Red-eared Slider (*Trachemys scripta elegans*) nests in the Greater Toronto Area

MARC DUPUIS-DESORMEAUX1,2, GRACE VAN ALSTYNE2, MAUREEN MUeller3, RUTH TAKAYESU3, VINCE D’ELIA4, and SUZANNE E. MACDONALD5

1Department of Biology, Glendon College, York University, 2275 Bayview Avenue, Toronto, Ontario M4N 3M6 Canada
2Toronto, Ontario, Canada
3Heart Lake Turtle Troopers, Brampton, Ontario, Canada
4Toronto and Region Conservation Authority, 101 Exchange Avenue, Vaughan, Ontario L4K 5R6 Canada
5Department of Psychology, York University, 4700 Keele Street, Toronto, Ontario M3J 1P3 Canada

*Corresponding author: marcd2@yorku.ca*


Abstract

Red-eared Slider (*Trachemys scripta elegans*) is a non-native turtle found in abundance in Toronto’s wetlands as a result of pet releases. Although this species is known to reproduce successfully in southwestern Ontario, Canada, there is yet no evidence to suggest successful reproduction in the Greater Toronto Area (GTA). As part of a native turtle nest protection program, volunteers inadvertently placed nest protector boxes over four slider nests in 2021 and 10 nests in 2022. This gave us the opportunity to determine whether nests produced viable offspring and whether these hatchlings would emerge in the fall. The exact nesting date for each nest was recorded. In 2021, eight of the 41 eggs from the slider nests showed very late-stage arrested embryonic development. In 2022, one of the nests had four hatchlings out of their eggshells but still inside the nest cavity. It is unclear whether the hatchlings would emerge later in the fall or overwinter in the nest cavity and emerge the following spring. If the small population sampled accurately reflects what occurs in the GTA, complete egg development may be possible for this species in some years, in some locations, with the right local micro-climate and micro-habitat. We discuss implications for turtle nest protection in Toronto.

Key words: Red-eared Slider; *Trachemys scripta elegans*; turtle nest protection; arrested development; Toronto; wetlands; turtle embryo; climate change; invasive species

Introduction

Red-eared Slider (*Trachemys scripta elegans*) is native to the central United States and northeastern Mexico but introduced in other parts of North America (Ernst and Lovich 2009) and many countries around the world (Rödder et al. 2009). Since the 1950s, these turtles have been favoured by the pet trade. They are now present in more than 90 countries and, at one time, were considered to be among the top 100 invasive species (Lowe et al. 2000). Sliders have been reported to outcompete some native turtles for basking sites (Cadi and Joly 2003; Lambert et al. 2019), although basking sites are usually not a limiting factor in Ontario (Seburn 2016). In some countries, native turtles have experienced weight loss and higher mortality after the introduction of Red-eared Sliders (Cadi and Joly 2004), and there is always the risk of introducing new pathogens when a pet turtle is released into the environment (Oi et al. 2012). In Canada, Red-eared Slider is considered a threat to some populations of native turtles, although population effects are uncertain (COSEWIC 2016a,b, 2018).

The 3-cm (carapace length) hatchlings grow to 30 cm and can quickly outgrow their enclosures, causing pet owners to release them into local wetlands (Ernst and Lovich 2009). Sliders can reproduce successfully outside their native range in a broad range of climatic conditions, including temperate areas (Standfuss et al. 2016). Viable hatchlings have been reported in many temperate countries and regions, such as Japan (Taniguchi et al. 2017), Spain (Perez-Santigosa et al. 2008), France (Cadi et al. 2004), Slovenia (Standfuss et al. 2016), British Columbia (Mitchell et al. 2022), and southern Ontario (Seburn 2016). Slider hatchlings can successfully emerge in southwestern Ontario in the fall and as far north as Oxford and Middlesex.
lands are known to nest (Dupuis-Desormeaux et al. 2022a). Since their documentation in the Greater Toronto Area (GTA; Seburn 2016), Red-eared Sliders have been reported in 130 locations, with 67% of Ontario sightings in the GTA (Gillingwater pers. comm. 13 May 2022). Red-eared Sliders found in many of Toronto’s wetlands are known to nest (Dupuis-Desormeaux et al. 2019, 2021), but hatchlings had not been discovered.

