbrella taxa and identifying them as *Ambystoma laterale*. Without genetic testing, positive identification of these salamanders is impossible during the fall season, so the best practice is to leave the observation at the genus level. Lack of public knowledge of citizen science is also a pitfall, with

likely several key observations of unique taxa going without uploading since the public is either unaware of the app or does not realize that the data is utilized by researchers.

## Summary Tables

**Table 4.** All herpetofauna species found within the specific Trent University Nature Area boundaries sampled during this study, with red squares displaying absence and green squares displaying presence. Along with how the data was obtained.

Species	PRNA	ACWNA	WCNA	OCWNA	Source
Eastern Garter Snake					OS and iNaturalist data
Eastern Milk Snake					OS, NHIC data, and iNaturalist data
Northern Red Belly Snake					OS and iNaturalist data
Northern Water Snake					iNaturalist data
Dekay's Brown Snake					iNaturalist data
Midland Painted Turtle					TBS and iNaturalist data
Common Snapping Turtle					TBS and iNaturalist data
Chorus Frogs					iNaturalist data
<i>Ambystoma spp.</i>					OS, RMS and iNaturalist data
American Toad					iNaturalist data
Grey Tree Frog					iNaturalist data

<b>American Bullfrog</b>					Incidental seen during TBS, iNaturalist data
<b>Green Frog</b>					OS, RMS and iNaturalist data
<b>Northern Leopard Frog</b>					RMS and iNaturalist data
<b>Mink Frog</b>					iNaturalist data
<b>Eastern Red Backed Salamander</b>					iNaturalist data
<b>Wood Frog</b>					iNaturalist data
<b>Spring Peeper</b>					OS and iNaturalist data

**Table 5.** The number of compiled observations per species from the sources of data utilized.

Species	iNaturalist	NHIC	Opportunistic Surveys	Turtle Basking Surveys	Road Mortality Surveys
Eastern Garter Snake	149	(	2	0	0
Eastern Milk Snake	39	(	1	0	0
Northern Red Belly Snake	76	(	1	0	1
Northern Water Snake	1	(	0	0	0
Dekay's Brown Snake	3	(	0	0	0
Midland Painted Turtle	52	(	0	22	0
Common Snapping Turtle	29	(	0	1	0
Chorus Frogs	34	(	0	0	0
<i>Ambystoma spp.</i>	124	(	28	0	43
American Toad	62	(	0	0	0
Gray Tree Frog	57	(	0	0	0
American Bullfrog	3	(	0	1	0
Green Frog	104	(	1	0	3
Northern Leopard Frog	484	(	0	0	5

Mink Frog	1	(	0	0	0
Eastern Red Backed Salamander	3	(	0	0	0
Wood Frog	37	(	0	0	0
Spring Peeper	75	(	1	0	0
Total	1333	∑	34	24	52

## Discussion

### Reptiles

#### Snakes

During our surveys and observed on iNaturalist Promise Rock Nature Area supported the highest reptile biodiversity. This likely is due to the connectivity that this nature area provides. It is located between the Wetland Complex Nature Area and the Otonabee River, which provides a large portion of class 3 habitat for reptile species. There is also the suspected large hibernaculum within 200m of the bench located at the intersection of the Rotary Greenway Trail and the hiking trails in PRNA. This means that PRNA has all three significant habitat classes (hibernaculum, foraging, and connectivity). There is a large amount of glacial till deposits throughout the nature area, which gives snakes ideal basking habitat and cover.

The PRNA displays some key factors for significant wildlife habitat (SWH) designation from the provincial government. This site supports a species of concern (eastern milk snake), is adjacent to both suitable forested habitat and wetland habitat and displayed the highest diversity of snake species within the TNA (OMNRF, 2000). This designation is worth further consideration, as it gives better protection on terrestrial habitats with sensitive habitat. The Wildlife Sanctuary Nature Area also would likely meet the standards for a SWH designation.

