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# Lake Okonoka Habitat Restoration Herpetological Monitoring Report

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## Contents

## Objective

This study provided an assessment of the distribution, species richness, and relative abundance of amphibians and reptiles that occur within the study area located on Belle Isle following restoration. The post-restoration results are intended to evaluate the amphibian and reptile response to measures implemented to improve habitat quality at Lake Okonoka and help guide future management to ensure the persistence and sustainability of these groups of wildlife on Belle Isle.

## Introduction

In 2022, Herpetological Resource and Management, LLC (HRM) was contracted by SmithGroup (SG) (formerly SmithGroupJJR) to conduct a post-restoration survey targeting amphibians and reptiles, associated with the Lake Okonoka (LO) restoration project (hereafter referred to as the LO Project). This work is part of a larger restoration initiative orchestrated by Friends of the Detroit River to improve wildlife habitat on Belle Isle. Previous restoration efforts have successfully been implemented at the Blue Heron Lagoon (BHL) and the South Fishing Pier (SFP). Due to their effectiveness as bioindicators, amphibians and reptiles were used as a metric to assess the ecological functionality and overall success of the restoration at BHL and SFP. As such, the same metric was applied to Lake Okonoka.

Amphibians and reptiles (collectively regionally known as herpetofauna) are recognized as key bioindicators, or gauges of environmental health. They are ecologically important as they fulfill an essential mid-level position in many food webs as both predators and as a prey base for other animals (Harding and Mifsud 2017). Their presence and relative abundance can be important tools in identifying and measuring overall ecosystem health (Cooperrider, Boyd et al. 1986; Guilfoyle 2010). Efforts to protect and minimize impacts to these species and their habitat are becoming increasingly important.

HRM conducted visual encounter transect surveys targeting herpetofauna within the LO Project restoration area. Pre-restoration surveys were conducted during the 2015 field season to assess community composition, species spatial distribution, and species richness, to provide herpetofauna-focused restoration recommendations as well as Best Management Practices (BMP) for Lake Okonoka and Belle Isle (Photos 1-6). HRM also completed post-restoration herpetofaunal assessment surveys during the 2022 field season and compiled additional BMPs (Photo 7). This report focuses on results of HRM's site assessment and BMP recommendations associated with the LO Project area.

## Site Description

The LO Project is located on the east end of Belle Isle, in Belle Isle Park, situated in the Detroit River in Wayne County, Michigan. Lake Okonoka is a shallow 24 acre lake with several small islands at its center. It is connected to Lake Tacoma on the southwest end of Belle Isle by the Nashua Canal. Lake Okonoka also connects to the BHL to the northeast under Lakeside Drive via a culvert with riprap consisting of large rocks (Photo 8). Underneath The Strand Road on the east side of the lake, Lake Okonoka also now connects to the Detroit River via a culvert with riprap. Lake Okonoka is bordered by a 200 acre Wet-Mesic Flatwood forest to its west and surrounded by seasonally mowed lawns and marshes with roads to its north, south, and east (The Strand/Lakeside Drive) (Kost, Albert et al. 2007). The west side of Lake Okonoka previously contained a paved road, Woodland Drive, that has been replaced with two cul-de-sacs leading to pavilions and open mowed lawn.

For a broad understanding of the geology and ecology of Belle Isle, see Bailey's Ecoregions of the United States, which identifies the island within the Humid Temperate Domain, Hot Continental Division, Eastern Broadleaf Forest Province and Erie and Ontario Lake Plain Section (Bailey 1995). This section of the Belle Isle is characterized by flat lakeplain, underlain by lacustrine clay and silt deposits. Michigan Natural Features Inventory classifies specific habitats based on vegetative and geological characters (MNFI 2007). Much of the restoration area for Lake Okonoka is unclassifiable open water or mowed lawn, but there are some areas of Emergent Marsh, Submergent Marsh, and Lakeplain Wet (or Wet-Mesic) Prairie. The small islands in the center of Lake Okonoka contain habitat that may be classified as Wet-Mesic Flatwood, however, they appear to be largely second growth and highly disturbed.