Every species of turtle subjected to Ontario winters must deal with extended freezing conditions, potential anoxia, and prolonged times in brumation, either under ice or in nest cavities, sometimes unsuccessfully (Dupuis-Desormeaux et al. 2022a). Turtles found at northern latitudes dig nests and lay eggs in the late spring and early summer. Incubation periods vary among species, but all eggs will hatch in the fall and hatchlings will either emerge then (as is most common in Snapping Turtle [Chelydra serpentina] and Blandings’ Turtle [Emydoidea blandingii]) or overwinter in the nest cavity and delay emergence until the following spring (typical for Midland Painted Turtle [Chrysemys picta marginata] and very occasionally Snapping Turtles). (See Lovich et al. 2014 and Ultsch 2006 for a comprehensive review of overwintering strategies and poor outcomes in Ontario (M.D.-D. unpubl. data; S. Gillingwater pers. obs.).) Delayed emergence in North American turtles is suggested to be an evolutionary advantageous trait only possessed by north-ern turtle populations (Gibbons and Nelson 1978). In its native range, the slider’s overwintering strategy varies, with most hatchlings emerging in the fall, but delayed emergence is documented in some areas, such as Illinois (Gibbons and Nelson 1978; Packard et al. 1997) and Florida (Jackson 1994).

Temperatures in nest cavities can fall below freezing in winter months; thus, turtle hatchlings that overwinter in the nest cavity at northern latitudes must be able to withstand freezing (St. Clair and Gregory 1990; Packard et al. 1999). Hatchlings that typically overwinter in nests, such as Midland Painted Turtles, can withstand lower temperatures for longer periods than turtles that tend to emerge from nest cavities in the fall (Red-eared Sliders, Snapping Turtles, and Blanding’s Turtles; Packard et al. 1999). Sliders are less adapted to withstand sub-zero temperatures, leading to increased hatching freezing of these species compared with Painted and Blanding’s Turtles (Packard et al. 1999).

We oversee a large group of volunteers, who perform a variety of tasks to safeguard native turtle populations, including protecting nests with anti-predator structures. Although sliders are not a species that we target for protection, a few slider nests are inadvertently protected every year. This provided an opportunity to collect data on nesting dates and outcomes at two sites in the GTA. Although our study was limited to two seasons at two study sites, we hope that given the ubiquitous presence of this non-native species in many Canadian cities, including the GTA, and the paucity of published data on their hatching success in Ontario, this small study will add to the knowledge of this species’ ability to reproduce and potentially spread.

Methods

Study sites

Nesting sites were discovered by volunteers who observed and followed turtles suspected of being ready to nest. The first nesting location was on a south-west facing hill at Loafer’s Lake Park, in Brampton, Regional Municipality of Peel in the GTA region of Ontario, Canada (43.72330°N, 79.80104°W), near the northern limit of the deciduous forest zone (Allen et al. 1990). The site is in a highly residential and commercial area. Etobicoke Creek is the primary inflow and outflow to Loafer’s Lake.

The second site, High Park, had nesting sites dispersed throughout the park. Volunteers started a nest protection program in 2022. High Park is a large urban park in the city of Toronto, Ontario, Canada (43.64650°N, 79.46370°W). The park is characterized by an oak savannah, a 14-ha naturalized pond with wetlands (Grenadier Pond), smaller wetlands and ponds, and a ravine.

Nest protecting and monitoring

Once a suspected nesting turtle was observed, volunteers followed the female to her nesting spot and allowed her to oviposit while protecting her from animals, vehicular traffic, people, and other disturbances. After successful egg-laying and the turtle’s safe return to the wetland, the volunteers placed a protection box over the nest to keep predators from digging up the eggs. The boxes were anchored in the ground with 30-cm nails and marked with a unique number identifier. The boxes were a ~60-cm by 60-cm frame, constructed of standard 2 × 4 inch wood (38 × 89 mm), with exit holes along the side, and covered with a sheet of galvanized steel mesh (1.3-cm mesh), a design commonly used throughout Ontario (M.D.-D. pers. obs.).

In 2021, volunteers placed 75 nests protectors at the Loafer’s Lake site and other nearby sites in Brampton, Ontario, protecting 36 Midland Painted Turtle nests, 34 Snapping Turtle nests, and five Red-eared Slider nests. The boxes were placed over the nesting area soon after egg laying in the spring and summer months and left until the fall (Snapping Turtles) or the following spring (Midland Painted and Red-eared Sliders), allowing for safe gestation, hatching, overwintering, and emergence.
The nests were monitored almost daily in the fall (Snapping Turtles) and in the early spring (Midland Painted Turtles and Red-eared Sliders) for signs of emergence. The nest protectors around Red-eared Slider nests laid in the summer of 2021 were removed, and the nests excavated on 10 May 2022, while those in 2022 were excavated in November 2022. We did not want to interfere with the Red-eared Slider nests in 2021 and potentially assist hatchling emergence, but we did monitor for emergence holes in fall 2021 and spring 2022 and found none. The nests were excavated to look for signs of emerged hatchlings (empty eggshells inside the nest cavities or emergence holes) or failed nesting (undeveloped eggs or dead hatchlings in the nest cavities).