## Turtles

The Trent-Severn Waterway displayed the highest number of turtles seen during turtle basking surveys and was the most reliable site for observing turtles. This could be due to a combination of factors, but mainly this site had the highest amount of emergent basking locations. These basking locations in the Trent-Severn Waterway support turtle diversity and prosperity (Harding, Mifsud, 2017; Munshower, 2019). The large surface area of this water body, and limited shade also support biodiversity, with more foraging options and space for dispersal. It also was easier to spot the turtles within the Trent-Severn Waterway due to the ridge on Nassau Mills Road, which was above the riparian vegetation. The Otonabee College Stormwater Ponds, and the Archaeology Pond were difficult to survey due to the tall riparian vegetation which blocked the view of the binoculars.

The Otonabee River should not be underestimated, as we did not find any individuals within the river during turtle basking surveys. However, 2km upstream is the Trent-Severn Waterway Lock 23, where there is a significant amount of turtle diversity including snapping, midland painted, eastern musk, and northern map turtles. This could mean that occasionally individuals either move downstream accidentally or purposefully disperse, and there could be a higher turtle diversity within the portion of the Otonabee River that runs through campus than what was observed. There could be a partnership between Parks Canada/Ontario Waterways (Trent-Severn Waterway) and Trent University to mitigate, survey, and manage the populations of turtles that exist in the boundaries of the Trent-Severn Waterway (Cass Stabler, personal communication 2024).

## Amphibians

Based on the observations pulled from iNaturalist and collected during field surveys, there are four areas of potentially significant wildlife habitats for woodland breeding amphibians. These habitats represent areas of extreme importance for amphibian biodiversity and are often the only area of suitable breeding habitat within a landscape (OMNRF, 2015). Two of these sites are highly supported by the observations, two are moderately supported. Significant wildlife habitat for woodland breeding amphibians includes small (>500m<sup>2</sup>) wetlands, ponds, or vernal pools located in or within 120 m of woodlands. For habitats to meet these criteria, there must be a presence of 1 (or more) of the listed salamander/newt species and 2 (or more) of the listed frog species (OMNRF, 2015). The listed species present on the Trent campus include *Ambystoma* spp, gray treefrog, spring peeper, wood frog, and western chorus frog.

The first area, highly supported by observations to indicate significant wildlife habitat for woodland breeding amphibians, is on the north side of Woodland Drive. This includes the southeast corner of TLFNA and the southern half of L22NA. This area of TLFNA is made up of marsh and woodland habitats. This area of L22NA is made up of savannah, marsh, swamp, woodland, and meadow (Trent Lands, 2021). *Ambystoma* spp, gray treefrog, spring peeper, wood frog, and western chorus frog have all been observed in this area. The second potentially significant wildlife habitat location is ACWNA. The same five species have been observed at the northeast corner of ACWNA. This area is made up of marsh, coniferous forest, and woodland habitats (Trent Lands, 2021).

The two areas of potentially significant wildlife habitat for woodland breeding amphibians, moderately supported by observations, are WCNA/PRNA and WSNA/CNA. Clusters of spring peeper, wood frog, gray treefrog, and *Ambystoma* spp observations along

University Road indicates the presence of breeding habitat within WSNA and/or CNA.

Observations of *Ambystoma* spp, gray treefrog, spring peeper, wood frog, and western chorus frog between PRNA and WCNA also indicate the possible presence of breeding habitat.

Based on the observations pulled from iNaturalist and collected during field surveys, there are three areas of potentially significant wildlife habitats for wetland breeding amphibians. Significant wildlife habitat for wetland breeding amphibians refers to larger wetlands (500m<sup>2</sup>) with abundant aquatic vegetation. These wetlands are typically rare and represent a critical habitat for amphibian biodiversity (OMNRF, 2015). For habitats to meet these criteria, there must be a presence of 1 (or more) of the listed salamander/newt species and 2 (or more) of the listed frog species (OMNRF, 2015). The listed species present on the Trent campus include american toad, *Ambystoma* spp, gray treefrog, western chorus frog, northern leopard frog, green frog, and american bullfrog.

