

Mass Mortality of Northern Map Turtles (*Graptemys geographica*)

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We report a mass mortality of Northern Map Turtles (*Graptemys geographica* [LeSueur, 1817]) on the north shore of Lake Erie, Ontario, Canada. Thirty-five dead adult females were recovered from a nesting area over a period of four weeks. Predation and boat strikes were both excluded as potential cause of death, but the actual cause could not be determined because of the poor condition of the carcasses. Other possible explanations for the mortality include poisoning, drowning, and infection with an unidentified pathogen. Mass mortality in long-lived species, such as turtles, can have long-term effects on population growth and is a cause for concern in a species at risk.

Key Words: Northern Map Turtle; *Graptemys geographica*; mass mortality; Lake Erie; Ontario; Canada

Introduction

In summer 2012, we documented a mass mortality of mature, female Northern Map Turtles (*Graptemys geographica* [LeSueur, 1817]) at a marsh–dune complex on the north shore of Lake Erie, Ontario, Canada. The exact location is withheld at the request of the permitting authority (Ontario Ministry of Natural Resources and Forestry). Location information can be obtained by written request to the Ontario Natural Heritage Information Centre (2nd Floor North Tower, 300 Water Street, Peterborough, Ontario K9J 3C7).

The Northern Map Turtle is listed as a species at risk in Canada; the Committee on the Status of Endangered Wildlife in Canada lists it as “Special Concern” (COSEWIC 2012). Thus, high, unexplained mortality in this species is cause for concern, and high mortality among mature females can have an especially long-lasting impact on long-lived species, such as turtles (Brooks *et al.* 1991). In this note, our goal is to make the details of this mortality available to other researchers who may encounter a similar event.

The first carcasses were found during surveys of a turtle nest site (a sandy beach) that we were monitoring from Monday to Saturday from late May to early July in the course of an ongoing conservation project. Six dead Northern Map Turtles were found between 17 June to 6 July 2012, near or just above the water line. Five of these carcasses were adult females; the sixth could not be sexed with certainty. Two had small tooth-marks on the shell that were not severe enough to cause death, but may have been left by scavengers, and two were in an advanced state of decomposition. The last two were found freshly dead (external tissue showed no signs of decomposition) with no obvious injuries to the skin or shell (Figure 1 a,b). Unfortunately, these carcasses were not sent for analysis, as the deaths appeared to represent incidental, natural mortality at the time. Daily, intensive monitoring of the nesting area ended on 7 July 2012.

On 16 July 2012, J. C. walked along the beach at the nesting site and discovered two desiccated Northern Map Turtle carcasses in sandy dunes well above the waterline. On 17 July 2012, he returned to the nesting area and, on further searching in the dunes, he found 27 more carcasses, all distributed within 100 m of one another and all well above the waterline. We returned several days later to collect and examine these, and were able to relocate and examine twenty-five. All 25 were female, as determined by shell shape and a curved carapace length of 21.6–27.1 cm (Ernst and Lovich 2009). The shells were intact (Figure 1c), excluding boat propeller strikes as a cause of death. The significant amount of tissue remaining on these carcasses suggested that the deaths had likely occurred in summer 2012, while the desiccation of the tissues suggested that the deaths had occurred several weeks before discovery of the carcasses. The exact time of death could not be determined, but it potentially coincided with that of the previously recorded mortalities.

No other turtle species were found dead on the nesting site in 2012, and a similar survey effort at this site in 2010, 2011, and 2013 found no dead Northern Map Turtles. Incidental dead and dying map turtles have been observed at the site during surveys of nearby habitat (Scott Gillingwater, Species At Risk Biologist, Upper Thames River Conservation Authority, personal communication, 25.09.2014; C. M. D., unpublished data). Some of these were attributable to road mortality, boat collisions, or predation, but often the cause of death could not be verified. The 2012 event was the first sudden concentration of map turtle carcasses discovered at the nesting site. Thus, this event appeared to be an isolated occurrence. Unfortunately, we could not identify the cause of death, but the following are possible explanations.

