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

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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 counties near London, Ontario (S. Gillingwater pers. comm. 13 May 2022). Since their documentation in Ontario in the 1950s, Red-eared Sliders have been reported in 130 locations, with 67% of Ontario sightings in the Greater Toronto Area (GTA; Seburn 2016). 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 Blanding's 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 northern 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 hatchling 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 southwest 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 hatchling 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 developmental 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 hatchling 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 1. State of Red-eared Slider (*Trachemys scripta elegans*) nests found in the Greater Toronto Area.

Nest	Nesting date	Clutch size	Outcome*	Stage†
Loafer's Lake				
1	16 June 2021	8	AD	24–26
2	2 July 2021	13	NV + AD	18–21
3	5 July 2021	8	NV	—
4	13 July 2021	12	NV	—
5	22 June 2022	13	AD	17–21
6	27 June 2022	7	AD	24
7	16 July 2022	13	NV + AD	14
8	23 July 2022	3	NV	—
9	26 July 2022	13	NV + AD	12–21
10	5 July 2022	15	NV + AD	14
High Park				
11	11 June 2022	8	NV + H	27
12	27 June 2022	13	AD	20–21
13	28 June 2022	13	NV	—
14	29 July 2022	6	NV	—

*AD = arrested development, H = hatched in nest cavity, NV = non-viable eggs.
†Stages range from 1 to 27, with 27 indicating hatched (Greenbaum 2002).

FIGURE 1. Red-eared Slider (*Trachemys scripta elegans*) embryo from nest #1 at Loafer's Lake, Ontario, Canada, encased in the shell and showing the unabsorbed egg yolk. This embryo was at stage 25 or 26 (detailed dissection required to determine exact stage). Photo: M. Dupuis-Desormeaux.

(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

FIGURE 2. Seven of the eight Red-eared Slider (*Trachemys scripta elegans*) embryos removed from their eggshells from the earliest nest of 2021 (#1) at the Loafer's Lake site, Ontario. Embryo stage ranges from 24 to 26. The eighth embryo from this nest was damaged during egg dissection. Photo: M. Dupuis-Desormeaux.

FIGURE 3. Hatched Red-eared Slider (*Trachemys scripta elegans*) inside the nesting cavity (nest #11), High Park, Ontario, after excavation on 8 November 2022. Photo: M. Dupuis-Desormeaux.

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

Writing – Original Draft: M.D.-D. and G.V.A.; Review & Editing: M.D.-D., G.V.A., M.M., R.T., V.D., and S.E.M.; Conceptualization: M.D.-D.; Data Collection: M.D.-D., G.V.A., M.M., and R.T.; Funding Acquisition: M.D.-D., V.D., and S.E.M.

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Literature Cited

Allen, G.M., P.F.J. Eagles, and S.D. Price. 1990. Conserving Carolinian Canada. University of Waterloo Press, Waterloo, Ontario, Canada.

Cadi, A., V. Delmas, A.C. Prevot-Julliard, P. Joly, C. Pieau, and M. Girondot. 2004. Successful reproduction of the introduced slider turtle (*Trachemys scripta elegans*) in the South of France. Aquatic Conservation: Marine and Freshwater Ecosystems 14: 237–246. https://doi.org/10.1002/aqc.607

Cadi, A., and P. Joly. 2003. Competition for basking places between the endangered European pond turtle (*Emys orbicularis galloitalica*) and the introduced red-eared slider (*Trachemys scripta elegans*). Canadian Journal of Zoology 81: 1392–1398. https://doi.org/10.1139/z03-108

Cadi, A., and P. Joly. 2004. Impact of the introduction of the red-eared slider (*Trachemys scripta elegans*) on survival rates of the European pond turtle (*Emys orbicularis*). Biodiversity and Conservation 13: 2511–2518. https://doi.org/10.1023/b:bioc.0000048451.07820.9c

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2016a. COSEWIC assessment and status report on the Western Painted Turtle *Chrysemys picta bellii*, Pacific Coast population, Intermountain – Rocky Mountain population and Prairie/Western Boreal – Canadian Shield population, in Canada. COSEWIC, Ottawa, Ontario, Canada.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2016b. COSEWIC assessment and status report on the Blanding's Turtle *Emydoidea blandingii*, Nova Scotia population and Great Lakes/St. Lawrence population, in Canada. COSEWIC, Ottawa, Ontario, Canada.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2018. COSEWIC assessment and status report on the Midland Painted Turtle *Chrysemys picta marginata* and the Eastern Painted Turtle *Chrysemys picta picta* in Canada. COSEWIC, Ottawa, Ontario, Canada.

Dupuis-Desormeaux, M., V. D'Elia, R. Burns, B. White, and S.E. MacDonald. 2019. A turtle population study in an isolated urban wetland complex in Ontario reveals a few surprises. FACETS 4: 584–597. https://doi.org/10.1139/facets-2019-0046

Dupuis-Desomeaux, M., S. Gillingwater, and S.J. Carstairs. 2022a. Cases of freeze-dried freshwater turtles at the northern limit of their ranges in southern Ontario. Canadian Field-Naturalist 136: 309–315. https://doi.org/10.22621/cfn.v136i4.2959

Dupuis-Desormeaux, M., J.E. Lovich, and J.W. Gibbons. 2022b. Re-evaluating invasive species in degraded ecosystems: a case study of red-eared slider turtles as partial ecological analogs. Discover Sustainability 3: 15. https://doi.org/10.1007/s43621-022-00083-w

Dupuis-Desormeaux, M., K. McDonald, D. Moro, T. Reid, C. Agnew, R. Johnson, and S.E. MacDonald. 2021. A snapshot of the distribution and demographics of freshwater turtles along Toronto's Lake Ontario coastal wetlands. Journal of Great Lakes Research 47: 283–294. https://doi.org/10.1016/j.jglr.2021.01.020

Ernst C.H., and J.E. Lovich. 2009. Turtles of the United States and Canada. Second Edition. John Hopkins University Press, Baltimore, Maryland, USA.