The first area of potentially significant wildlife habitat for wetland breeding amphibians is ACWNA. American toad, *Ambystoma* spp, gray treefrog, western chorus frog, northern leopard frog, and green frogs have all been observed on iNaturalist in this area. This indicates that the permanent wetland in the ACWNA is likely being used as critical breeding habitat. The second potentially significant wildlife habitat is WSNA. The same 6 species observed in ACWNA have also been observed within WSNA. The final location of potentially significant wildlife habitat is WCNA. Observations of northern leopard frog, *Ambystoma* spp, gray treefrog, american toad, and western chorus frog have all been recorded in WCNA. This indicates the use of the large wetland within this area as breeding habitat.

Further investigation of these nature areas to identify the presence and locations of suitable aquatic habitats should be completed to confirm if these areas meet the criteria for

significant wildlife habitat. To confirm that these areas meet the criteria, further studies should be conducted during breeding season to determine the presence of breeding populations.

## Recommendations

### Road Mortality Mitigation

One low cost, relatively easy-to-implement strategy to reduce herpetofauna road mortality is the installation of seasonal road signage. The presence of wildlife crossing signs on areas of high amphibian and reptile movement can be an effective method of reducing road mortality by changing driver behavior. These signs should be implemented seasonally to avoid driver habituation. Wildlife crossing signage should be installed on both sides of roads that intersect movement corridors (OMNRF, 2016). At Trent, amphibian crossing signage is recommended for Woodland Drive, University Drive, and Pioneer Road. This recommendation is based on the observations collected during road mortality surveys, which indicate these roads to be areas of amphibian movement. Further studies should be conducted to determine the ideal location for reptile movement signage. Although signage can be an effective mitigation strategy, it should be implemented alongside other strategies. The effectiveness of road signage has limits and cannot, alone, serve as an effective road mortality mitigation strategy (OMNRF, 2016).

Another recommendation to reduce amphibian road mortality is the extension of the Gzowski Way sloped curb. Modifying the curb on East Bank Drive between Gzowski Way and Pioneer Road is recommended to reduce the risk facing amphibians utilizing ACWNA habitat. The same best management practices previously used for the Gzowski Way curb modification should be applied. Sloping the curb to 45° aims to make migration over the road easier for

amphibians by reducing the effort required to escape the road (OMNRF, 2016). Other constructed mitigation techniques can also be very effective strategies; however, the observations gathered during field surveys are not sufficient to make recommendations. Culverts, eco passages, and other curb modifications require vast planning, resources, and monitoring that should be investigated further in future studies.

During road mortality surveys, Woodland Drive was closed to traffic for construction at the intersection of Woodland Drive and Water Street. As a result, very few DOR observations were found here during road mortality surveys. This section of Woodland Drive has low traffic and would be a good candidate for seasonal road closure. The road closure would need to occur for 2-3 weeks during the fall and spring migration periods (OMNRF, 2016). Further surveys and analysis should be done to determine the specific dates for closure. Woodland Drive is not owned by the university, making seasonal closure outside the capabilities of the Trent Facilities team. Collaboration between the Facilities team, local naturalists, and student groups to campaign for the seasonal closure of Woodland Drive is recommended. Public education campaigns to garner support for amphibian road mortality mitigation can be a useful tool in the approval of seasonal road closures (OMNRF, 2016).

## Supporting Herptile Biodiversity

One of the most significant considerations for on-campus biodiversity is the preservation of significant habitats. Habitat loss and reduction from land-use change causes disproportionately large extirpations within herpetofauna (Gardner et. al. 2007; Lessbarreres et. al. 2014). It was found during our surveys, and personal observations that there are a few confirmed critical herpetofauna habitat zones on campus. One example of such a habitat is the snake hibernacula observed within the Wildlife Sanctuary Nature Area and the Promise Rock Nature Area. With

increasing encroachment onto sensitive habitat, it could be beneficial to investigate the creation of artificial hibernacula within the TNA. This process is conducted using heavy machinery (backhoe or excavator) and large substrates such as concrete slabs and rotting logs (Crowley et. al. 2018). Before starting construction, it is important to ensure there are no other critical habitats impacted by the vibrational/compaction factors caused by heavy machinery (Crowley et. al. 2018).