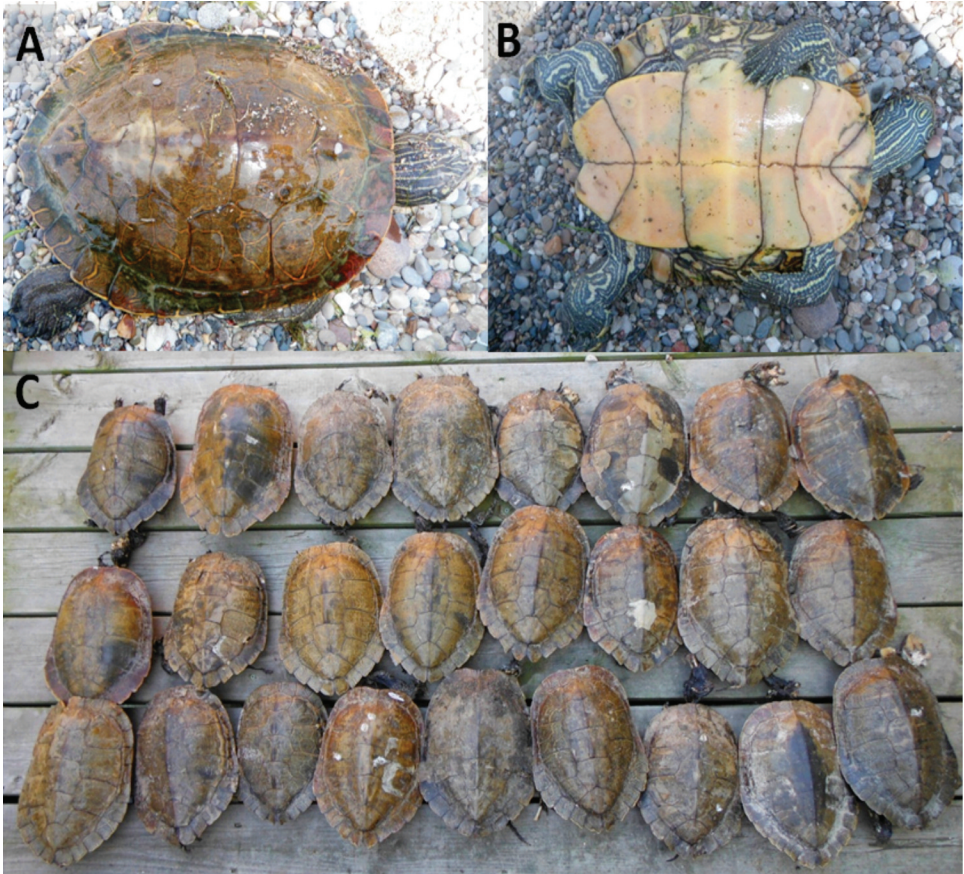


FIGURE 1. Dorsal (A) and ventral (B) views of a mature female Northern Map Turtle (*Graptemys geographica* [LeSueur, 1817]) found dead with no apparent injuries on 6 July 2012 and (C) desiccated carcasses of 25 of 29 Northern Map Turtles found dead from unknown causes on 16 and 17 July 2012 on the north shore of Lake Erie, Ontario.

Drowning in a commercial hoop trap or a fishing trawl net

Northern Map Turtles have never been caught in baited hoop traps used for research at this site despite their abundance, but they are caught in hoop traps elsewhere in Ontario (Larocque and Colotelo 2012; Larocque and Cooke 2012a,b). However, commercial fishing nets are employed adjacent to this nesting area, and female Northern Map Turtles form large aquatic basking aggregations at this site (C. M. D., personal observation). Northern Map Turtles typically dive when startled or disturbed; thus, the approach of a fishing vessel could cause a basking aggregation to dive into the path of an oncoming net in which the turtles could drown if they were not removed quickly. This scenario does not explain why six recently deceased turtles were found at the site early in the nesting season.

Predation during nesting

Nesting turtles are vulnerable to predation (Tucker *et al.* 1999), and some predators leave the shell intact.

