The Canadian Field-Naturalist

Distribution and breeding potential of the exotic False Map Turtle (*Graptemys pseudogeographica*) in Canada

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Abstract

False Map Turtle (*Graptemys pseudogeographica*) is widespread in the central United States, and its native range extends close to the Canadian border. It is common in the pet trade and has been released into the wild outside its native range. We examined observations of False Map Turtle from iNaturalist Canada, an online platform to document native and non-native species, and confirmed 20 observations in Canada from eight cities in three provinces. The earliest observation was in April 2014 from Victoria, British Columbia. Fourteen of the 20 observations (70%) were from 2020 to February 2024. All the turtles were either large juveniles or adults. Climate data from the northern part of the False Map Turtle's native range and from Canadian cities suggest that individuals could survive the winter in parts of southern Canada and successfully breed in parts of southern Ontario during the warmest years.

Key words: Community science; exotic species; False Map Turtle; *Graptemys pseudogeographica*; iNaturalist

Introduction

The trade in exotic pets is a large, international industry and reptiles are the second most common group of species in the global trade (Bush *et al.* 2014). Turtles have been common in the pet trade for decades (D'Aoust and Lior 1978; Kopecký *et al.* 2013). Red-eared Slider (*Trachemys scripta elegans*) has been the most commonly traded turtle species and many have been released into the wild making it the most widespread turtle species in the world (Ernst and Lovich 2009). Other turtle species, including False Map Turtle (*Graptemys pseudographica*), are becoming common in the pet trade (Kopecký *et al.* 2013; Lyons *et al.* 2013). A recent study found 120 species of turtles for sale (Sung *et al.* 2021).

We focussed on False Map Turtle because its northern range comes close to Canada and, therefore, it could survive Canadian winters, successfully breed in parts of Canada, and possibly become established in this country. Other species in the pet trade that have been released into Canada, such as Greek Tortoise (*Testudo graeca*), Florida Redbelly Turtle (*Pseudemys nelsoni*), and Florida Softshell (*Apalone ferox*), are rarely reported in the wild (iNaturalist Canada 2024); given their association with warmer climates, they are unlikely to be able to breed successfully in Canada.

The native range of False Map Turtle is limited to the United States, extending as far north as North Dakota, Minnesota, and Wisconsin (Ernst and Lovich 2009). The species is mainly limited to large streams and rivers that are part of the Missouri and Mississippi River systems (Ernst and Lovich 2009). Two subspecies have been identified, although there is some taxonomic uncertainty regarding this arrangement (Thomson *et al.* 2018): False Map Turtle (*G. p. pseudogeographica*), found in the northern part of the range, and Mississippi Map Turtle (*G. p. kohnii*), found in the southern part of the range.

Between 2011 and 2020, over 500 000 False Map Turtles were exported from the United States (CITES Secretariat 2022). Adult females can reach 27 cm in carapace length (Ernst and Lovich 2009), so pets that survive can become too large to easily maintain in captivity. Released pets have been found outside the native range in the United States (Spinks *et al.* 2003; Smith *et al.* 2020) and in other countries, such as Croatia (Jelić and Jelić 2015), Germany (Schradin 2020; Tietz *et al.* 2023), Italy (Ferri *et al.* 2021), Romania (Iftime and Iftime 2021), Spain (Poch *et al.* 2020), and the Republic of Korea (Koo *et al.* 2020). Nesting has been confirmed at two locations in Italy (Ferri *et al.* 2021), and successful reproduction has been confirmed in Germany (Tietz *et al.* 2023).

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To assess the current distribution of False Map Turtle in Canada, we used data from iNaturalist Canada, an online platform for naturalists to record observations of native and exotic species. To date, iNaturalist Canada has more than 13 million observations of more than 38 000 species reported by more than 200 000 people (iNaturalist Canada 2024). Data from iNaturalist have been used to examine the distribution of exotic species (Werenkraut *et al.* 2020; Martel *et al.* 2022; Mo and Mo 2022) and to better assess the distribution of rare species (Gaier and Resasco 2023). The >66 000 observations of turtles on iNaturalist Canada make it a rich database, and iNaturalist is an ideal tool for assessing the distribution of a rare, exotic species that can be readily identified from photographs. These data can be better at detecting rare species than more structured surveys (Roberts *et al.* 2022) because community science allows for many eyes (or cameras) in many places. We also compared the climate in the northern portion of False Map Turtle's native range with that in Canadian cities to assess the likelihood of successful breeding in Canada and the species' ability to survive the winter.