There are several factors to note before selecting a final site for constructing hibernaculum. Monitoring the depth of the frost line and water table for at least three years before construction is critical to make sure that snakes will survive overwintering in this specific location (Crowley et. al. 2018). Frost lines are monitored by inserting a frost tube 2-3m into the ground (Crowley et. al. 2018). The water table can be measured by drilling into the ground and measuring the depth of the water that enters the holes during the winter (Crowley et. al. 2018). The snakes should have access to at least a portion of the water table during hibernation, but this portion should be at the very bottom of the new hibernaculum to avoid flooding events (Crowley et. al. 2018). After monitoring the frost line and water table, sites on south-facing slopes with well-drained soil and access (within 100m) to basking locations can be selected for construction (Crowley et. al. 2018).

The construction process is intensive and thorough and therefore only the keys stages are summarized in this report. The first of which is the excavation of the selected site. The hole should be at least 2m deep (a depth below the frost line and 1m below the water table) and 4m wide at the surface (Crowley et. al. 2018). At this time any features to promote drainage should be implemented if necessary (spillways ect) (Crowley et. al. 2018). The next stage is to lay the groundwork for the hibernaculum. This involved lining the base with gravel and

installing/modifying plastic piping to allow for heat retention within the inner chambers of the hibernaculum (Crowley et. al. 2018). The next stage is to create the underground chambers. This is done by placing concrete blocks/slabs, rock and woody debris (small amounts only placed at the entrance) into the excavated hole (Crowley et. al. 2018). The concrete slabs should be placed on cinder blocks laid on top of the gravel layer, which allows for chambers to be made rather than the blocks sitting on one another (Crowley et. al. 2018). When placing materials in the hole, they should be at odd angles to create chambers (Crowley et. al. 2018). The final step is to complete the surface entrance of the hibernaculum. A layer of landscape fabric ovetop of the centre of the hibernaculum should be placed then covered with any natural landscape features (organic debris, soil, or smaller cobble) (Crowley et. al. 2018). The final cover of the hibernaculum should be a low mound that does not protrude above the ground's natural surface (Crowley et. al. 2018). After covering the hibernaculum, the creation of basking locations with rocks, or brush should be done (Crowley et. al. 2018). The entrances of the plastic piping should be surrounded with natural landscape features (Crowley et. al. 2018). Temperature loggers should be installed to monitor the internal/external temperatures of the hibernaculum (Crowley et. al. 2018).

Following construction, the artificial hibernaculum should be monitored for several years to make sure snakes are utilizing it and it is not causing any adverse effects (Crowley et. al. 2018). It is also suggested to create 3 separate new hibernacula near the old location to increase the probability of more snakes using the new hibernaculum (Crowley et. al. 2018).

It was noted that there was a lack of ideal basking structures within the Otonabee College Stormwater Ponds, Archaeology Permanent Pond, and Otonabee River. Implementing new basking locations could be an easy and cost-effective way to boost the biodiversity of turtle

species in this nature area. Large, buoyant logs should be used to create basking habitat for turtle species (Munshower, 2019). Using heavier objects such as rocks or concrete could impact any organism living in the benthic zone of the water body. Using logs also would create habitat for invertebrate species and larval amphibians. Boosting the available habitat for invertebrate species also allows for more food present in the water bodies, which would also boost biodiversity and ecosystem health. When placing logs into the ponds, they should be close to the shoreline (due to the small surface area of the ponds, within 1m or resting on the shore would be ideal) (Munshower, 2019). They also should be anchored somehow to remain in an effective location. This could be done either by weighing them down or using rope to tie them to neighboring trees. The spread of unwanted pathogens, such as chytrid fungus, should also be considered when implementing artificial basking locations. Ideally, the logs should come from the same watershed as the pond in question (logs from east bank should not be used in the stormwater ponds on west bank and vice versa).

The section of the Otonabee River sampled during turtle basking surveys also did not yield any turtle species seen. This is partially due to the severely impaired riparian zone, but it also is due to lack of optimal basking locations in this portion of the Otonabee (Munshower, 2019). Creating some basking locations on dead logs jutting out from the shoreline could improve the health of the riparian zone as well, by creating cover for fish/invertebrates and promoting the overall biodiversity of this portion of the Otonabee River (Munshower, 2019). Artificial turtle basking locations should be implemented within the Otonabee Stormwater Ponds, and Archaeology Pond. It would be beneficial to investigate further into the legitimacy of implementing these basking sites within the Otonabee River, since it is not owned by Trent.

