TG
RESEARCH & MITIGATION

ARTIFICIAL NESTING MOUNDS BEST MANAGEMENT PRACTICES

LITERATURE REVIEW

Introduction

The Blanding's Turtle (Emydoidea blandingii) is a semi-aquatic turtle with a life history characterized by extreme longevity and delayed sexual maturity (Congdon et al. 2003). Its distribution ranges from the North American Great Lakes, west to Nebraska, with disjunct populations in northeastern North America (King et al. 2021). The diet of the Blanding's Turtle is primarily carnivorous, consisting of snails, crayfish, earthworms, insects, and small amounts of plant matter (Rowe, 1992). They rely on widely spaced vernal pools and small permanent wetlands (Sajwaj et al. 1997) with soft organic substrates, and emergent vegetation such as cattails and sedge tussocks (Henning and Hinz, 2016). These macro and microhabitats are important for basking, feeding, reproduction, and overwintering (Sajwaj et al. 1997). On a global scale, Blanding's Turtles are listed as Endangered (van Dijk, 2011) and are declining throughout their range (Hamilton et al. 2018).

Threats to Blanding's Turtles include habitat loss, nest predation by subsidized predators, road mortality, and illegal collection for the pet trade (King et al. 2021). The life-history characteristics of species with extreme longevity, such as the Blanding's Turtle, consist of co-evolved traits that result in high sensitivity and intolerance for anthropogenic disturbances, which impairs the ability of populations to recover from the pressures of human activity (Congdon et al. 1993).

Nesting Ecology of Blanding's Turtles

Since Blanding's Turtles demonstrate a low juvenile survivorship and delayed sexual maturity, the loss of mature turtles is detrimental to species persistence, regardless of efforts to increase hatchling survival (Sajwaj et al. 1997). Mature females are at greatest risk of mortality as a result of anthropogenic activity due to their extensive overland nesting forays (Steen et al. 2012), highlighting the importance of mitigating this risk using conservation-minded approaches. In addition, as land cover changes decrease both the quality and quantity of habitats, females must travel further to find suitable nesting sites, which further increases their risk of mortality (Walston et al. 2015).

Blanding's Turtles require well drained, minimally vegetated soil with an open canopy for nesting (Dowling et al. 2010), with over 90% of nests occurring in, on, or near human-made disturbances such as roads and agricultural fields (Sajwaj et al. 1997). Average clutch sizes range from 3-15 eggs, and clutch frequency is annual, although some individuals skip reproduction for one to several consecutive years (Congdon et al. 1983). Nesting forays typically begin in the evening, and nesting is completed after dark, often during rainy conditions (Wilson, 1998). Upland habitat is not a barrier to the movement of Blanding's Turtles, and when suitable nesting habitat is limited, gravid females will undergo extensive interwetland movements (Edge et al. 2010).

The Role of Mitigation in Blanding's Turtle Conservation

In the evolutionary history of turtles, natural disturbances were required to open canopies to create ideal nesting habitat; humans are now the primary source of this disturbance, explaining the correlation between turtle nesting and anthropogenic areas (Beaudry et al. 2010). Blanding's Turtles are known to nest in both concentrated aggregations and in dispersed, remote sites (Northeast Blanding's Turtle Working Group, 2013). The moisture levels and thermal qualities of nesting substrate are major factors influencing nest site success, because moisture and temperature are important in successful, timely development and temperature dependent sex determination (Mui et al. 2016; Wilson, 1998). In some Ontario populations, Blanding's Turtle nest success is as low as 0% (Long Point Basin Land Trust, 2017). Only 8% of nests are considered totally successful (all eggs hatched successfully), and of the failed nests, 78% were destroyed by predators; combining abiotic (soil erosion, flooding, desiccation, and root intrusion) and predator-driven nest failure, it is estimated that populations will decrease by 50% in the nest 78 years (Avery et al. 2000). If embryo survival decreases beyond this, adult and juvenile survivorship must increase by 1.5% and 2.2%, respectively (Wilson, 1998).