Methods

We obtained observations of False Map Turtles from iNaturalist Canada submitted before the end of February 2024. We examined each photograph and excluded any observations we could not confirm as a False Map Turtle based on the presence of the postorbital mark. Observations were mapped using QGIS 3.4 (QGIS Development Team 2022). We obtained the mean monthly climate normal data (1991–2020) for Minneapolis, Minnesota (NOAA 2022) and for selected Canadian cities (1981–2010; Government of Canada 2022). We used the mean monthly temperature of the warmest month as an indicator of hatching success as it is strongly correlated with where the exotic Red-eared Slider could successfully breed in Italy (Ficetola *et al.* 2009). To determine whether recent temperatures are warmer than the 30-year climate normal, we also obtained the mean monthly air temperature for Canadian cities for the last five years (2018–2022). We used the number of days between the average first date of fall frost and the last spring frost as a measure of the winter's length. Longer winters can reduce turtle survival more often than the severity of the winter as a result of prolonged hypoxia or anoxia (Ultsch 2006).

Results

We confirmed 20 observations of False Map Turtles in Canada, from eight cities in three provinces (Table 1). The earliest observation was in April 2014 in Victoria, British Columbia. Fourteen of the 20 observations (70%) were from 2020 to 2024. All of the turtles were either large juveniles or adults. Although determining the sex of adult map turtles is easy when the individual is in the hand, sexing from photographs can be difficult if the tail is not visible; thus, we do not report sex.

British Columbia

Nine of the 20 observations (48%) were from British Columbia. Six were from Beacon Hill Park in Victoria. The park contains a pond roughly 0.2 km long with small islands. Two individuals were observed on the same day in May 2021. Observations at Beacon Hill Park range from 29 April to 25 September. It is uncertain whether turtles observed in different years represent the same individuals or different turtles.

One False Map Turtle was observed in Cathers Lake in Nanaimo, a lake ~0.7 km long and surrounded by houses. False Map Turtles were reported from Stanley Park, Vancouver, in 2022 and 2024; one was observed in Lost Lagoon, a small, artificial lake roughly 0.5 km long.

Ontario

Eight of the 20 (40%) observations were from Ontario (Table 1). We found five observations of False Map Turtles in Toronto from five locations that were all parks or urban greenspaces with ponds or rivers. One of the locations was Rouge National Urban Park. The five sites in Toronto were all at least 7.6 km apart and spanned a distance of 47 km.

One False Map Turtle was observed in Lake Simcoe in Barrie in 2019, one was observed in Clergue Park in Sault Ste. Marie in 2023, and one was observed in the Ottawa River in Ottawa in 2018.

Quebec

Three observations of False Map Turtles were from Québec City (Table 1). The first was observed in the Saint-Charles River in the urban portion of the city in 2020. Two other observations were ~8 km to the west in a small, artificial lake ~0.7 km in length in Parc de la Base de Plein Air de Sainte-Foy in 2021 and 2022.

Climate data

The mean monthly temperature for July, the warmest month of the year, for Minneapolis, Minnesota, near the northern limit of False Map Turtle's range, is 23.5°C. All Canadian cities with observations of False Map Turtles are at least 2°C cooler than Minneapolis (Table 2). Windsor, Ontario, the southernmost city in Canada, has a July monthly temperature that is only 0.5°C cooler than Minneapolis (Table 2). In addition, the mean monthly temperature for September in Windsor (17.9°C) is warmer than Minneapolis (17.5°C).

TABLE 1. Reported observations of False Map Turtle (*Graptemys pseudogeographica*) in Canada.