Crows (*Corvus brachyrhynchos*) and ravens (*Corvus corax*) sometimes prey on turtles and tortoises, and they may do so by pecking into the abdomen above the tail so that the shell remains intact (Boarman 1997; Baxter-Gilbert *et al.* 2013). If the carcass is not found before decomposition begins, it can be difficult to identify this cause of death, but the carcasses that were found before desiccation showed no signs of such predation. Furthermore, four sympatric turtle species nest in comparable numbers at this site, and the predation scenario does not explain why mortality was apparently restricted to mature, female Northern Map Turtles.

A failed poaching attempt

We cannot rule out the possibility that the turtles were killed by humans, either intentionally or accidentally. However, we have no evidence to support this scenario.

Poisoning

This scenario requires a contaminated food source consumed only by mature female Northern Map Tur-

tles. One possible option is botulism: poisoning caused by toxins produced by the bacterium, *Clostridium botulinum*. The toxin can accumulate in molluscs and gastropods, which are major food sources for both male and female Northern Map Turtles (Bulté *et al.* 2008; Richards-Dimitrie *et al.* 2013). Botulism is not uncommon in wildlife in the Great Lakes, but the Canadian Cooperative Wildlife Health Centre (CCWHC) received no reports of mortality of co-occurring species that consume molluscs or botulism-related waterfowl mortality in the area in 2012 (Lenny Shirose, CCWHC, Guelph, Ontario, Canada, 13.12.2013, personal communication). Botulism or poisoning from another source also does not easily explain the female bias in mortality, because both male and female Northern Map Turtles consume molluscs and gastropods (Bulté *et al.* 2008). Environmental contamination strong enough to kill 35 mature female Northern Map Turtles would likely also cause significant mortality of conspecific males and of other aquatic species.

An unidentified pathogen

The prevalence of emerging infectious diseases in wildlife appears to be increasing globally (Daszak *et al.* 2001). The degraded condition of the carcasses unfortunately precluded us from testing for pathogens, and this scenario requires significant inter-sex variation in pathogen susceptibility. Nevertheless, viruses and pathogenic fungi and bacteria are documented in some chelonid populations (Marschang 2011; Silbernagel *et al.* 2013) and can have a significant impact. Unusually high mortality of Blanding's Turtle (*Emydoidea blandingii*) and Painted Turtle (*Chrysemys picta*) was recently recorded at a site on Manitoulin Island (Jacqueline Litzgus, Professor, Laurentian University, personal communication; Mender 2014), with the cause of death as yet unconfirmed. Seven of Canada's turtle species are listed under the federal *Species at Risk Act*, and infection of threatened populations with a lethal pathogen could have significant consequences for conservation of turtles in Canada.

Winterkill

Turtles that die during overwintering or shortly after emergence can sometimes take a long time to decompose, especially if the carcasses are located in cool areas. Anoxic conditions can trigger mass mortalities during overwintering; for example, a mass mortality of the Midland Painted Turtle (*Chrysemys picta marginata* Agassiz, 1857) occurred in 2000 at our study site, in a small pond that apparently became anoxic during overwintering (S. Gillingwater, 25.09.2014, personal communication), and Bleakney (1966) reports a similar mass mortality of Painted Turtles and Blanding's Turtles during the spring in Carleton County, which may also be attributable to winterkill.

We cannot rule out the possibility that some of the desiccated carcasses perished while overwintering and were moved posthumously. However, winterkill does

not explain the freshly dead females found at the start of the nesting season, and it does not explain how the more desiccated carcasses arrived in the dunes, well above the waterline, following the nesting season.

At the Lake Erie site, eggs are laid in approximately 300 Northern Map Turtle nests each year (C. M. D., unpublished data based on 3 years of surveys). We do not have robust estimates of the size of this population and, therefore, cannot directly estimate the effect of the 2012 mortality event. However, assuming yearly nesting by females, it may represent the removal of approximately 10% of the reproductive females from this population in a single year. High mortality of mature individuals can have a significant, long-term impact on turtle populations, because turtles are slow to mature and do not exhibit density-dependent changes in reproductive output (Brooks *et al.* 1991; Congdon *et al.* 1993). It is critical that significant mortality events are monitored and investigated, and we hope that our observation will encourage further reporting of similar events when they are observed.

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