The extension of the curb that borders Awna and Gzowski Way Road would be beneficial. As of right now, there is no barrier between Gzowski College parking lot X and the Awna permanent water body. This leads to an influx of road salt, as there is no barrier to prevent the salt from entering the wetland. An extension of the rolled curb that currently exists on Gzowski Way Road into Gzowski parking lot X would reduce the salt influx and would positively support the amphibian biodiversity. There is also already a protocol for curb replacement and extension created during the Gzowski Way curb's replacement.

The construction of artificial hibernacula, extension of Gzowski Way Curb and the deployment of artificial basking locations can be aided by the Trent Grounds Committee. Trent Grounds can supply the materials needed to successfully complete these tasks and provide more people to assist with construction.

Lack of education on the strengths of citizen science also leads to some misunderstanding of the true diversity and distribution of herpetofauna on campus, with more specialists reporting on herpetofauna than the public (Hecht et. al. 2021). This is simply due to the public not knowing that both iNaturalist exists, and it is utilized by researchers for land-use considerations (Hecht et. al. 2021). Some simple signage at the entrances of the nature areas (specifically Wildlife Sanctuary, Promise Rock, and Canal Nature Areas) with a QR code to campus iNaturalist projects, and a small sentence about how the data is used would yield to a better understanding of citizen science. Outreach workshops, like the one facilitated by the Peterborough Field Naturalists and the researchers of this project, would be beneficial too. This gives the public the opportunity to interact with, and learn how to use the app. This will be highlighted more in the next section of the report.

**Table 6.** All herpetofauna species present in or suspected to be within the Trent Nature Areas with the priority of mitigation/protection based on our analysis. Species coloured yellow were found during surveys, species coloured dark orange were only found in the iNaturalist observations and species coloured light orange are suspected to exist within the TNA based on historical knowledge and ranges. The most important priorities are coloured in red.

Abbreviations: SAR (Species at risk), NAR (Not at risk).

Species	Priority	Action(s)	Reasoning
Eastern Garter Snake	Low	N/A	Widespread
Eastern Milk Snake	High	Artificial Hibernacula, spring RMS	Provincially tracked species, SAR
Northern Red Belly Snake	Medium	RMS on Pioneer Road	High quantity of individuals on roadway
Northern Water Snake	Medium	Further targeted survey effort	Unknown distribution/drivers of distribution on campus
Dekay's Brown Snake	Medium	Further targeted survey effort	Unknown distribution/drivers of distribution on campus
Midland Painted Turtle	High	Springtime RMS, nesting surveys, artificial basking sites	SAR
Common Snapping Turtle	High	Springtime RMS, nesting surveys, artificial basking sites	SAR
Northern Map Turtle	High	Further targeted survey effort, springtime RMS, nesting surveys, artificial basking sites	SAR/provincially tracked species, could overlap range in TNA
Blanding's Turtle	High	Further targeted survey effort, springtime RMS, nesting surveys, artificial basking sites	SAR/provincially tracked species, could overlap range in TNA (some historic observations in Nassau Wetland Complex)
Eastern Musk Turtle	High	Further targeted survey effort, springtime RMS, nesting surveys, artificial basking sites	SAR, observations in Otonabee River near campus and in Trent-Severn Waterway Lagoon
Chorus Frogs	High	Acoustic monitoring of known call sites, RMS	SAR, populations sensitive to changes

<i>Ambystoma spp.</i>	High	Further RMS, signage on Woodland Drive/Gzowski Way	High road mortality observed, abundance unique to campus
American Toad	Low	N/A	Abundant, NAR
Gray Tree Frog	Low	N/A	Abundant, NAR
American Bullfrog	Low	N/A	Uncommon on campus, but no concerns of biodiversity loss, NAR
Green Frog	Low	N/A	Abundant, NAR
Northern Leopard Frog	Medium	RMS	Highest iNat observations and high road mortality seen
Mink Frog	Low	N/A	Locally uncommon transient visitor
Eastern Red Backed Salamander	Medium	Further targeted survey effort	Unknown distribution drivers
Wood Frog	Low	N/A	Abundant, NAR
Spring Peeper	Low	N/A	Abundant, NAR