In 2022, volunteers protected 63 Midland Painted Turtle nests, 75 Snapping Turtle nests, 10 Red-eared Slider nests, and one Eastern Musk Turtle (Sternotherus odoratus) nest. Only Red-eared Slider nests were systematically excavated and inspected in November 2022.

Results

We documented five Red-eared Slider nests and protected four (one nest protector was placed over the wrong area) at Loafer’s Lake in 2021 and 10 nests in 2022 (both study sites combined). The four protected nests from 2021 yielded clutch sizes ranging from 8 to 13 eggs (Table 1). There was no successful hatching in any of these nests. All slider nests lacked an exit hole, empty shells inside the nests, and signs that any hatchlings had exited their eggs or the nest cavities before we excavated the nests. Recorded nesting dates for the sliders ranged from 16 June to 13 July 2021.

After excavating the nests, we counted and dissected the eggs and investigated hatching development of the earliest laid nest in greater detail. Slider egg development in all the nests stopped at the late embryonic stages. Each embryo appeared to be connected to a large yolk sac within the eggshell (Figure 1). Using the 27-stage embryonic development scheme of Yntema et al. (1968) and based on Greenbaum’s (2002) study of Red-eared Sliders, the embryos of the earliest nest (#1) appeared to be arrested at stages 24–26 (Figure 2), close to the hatching stage (stage 27). In contrast, 27/34 (79.4%) protected Snapping Turtle and 26/36 (72.2%) Midland Painted Turtle nests showed successful emergence. The failed Snapping and Midland Painted Turtle nests had suffered from a variety of issues, including flooding, rooting (plant roots invading the eggs), infertile eggs (showing no embryonic development), egg predation, egg desiccation, nest cavity collapse, and hatching entanglement in grass roots and blades. We were also unable to relocate a small number of the nests because of poor nest protector placement. None of the native species exhibited late-term embryonic arrested development.

In 2022, Red-eared Sliders nested from 11 June to 29 July. We excavated nests between 8 and 14 November. Nine of the 10 excavated nests had eggs

<table>
<thead>
<tr>
<th>Nest</th>
<th>Nesting date</th>
<th>Clutch size</th>
<th>Outcome*</th>
<th>Stage†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loafer’s Lake</td>
<td>16 June 2021</td>
<td>8</td>
<td>AD</td>
<td>24–26</td>
</tr>
<tr>
<td>2</td>
<td>2 July 2021</td>
<td>13</td>
<td>NV + AD</td>
<td>18–21</td>
</tr>
<tr>
<td>3</td>
<td>5 July 2021</td>
<td>8</td>
<td>NV</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>13 July 2021</td>
<td>12</td>
<td>NV</td>
<td>—</td>
</tr>
<tr>
<td>5</td>
<td>22 June 2022</td>
<td>13</td>
<td>AD</td>
<td>17–21</td>
</tr>
<tr>
<td>6</td>
<td>27 June 2022</td>
<td>7</td>
<td>AD</td>
<td>24</td>
</tr>
<tr>
<td>7</td>
<td>16 July 2022</td>
<td>13</td>
<td>NV + AD</td>
<td>14</td>
</tr>
<tr>
<td>8</td>
<td>23 July 2022</td>
<td>3</td>
<td>NV</td>
<td>—</td>
</tr>
<tr>
<td>9</td>
<td>26 July 2022</td>
<td>13</td>
<td>NV + AD</td>
<td>12–21</td>
</tr>
<tr>
<td>10</td>
<td>5 July 2022</td>
<td>15</td>
<td>NV + AD</td>
<td>14</td>
</tr>
<tr>
<td>High Park</td>
<td>11 June 2022</td>
<td>8</td>
<td>NV + H</td>
<td>27</td>
</tr>
<tr>
<td>12</td>
<td>27 June 2022</td>
<td>13</td>
<td>AD</td>
<td>20–21</td>
</tr>
<tr>
<td>13</td>
<td>28 June 2022</td>
<td>13</td>
<td>NV</td>
<td>—</td>
</tr>
<tr>
<td>14</td>
<td>29 July 2022</td>
<td>6</td>
<td>NV</td>
<td>—</td>
</tr>
</tbody>
</table>

*AD = arrested development, H = hatched in nest cavity, NV = non-viable eggs. †Stages range from 1 to 27, with 27 indicating hatched (Greenbaum 2002).
(3–15 eggs) that had either failed because of arrested embryonic development or were non-viable (eggs were desiccated and sunken; Table 1). We also documented double clutching, confirmed by photographs taken of a female after laying her eggs. The female that laid the eggs in nest #5 at Loafer’s Lake on 22 June (13 eggs) also laid a clutch on 16 July (nest #7, 13 eggs). We suspect that the female that laid eggs in nest #8 on 23 July was disturbed as there were only three eggs and the nest was not covered before she left the site.