City	Location	Date	Observation URL
British Columbia			
Nanaimo	Cathers Lake	22 May 2021	https://inaturalist.ca/observations/80115971
Victoria	Beacon Hill Park	29 April 2014	https://inaturalist.ca/observations/44371704
		14 May 2020	https://inaturalist.ca/observations/45882807
		21 May 2021	https://inaturalist.ca/observations/79732327
		21 May 2021	https://inaturalist.ca/observations/79732329
		10 July 2022	https://inaturalist.ca/observations/125892979
		25 September 2022	https://inaturalist.ca/observations/136477853
Vancouver	Stanley Park	1 June 2022	https://inaturalist.ca/observations/119786383
		1 February 2024	https://inaturalist.ca/observations/198364947
Ontario			
Sault Ste. Marie	Clergue Park	27 August 2023	https://inaturalist.ca/observations/180483960
Barrie	Lake Simcoe	9 June 2019	https://inaturalist.ca/observations/135585570
Toronto	Don Valley Brick Works Park	28 August 2018	https://inaturalist.ca/observations/16000852
	Centennial Park	13 May 2019	https://inaturalist.ca/observations/33046163
	Rouge National Urban Park	23 July 2019	https://inaturalist.ca/observations/71496738
	Humber River	19 July 2020	https://inaturalist.ca/observations/54776827
	Kariya Park	15 May 2022	https://inaturalist.ca/observations/119655401
Ottawa	Ottawa River	26 May 2018	https://inaturalist.ca/observations/20197044
Quebec			
Québec City	St. Charles River	4 July 2020	https://inaturalist.ca/observations/71464227
	Parc de la Base de Plein Air de Sainte-Foy	12 July 2021	https://inaturalist.ca/observations/108234441
		1 July 2023	https://inaturalist.ca/observations/170443123

Source: iNaturalist Canada 2024.

TABLE 2. Summer and winter climate data near the northern limit of distribution of False Map Turtle (*Graptemys pseudogeographica*) in cities with observations of False Map Turtle or where successful breeding could occur.

Location	July 30-year average temperature, °C*	July mean temperature, 2018–2022, °C (maximum)	Frost period, days†
United States			
Minneapolis	23.5		202
Canada			
Victoria	16.9	17.8 (18.3)	153
Vancouver	18.0	18.7 (19.4)	128
Ottawa	21.0	22.0 (24.0)	205
Toronto	21.5	23.1 (25.0)	196
Windsor	23.0	23.4 (24.6)	169
Québec City	19.3	20.0 (20.9)	219

*1991–2020 for Minneapolis (NOAA 2022); 1981–2010 for the Canadian cities (Government of Canada 2022).
†Number of days between the average dates of the first fall frost and the last spring frost.

Considering just the years 2018–2022, both Toronto (23.1°C) and Windsor (23.4°C) have mean monthly July temperatures within 0.5°C of the mean monthly July temperature in Minneapolis (Table 2). Both cities exceeded 23.5°C in some years: Toronto in 2020 and Windsor in 2019 and 2020. Although Ottawa was cooler than Minneapolis on average (22.0°C), in one year (2020) it exceeded the July mean monthly temperature of Minneapolis. The frost period in Minneapolis averages 202 days which is longer than cities in southern British Columbia and southern Ontario (Table 2).

Discussion

False Map Turtle has been observed in three Canadian provinces. Its range in Canada may be broader than documented here, as some observations of the species on iNaturalist Canada may have been misidentified as the native Northern Map Turtle (*Graptemys geographica*). Some False Map Turtle observations had originally been identified as Northern Map Turtle, but not all misidentifications may have been corrected. Misidentification of species can be a problem with iNaturalist data, but it is usually greater for smaller and harder to identify species (Barbato *et al.* 2021; McMullin and Allen 2022). Nonetheless, it would be easy for an observer to assume that a False Map Turtle was really a Northern Map Turtle, the only species of *Graptemys* native to Canada. We examined all 1953 observations of Northern Map Turtle on iNaturalist Canada for another project (Seburn *et al.* 2023) and found only two cases where False Map Turtle had been incorrectly identified as Northern Map Turtle (0.1%), suggesting that misidentification is not a major issue. It is possible that in photos that do not show the diagnostic head markings, False Map Turtle could be assumed to be the native Northern Map Turtle.

Overall, iNaturalist Canada should be a good resource for assessing the distribution of a large, exotic turtle species. iNaturalist data tend to be biased toward larger-bodied animals (Callaghan *et al.* 2021) and toward more urban areas (Di Cecco *et al.* 2021; Mesaglio and Callaghan 2021) where pet turtles are most likely to be released (Seburn 2015; Poch *et al.* 2020; Mitchell *et al.* 2022).