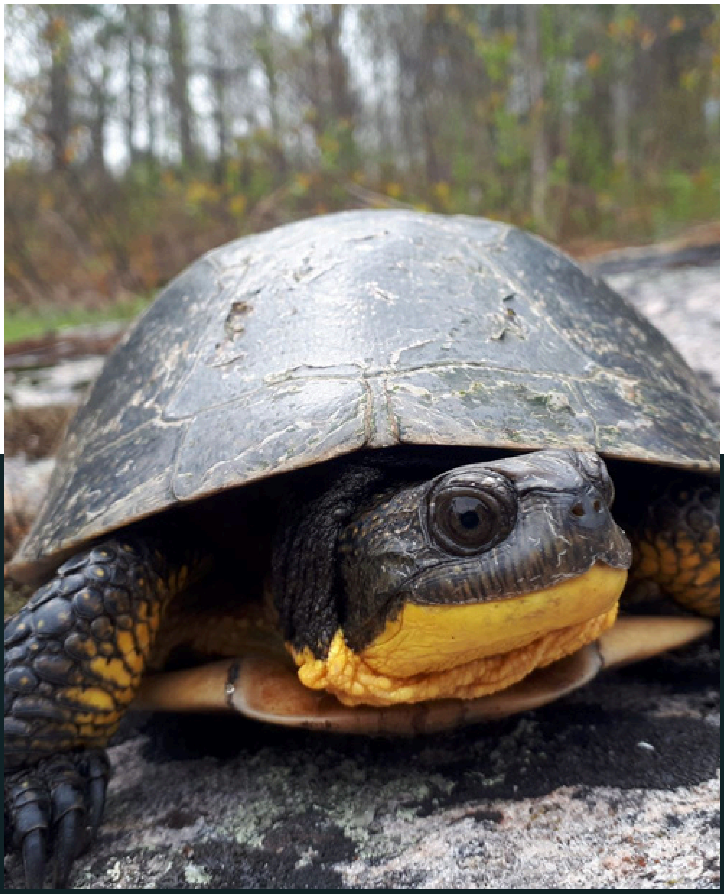
In the face of Blanding's Turtle population declines, broad scale efforts have been made to mitigate the risk of mortality. These include nest protection, headstarting (McElroy et al. 2024), habitat restoration (Markle et al. 2024), ex situ egg incubation (Kastle et al. 2021), ecopassages and mitigation fencing (Heaven et al. 2019; Boyle et al. 2021; Taylor et al. 2014), timing of road maintenance (Long Point Basin Land Trust, 2017), and creation of artificial nesting sites (Paterson et al. 2013). For the greatest success, these mitigation measures should be used in combination to complement each other's effects. For example, artificial nesting sites can be used to facilitate the reduction of predation pressures by incorporating nest cages (Beaudry et al. 2010). Likewise, since gravel roadsides are a hazardous but commonly used nesting substrate, paving these road shoulders in March-April or November-December (pre-nesting season and post-hatchling emergence, respectively) and replacing this habitat with artificial nesting sites is a good mitigation strategy (Paterson et al. 2013; Long Point Basin Land Trust, 2017).

To offset the higher mortality rates found in mature female Blanding's Turtles during nesting forays, artificial nesting mounds can be created. These work by providing suitable nesting habitat and decreasing the distance of nesting migrations, which reduces the need for turtles to encounter roads (Paterson et al. 2013). Although turtles exhibit nest site fidelity, they are known to switch to sites with anthropogenic substrates (such as the gravel of road shoulders), indicating flexibility if suitable substrate is available (Beaudry et al. 2010). This means that turtles also have the ability to use artificial nesting sites if they are encountering them; similarly, if the artificial nesting habitat is optimal, then usage should increase with time (Paterson et al. 2013).

Design and Specifications

Substrate

Gravid female Blanding's Turtles avoid nesting in fine-textured soils, indicating that they are seeking a coarser, more gravelly substrate, likely to retain heat and promote adequate drainage (Kiviat et al. 2004). It is important to choose a substrate that does not drown the eggs, but will provide optimal moisture to allow the embryos to consume residual yolk, increase valuable incubation time, and maximize hatchling body size (Toronto Zoo, N.D.). Since Blanding's Turtles select



for gravel road shoulders, the substrate combination used by the Ministry of Transportation Ontario to cover the sand subbase of road shoulders can act as artificial nesting mound substrate. It is composed of crushed rock with the following constituents: a mixture of crushed gravel, sand, and fines (made of hard particles produced from naturally formed deposits, or crushed slag from iron blast furnace/nickel slag). It may also include natural aggregates, reclaimed Portland cement concrete, and asphalt pavement material (Toronto Zoo, N.D.). This granular 'A' substrate and sand subbase recipe (Ontario Provincial Standard Specification, 2023) has the following particle sizes when passed through sieves (Figure 1):

Graduation requirements of granular 'A'

Sieve designation	% passing
150 mm	N/A
106 mm	N/A
37.5 mm	N/A
26.5 mm	100
19.0 mm	85-100
13.2 mm	65-90
9.5 mm	50-73
4.75 mm	35-55
1.18 mm	15-40
300 µm	5-22
150 µm	N/A
75 µm	2.0-8.0

Fig 1. MTO standard granular A aggregate graduation requirements when passing through a sieve.