Portions of the shoreline of Lake Okonoka have a narrow swath of trees and shrubs with herbaceous vegetation present. The upland herbaceous vegetation was observed to have been recently mowed during our 2022 field assessments on all sides (north, south, east, and west) of Lake Okonoka (Photo 9 and Photo 10). A majority of the assessment area bordering The Strand Road on the east and north side of Lake Okonoka contain high vertical curbs, creating a barrier to herpetofauna movement (Photo 11). Significant litter from patrons was observed during HRM's habitat assessments including several instances of discarded fishing line along the lake's edge (Photo 12).

## Herpetofaunal Regulations

Michigan's Threatened and Endangered species are afforded protection against collection or take through the Natural Resources and Environmental Protection Act, Part 365, Endangered Species Protection, administered by the Michigan Department of Natural Resources (MDNR) Wildlife Division. The law requires permits when listed species might be harmed, handled, or disturbed, even if proposed work includes conservation activities that are likely to benefit the species

long-term (Michigan Department of Natural Resources 1994). Most Special Concern species in Michigan are not afforded protection under this legislation; however, Special Concern reptiles and amphibians are protected from take in accordance with MDNR Fisheries Division Order (224.16). The order states that take from the wild or possession of any such species is prohibited except as authorized under a Scientific Collector's Permit (Michigan Department of Natural Resources 2016).

One state threatened species is known to Belle Isle and has the potential to occur within the LO Project restoration area, the Eastern Fox Snake (*Pantherophis gloydi*). Additionally, four species of special concern are present on Belle Isle and may be present within the LO Project area including the Mudpuppy (*Necturus maculosus maculosus*), Butler's Garter Snake (*Thamnophis butleri*), Blanding's Turtle (*Emydoidea Blandingii*), and the Eastern Box Turtle (*Terrapene carolina carolina*).

## Methods

### *Herpetofaunal Surveys*

HRM staff, trained in the sampling and identification of amphibians and reptiles, conducted comprehensive herpetofaunal surveys in the spring and early summer of 2022. The objective of the surveys were to assess herpetofauna presence and spatial distribution post-restoration of the LO Project area. Weather conditions at the time of survey were suitable for detection of herpetofauna. The assessments were completed by transecting the lake edge and adjacent upland habitat within the restoration area in a counterclockwise direction. Various methods were employed to document species diversity and distribution. These included turning over natural and artificial cover materials, visual observations, and anuran (frog and toad) calling surveys.

No voucher specimens were collected, though photographs were taken when possible. All survey activities were in accordance with HRM's Scientific Collector's and Threatened and Endangered Species permits issued by the State of Michigan.

### *Terrestrial Habitat*

Terrestrial time-constrained ground searches and defined transect surveys were used to inventory all upland habitats for evidence of reptiles and amphibians. Ground searches consisted of investigating potential basking and nesting areas, as well as turning over natural and artificial cover objects (logs, boards, debris, etc.). Amphibians and reptiles discovered during ground searches were identified by morphological characteristics.

### *Aquatic Habitats*

Aquatic searches involved examining each type of aquatic habitat within the assessment area. Aquatic habitats were investigated for all life stages of amphibians and reptiles (i.e. egg, larval, metamorphic). Sampling for these species involved capturing individuals by hand, observation through binoculars, and aural surveys (Photo 13).

### *Data Collection*

Each positively identified amphibian and reptile was recorded in the HRM database. The following data were collected for each record: (1) species, (2) sex (when possible), (3) behavior, (4) age class, and (5) reproductive condition (if it can be determined). Observation locations were recorded using Trimble® Global Positioning System (GPS) Units, which record the location to U.S. Environmental Protection Agency (EPA) Tier II National Geospatial Data Spatial Standards and were mapped using ArcMap® software. Control points were obtained during the survey to confirm spatial accuracy and equipment functionality.

### *Best Management Practices*

Based on the results of the post-restoration surveys, and HRM staff professional experience, a suite of BMPs were developed for the LO Project. These BMPs are provided should opportunities for continued restoration on Belle Isle and Lake Okonoka occur. HRM recommends some be considered as part of the existing restoration effort to improve the function of the habitat for herpetofauna.