False Map Turtle likely remains fairly uncommon in Canadian waterbodies. During 2016–2019, intensive turtle surveys of multiple wetlands in Toronto found only one False Map Turtle (Dupuis-Desormeaux *et al.* 2021). In contrast, iNaturalist Canada has more than 3200 observations of Pond Slider (*Trachemys scripta*; iNaturalist Canada 2024). The number of exotic False Map Turtles in Canada could increase substantially in the future, if the species continues to be sold in pet stores and unwanted turtles are released into the wild when they are too big to care for.

Most (70%) False Map Turtle observations were from 2020 onward. This could reflect a growing number of False Map Turtle individuals in the wild, but could simply be a reflection of iNaturalist data being biased toward the recent past, as the number of users and observations has been growing exponentially over the past decade (Di Cecco *et al.* 2021; Mesaglio and Callaghan 2021). Similarly, 76% of Pond Slider observations on iNaturalist Canada were from 2020 onward.

The frost period in many Canadian cities with False Map Turtle observations is shorter than that of Minneapolis (Table 2) suggesting that False Map Turtle could successfully overwinter in southern British Columbia and southern Ontario. It may even be able to overwinter in Ottawa, which has a frost period only slightly longer than that of Minneapolis. The northern distribution limit of turtles may be more limited by cooler summers than colder winters because lower incubation temperatures result in reduced hatching success of eggs (Obbard and Brooks 1981; Bobyn and Brooks 1994; Iverson 2022). In terms of exotic species, successful reproduction of Red-eared Slider in Europe is strongly correlated with summer but not winter temperatures (Ficetola *et al.* 2009). In addition, many nests of the exotic Red-eared Slider in southwestern British Columbia failed to hatch because of relatively cool summer temperatures, and more eggs hatched during a warmer summer (Mitchell *et al.* 2022). Similarly, most eggs of the exotic Red-eared Slider failed to hatch in Toronto, Ontario (Dupuis-Desormeaux *et al.* 2022). It is noteworthy that some eggs did successfully hatch although the hatchlings did not emerge from the nest. Dupuis-Desormeaux *et al.* (2022) demonstrate that a species that is native to areas south of Canada can breed in Ontario and its eggs hatch under suitable conditions. Their results suggest that other species found close to the Canadian border may also be able to successfully breed in Canada under suitable conditions.

If the mean monthly temperature of the warmest month at the northern edge of the False Map Turtle's distribution is a good indication of thermal limits to successful reproduction, then it is possible that the species cannot successfully breed in British Columbia because the July mean monthly temperature in Vancouver and Victoria is more than 5°C cooler than Minneapolis. Considering just the climate normal data for Ontario, Toronto is 2°C cooler than Minneapolis and this may be sufficient to prevent nests from hatching except in the warmest locations or warmest years. Windsor, in extreme southwestern Ontario, is only 0.5°C cooler than Minneapolis, suggesting that eggs could hatch successfully. In addition, Windsor is 0.5°C warmer than Minneapolis in September which could give eggs more time to develop and hatch before fall. Considering just the last five years, Windsor, Toronto, and Ottawa had years where the mean monthly July air temperature was warmer than the average for Minneapolis. Given recent summer temperatures, it is quite possible that False Map Turtle nests could successfully hatch in the warmest years in many areas in southern Ontario. Continued warming from climate change could lead to summer temperatures 2–4°C warmer in the Great Lakes area by

mid-century (Zhang *et al.* 2020), which could result in successful hatching in more years, or a larger area of southern Ontario where False Map Turtle could successfully breed.

Even if False Map Turtle cannot successfully breed in most of Canada, the release of unwanted pets can still pose a risk to native turtle species. In the past, False Map Turtle has successfully bred with Northern Map Turtle (Freedberg and Myers 2012). It is possible that released pets could breed with native Northern Map Turtles resulting in hybrid offspring, which may be less adapted to northern environments. In addition, turtles in the pet trade potentially face a number of extrinsic stressors, such as crowding, unhygienic handling, poor water quality, polluted feeding, and inadequate nutrition, which can predispose pet turtles to viral or bacterial infections which can be transmitted to other species or cause mortality (Brenes *et al.* 2014; McKenzie *et al.* 2019; Hossain and Heo 2021). The release of any exotic turtle into the wild poses a risk of the release of a novel pathogen that could harm native turtle species or other aquatic wildlife. Efforts should be undertaken to limit the release of unwanted pet turtles into the wild.

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