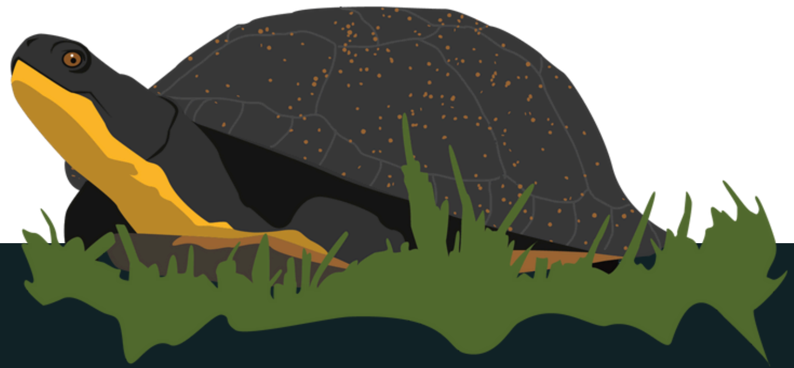
To accommodate for the annual climatic conditions, some variation in the type and size of substrate particles should be used in each nesting mound. Loam, a combination of sand (0.06-2.0 mm), silt (0.004-0.06 mm), and clay (less than 0.004 mm) can be created with varying proportions of its constituents (Toronto Zoo, N.D.). Another option is to use local gravelly glacial outwash soils (Hoosic gravelly loam) (Kiviat et al. 2004). In addition, substrates being transported to a new location should always be washed to avoid the spread of invasive plant species (Massachusetts Division of Fisheries and Wildlife, 2009). If native soil mineral is not acceptable, a fine sand consisting of <5% clay and <25% gravel should be deposited over the parent soil (Massachusetts Division of Fisheries and Wildlife, 2009). Riprap and retaining walls should not be used (Standing et al. 1999), because hatchling turtles become stuck and unable to free themselves, leading to risk of desiccation and predation (Drektaan, 2023).

Vegetation

An open canopy and sparse vegetation is required for successful egg incubation (Massachusetts Division of Fisheries and Wildlife, 2009), because shade from tall plant growth causes cooler temperatures that may delay the development of the embryos, and thus they may not hatch before the fall freeze (Toronto Zoo, N.D.). Nearby ground vegetation is required for hatchling protection and stabilization, however. Native, xeric-adapted plants such as cespitose grasses and sedges, bryophytes and lichens are recommended to cover approximately 2-5% of the site (Northeast Blanding's Turtle Working Group, 2013; Massachusetts Division of Fisheries and Wildlife, 2009). Monitoring should be done for the colonization of invasive plant species (Northeast Blanding's Turtle Working Group, 2013). A layer of geotextile cloth can be placed under the nesting mound to prevent additional unwanted vegetation growth (Paterson et al. 2013). If constructing artificial nesting mounds on a rock barren-dominated landscape, transplanted lichen (Cladonia spp.) and moss (Polytrichum spp.) should be used to simulate the natural environment and decrease erosion that would be caused by a typical gravel and sand substrate (Markle et al. 2024).

Location

The location of an artificial nesting site can determine the success of the mound. Artificial nesting mounds should be south or south-west facing to maximize sun exposure (Toronto Zoo, N.D.). Nesting habitats should be created in an area that is known to have nesting activity, to increase the chances of the mound being used (Massachusetts Division of Fisheries and Wildlife, 2009), and should be no more than 500-1000 ft from the nearest wetland (Wilson, 1998). The artificial mounds should have no barriers (such as roads) between it and the nearest wetland (Massachusetts Division of Fisheries and Wildlife, 2009). The size of the mounds should be approximately 3.0 m radius and 0.5 m high, with each mound spaced 1.5 km apart (Paterson et al. 2013). Artificial nesting sites benefit from a diversity of slopes and rolling hills (Northeastern Blanding's Turtle Working Group, 2013), and linear landscape features such as roads, shorelines, and paths should be avoided, as those may be used by predators (Toronto Zoo, N.D.). Nesting mounds must be placed above the spring/summer floodplain (Massachusetts Division of Fisheries and Wildlife, 2009).



Conclusion

Blanding's Turtle populations are rapidly declining in the face of anthropogenic stressors, such as habitat loss and road mortality (King et al. 2021). Mitigation measures such as the implementation of artificial nesting mounds can reduce the impact of these threats if done correctly. When combined with other conservation-minded initiatives, artificial nesting mounds are a key player in the persistence of Blanding's Turtle populations throughout their distribution.

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