## Future Research

One of the most important ways to further knowledge of herpetofauna distribution and threats on campus is to conduct more projects such as this. More community-based research (CBR) projects would not only further understanding but also connect stakeholders and members of the community together. Through personal communication, staff members of Parks Canada responsible for managing the Trent-Severn Waterway showed interest in aiding with future CBR projects that might coincide with the Trent-Severn Waterway. With the framework laid out during this project, it should be easier for further CBR projects to continue studying on-campus herpetofauna. Some examples of possible projects are highlighted in the table below.

**Table 7.** Some possible CBR and/or monitoring projects that students can conduct with some possible community organizations listed.

Type of Project	Project Description	Possible Community Organization(s)
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CBR	The deployment/development of artificial turtle basking structures	Parks Canada, Trent Land Use Committee, Trent Grounds
CBR	Further RMS with specific investigation into the mitigation of Woodland Drive and considerations in Municipality zone laws	Trent Land Use Committee, Trent Grounds, Municipality of Peterborough
CBR/thesis	Before-after-control-impact (BACI) study of any mitigation methods implemented on campus (artificial basking, road mortality mitigation methods, signage etc.)	Trent Land Use Committee, Trent Grounds, Municipality of Peterborough, Parks Canada
CBR/individual	The effectiveness of citizen science/gauging public awareness	Peterborough Field Naturalists
CBR/Thesis	Long-term monitoring of suspected on-campus snake hibernacula	Trent Land Use Committee
CBR	Specific focus on stratified OS with a more scientific approach (transect sampling) to quantify biodiversity	Trent Land Use Committee
CBR/individual	Targeted surveys for species with unknown distributions (dekeys brown snake, northern water snake, unknown turtles Eastern red backed salamander)	Trent Land Use Committee
CBR	Continuation of OS within other nature areas	Trent Land Use Committee
CBR/individual	Monitoring of salinity within campus permanent/ephemeral water bodies and possible implementation of a curb extension	Trent Land Use Committee, U-Links Centre for Community-Based Research, Trent Grounds

## Appendix

Raw survey data available upon request.

**Appendix 1.** A blank copy of the field sheet used to complete turtle basking surveys.

2023/24 The State of Herpetofauna Biodiversity on the Trent University Symons Campus  
 BIOL 4891 Community Based Research Project Fieldsheets

Specific Nature Area:		Location/number of pictures:	Date (dd-MON-year):	Observers:		
GPS Coordinates				Site area (ha):	Site Comments:	
Latitude	Longitude					
Vegetation Community						
Survey Effort						
# of people:	Hours:	Borders of area:	People hours effort:			
Weather						
Cloud Cover (%):	Air temperature (°C):		Comments:			
Precipitation:	Precipitation within 24 hours:					
Species Surveys						
Species	Photo	Coordinates	Habitat type	Behaviour	Survey type	

	Number/Location				
Species	Photo Number/Location	Coordinates	Habitat type	Behaviour	Survey type

**Appendix 2.** A blank copy of the field sheet used to complete opportunistic surveys.

2023/24 The State of Herpetofauna Biodiversity on the Trent University Symons Campus  
 BIOL 4891 Community Based Research Project Fieldsheets

Specific Nature Area:		Location/number of pictures:	Date (dd-MON-year):	Observers:		
GPS Coordinates				Site area (ha):	Site Comments:	
Latitude	Longitude					
Vegetation Community						
Survey Effort						
# of people:	Hours:	Borders of area:	People hours effort:			
Weather						
Cloud Cover (%):	Air temperature (°C):		Comments:			
Precipitation:	Precipitation within 24 hours:					
Species Surveys						
Species	Photo	Coordinates	Habitat type	Behaviour	Survey type	

	Number/Location				
Species	Photo Number/Location	Coordinates	Habitat type	Behaviour	Survey type

**Appendix 3.** A blank copy of the field sheet used to complete road mortality surveys.



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