Ficetola, G.F., W. Thuiller, and E. Padoa-Schioppa. 2009. From introduction to the establishment of alien species: bioclimatic differences between presence and reproduction localities in the slider turtle. Diversity and Distributions 15: 108–116. https://doi.org/10.1111/j.1472-4642.2008.00516.x

Gibbons, J.W., and D.H. Nelson. 1978. The evolutionary significance of delayed emergence from the nest by hatchling turtles. Evolution 32: 297–303. https://doi.org/10.2307/2407597

Greenbaum, E. 2002. A standardized series of embryonic stages for the emydid turtle *Trachemys scripta*. Canadian Journal of Zoology 80: 1350–1370. https://doi.org/10.1139/z02-111

Jackson, D.R. 1994. Overwintering of hatchling turtles in northern Florida. Journal of Herpetology 28: 401–402. https://doi.org/10.2307/1564549

Lambert, M.R., J.M. McKenzie, R.M. Screen, A.G. Clause, B.B. Johnson, G.G. Mount, H.B. Shaffer, and G.B. Pauly. 2019. Experimental removal of introduced slider turtles offers new insight into competition with a native, threatened turtle. PeerJ 7: e7444. https://doi.org/10.7717/peerj.7444

Lovich, J.E., C.H. Ernst, E.E. Ernst, and J.L. Riley. 2014. A 21-year study of seasonal and interspecific variation of hatchling emergence in a nearctic freshwater turtle community: to overwinter or not to overwinter? Herpetological Monographs 28: 93–109. https://doi.org/10.1655/herpmonographs-d-14-00001

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.

Mitchell, A.M., V.L. Kilburn, R. Seifert, and D. MacTavish. 2022. Evidence of successful hatching by introduced Red-eared Slider (*Trachemys scripta elegans*) in British Columbia, Canada. Canadian Field-Naturalist 136: 122–132. https://doi.org/10.22621/cfn.v136i2.2653

Oi, M., J. Araki, J. Matsumoto, and S. Nogami. 2012. Helminth fauna of a turtle species introduced in Japan, the red-eared slider turtle (*Trachemys scripta elegans*). Research in Veterinary Science 93: 826–830. https://doi.org/10.1016/j.rvsc.2011.10.001

Packard, G.C., M.J. Packard, J.W. Lang, and J.K. Tucker. 1999. Tolerance for freezing in hatchling turtles. Journal of Herpetology 33: 536–543. https://doi.org/10.2307/1565569

Packard, G.C., J.K. Tucker, D. Nicholson, and M.J. Packard. 1997. Cold tolerance in hatchling slider turtles (*Trachemys scripta*). Copeia 1997: 339–345. https://doi.org/10.2307/1447753

Perez-Santigosa, N., C. Díaz-Paniagua, and J. Hidalgo-Vila. 2008. The reproductive ecology of exotic *Trachemys scripta elegans* in an invaded area of southern Europe. Aquatic Conservation: Marine and Freshwater Ecosystems 18: 1302–1310. https://doi.org/10.1002/aqc.974

Rödder, D., S. Schmidtlein, M. Veith, and S. Lötters. 2009. Alien invasive slider turtle in unpredicted habitat: a matter of niche shift or of predictors studied? PLoS ONE 4: e7843. https://doi.org/10.1371/journal.pone.0007843

Seburn, D.C. 2016. Distribution of the exotic Pond Slider (*Trachemys scripta*) in Ontario. Canadian Field-Naturalist 129: 342–348. https://doi.org/10.22621/cfn.v129i4.1756

St. Clair, R.C., and P.T. Gregory. 1990. Factors affecting the northern range limit of painted turtles (*Chrysemys picta*): winter acidosis or freezing? Copeia 1990: 1083–1089. https://doi.org/10.2307/1446492

Standfuss, B., G. Lipovšek, U. Fritz, and M. Vamberger.

2016. Threat or fiction: is the pond slider (*Trachemys scripta*) really invasive in Central Europe? A case study from Slovenia. Conservation Genetics 17: 557–563. https://doi.org/10.1007/s10592-015-0805-2

Taniguchi, M., J.E. Lovich, K. Mine, S. Ueno, and N. Kamezaki. 2017. Unusual population attributes of invasive red-eared slider turtles (*Trachemys scripta elegans*) in Japan: do they have a performance advantage? Aquatic Invasions 12: 97–108. https://doi.org/10.3391/ai.2017.12.1.10

Ultsch, G.R. 2006. The ecology of overwintering among turtles: where turtles overwinter and its consequences. Biological Reviews 81: 339–367. https://doi.org/10.1017/s1464793106007032

Yntema, C.L. 1968. A series of stages in the embryonic development of *Chelydra serpentina*. Journal of Morphology 125: 219–251. https://doi.org/10.1002/jmor.1051250207

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