When we excavated nest #11 (laid on 11 June) in 2022, we found four hatched turtles on top of four non-viable eggs (Figure 3). This nest was found at the side of a road, in full sun. Most other slider nests were found in part shade.

Embryonic development in the other nests from 2022 varied greatly from stage 12 to 24 (Table 1). We removed the live hatchlings from nest #11, and they were adopted by a volunteer. Prospective adopters were educated on the equipment and long-term commitment required to keep this species in captivity and how it is illegal to release pet turtles into Ontario wetlands.

**Discussion**

Red-eared Slider clutches were not successful at the Loafer’s Lake site in 2021 or 2022 despite their location near Painted and Snapping Turtle nests with predominantly successful emergence in both years. The peak nesting time for native turtles at this site was 8–14 June (unpubl. data), and the slider eggs were laid after this peak in both years. Some of the excavated slider eggs at Loafer’s Lake showed late embryonic development but no evidence of pipping and hatching. The eggs of the earliest laid nest (#1) were the most developed of the excavated slider clutches, but...
were still unable to develop fully, suggesting that the local climatic conditions at this site might be a limiting factor (Ficetola et al. 2009).

However, the success of one nest at producing viable offspring at our High Park site in 2022 raises more issues. Because we excavated the nest on 8 November 2022, it is uncertain whether the hatchlings would have exited the nest at some point before the first freeze and snowfall (which was 16 November 2022, M.D.-D. pers. obs.). Also worthy of noting is that the volunteers who work diligently at protecting turtles had a strong protective instinct toward these slider hatchlings. Thus, the hatchlings were not euthanized. Given our small sample size and the fact that only one of the 14 monitored nests was able to produce viable hatchlings, we recommend further investigations into factors limiting Red-eared Slider reproduction in Ontario. With at least one nest with hatched, but not emerged turtles, in the GTA, sliders there might be poised to reproduce successfully during the summer. As climate continues to warm, causing potentially warmer summer and fall temperatures, Red-eared Slider eggs in Toronto may be able to develop fully more frequently and hatch and emerge in the fall as they do further south in Ontario (Seburn 2016). Some of us have argued that having non-native sliders in urban wetlands might not be as bad as often portrayed and may provide important ecosystem functions (Dupuis-Desormeaux et al. 2022b), but others have a much more conservative view (Mitchell et al. 2022).

Our study also raises questions as to which course of action to take when volunteers discover slider nests now that we know they can produce viable hatchlings. Should we ask volunteers to remove the eggs, destroy the nest, or let nature take its course? Our volunteers felt much more inclined to simulate a predation event and destroy newly laid eggs than to remove hatchlings for euthanasia. Local conservation authorities might discuss a plan to take eggs from all slider nests before any advanced embryonic development happens to avoid creating moral dilemmas among the volunteers.

We suggest that further research on the post-emergence survival of slider hatchlings in Ontario wetlands is also needed to better understand the potential ecological effects of this non-native species and whether these effects pose threats to Ontario’s native turtle species.

Author Contributions

Acknowledgements
We thank all the volunteers of the Heart Lake Turtle Troopers and the Turtle Protectors High Park who worked tirelessly to protect and monitor nesting sites, specifically the organizational work done by Jamie-Lee Ball, Christina Cicconetti, Lori Leckie, Leah Nacua, and Rebecca Zimmerman for the Troopers and Jenny Davis and Carolynn Crawley for the Protectors. We also thank Scott Gillingwater (Upper Thames River Conservation Authority) and Jeff Lovich for their helpful comments on the first draft and the support and encouragement provided by David Seburn.

Literature Cited


Dupuis-Desormeaux, M., M. Browne, S. Boudjelas, and M. De Poorter. 2000. 100 of the world’s worst invasive alien species: a selection from the Global Invasive Species Database. Invasive Species Specialist Group, University of Auckland, Auckland, New Zealand.


Lowe, S., M. Browne, S. Boudjelas, and M. De Poorter. 2000. 100 of the world’s worst invasive alien species: a selection from the Global Invasive Species Database. Invasive Species Specialist Group, University of Auckland, Auckland, New Zealand.


Received 2 June 2022
Accepted 23 February 2023
Associate Editor: W.D. Halliday