## Results

Ongoing research into the genetics, physiology, behavior, and fossil history of amphibians and reptiles has led to debates about their proper classification. Some biologists have proposed the splitting of established genera like *Rana* ("typical frogs") and *Bufo* ("true toads") into the newer genera *Lithobates* and *Anaxyrus*, respectively (Harding and Holman 1999). Some suggestions have included using the newly proposed groupings as subgenera, allowing recognition of the new divisions while maintaining name stability. For the purposes of this report, this system will be followed for the genus of toad *Bufo* (*Anaxyrus*). The genus of "typical frogs" will not include subgenera based on a recent publication which supports the placement of all North American ranid frogs in the genus *Rana* (Yuan et al. 2016 ). These classifications are also recognized by Harding and Mifsud (Harding and Mifsud 2017).

### *Herpetofaunal Survey Findings*

Herpetofaunal pre-restoration surveys were conducted in the spring and summer of 2015. Results of the pre-restoration surveys found a total of ten (10) species of herpetofauna including four (4) amphibian species: Eastern American Toad (*Bufo americanus americanus*), Bullfrog (*Rana catesbeiana*), Green Frog (*Rana clamitans melanota*), and Northern Leopard Frog (*Rana pipiens*); five (5) turtle species: Midland Painted Turtle (*Chrysemys picta marginata*), Northern Map Turtle (*Graptemys geographica*), Red-eared Slider (*Trachemys scripta elegans*), Yellow-Bellied Slider (*Trachemys scripta scripta*), and Eastern Box Turtle (*Terrapene carolina carolina*); and one (1) snake species: Northern Water Snake (*Nerodia sipedon sipedon*) (Table 1) (Map 1).

Post-restoration surveys conducted in 2022 resulted in twelve (12) species of herpetofauna detected. This included four (4) amphibian species: Eastern American Toad (Photo 14), Bullfrog (Photo 15 and Photo 16), Green Frog, Northern Leopard Frog (Photo 17); five (5) turtle species: Midland Painted Turtle, Northern Map Turtle, Red-eared Slider (Photo 18), Eastern Spiny Softshell (*Apalone spinifera spinifera*) (Photo 19), Eastern Snapping Turtle (*Chelydra serpentina serpentina*) (Photo 20); and three (3) snake species: Northern Water Snake (Photo 21), Northern Brown Snake (*Storeria dekayi dekayi*), Eastern Garter Snake (*Thamnophis sirtalis sirtalis*) (Photo 22), (Table 1), (Map 2). Four (4) of these species were not observed in 2015 surveys including two (2) turtle species, the Eastern Spiny Softshell and Eastern Snapping Turtle, and two (2) snake species, the Eastern Garter Snake and Northern Brown Snake.

## Discussion and Recommendations

Following the Lake Okonoka site restoration and implementation of several of the BMP's proposed by HRM in 2015, HRM observed a total of twelve (12) species of herpetofauna in the LO Project area in 2022 surveys. Prior to the restoration, ten (10) herpetofauna species were found. Thus, an increase of species richness was found from 2015 to 2022. Of the twelve species found in 2022, four herpetofauna species were observed that were not previously found in the LO Project area, consisting of two turtle species including the Eastern Spiny Softshell and Eastern Snapping Turtle, and two snake species including the Northern Brown Snake and Eastern Garter Snake. Of the twelve species found in 2022, egg masses of Bullfrogs and two juvenile Northern Water Snakes were observed. The presence of multiple life stages of herpetofauna suggests that recruitment is taking place within the LO Project area and successful breeding has occurred by both reptile and amphibian species.

Two (2) turtle species previously not encountered at Lake Okonoka, the Eastern Spiny Softshell and Eastern Snapping Turtle were found during 2022 surveys. Both of these species are long-lived and slow to mature, the Eastern Snapping Turtle can range from eleven (11) to twenty (20) years to reach sexual maturity and can survive for an estimated forty (40) to fifty (50) years (Harding and Mifsud 2017). The Eastern Spiny Softshell Turtle takes between eight (8) to ten (10) years (for females) to reach sexual maturity and are estimated to live up to fifty (50) years. Eastern

Spiny Softshell turtles are also sensitive to pollutants that kill fish and require high oxygen presences (Harding and Mifsud 2017). The presence of Eastern Spiny Softshell Turtles in the LO Project area suggests that the lake water quality has improved since restoration. Both turtle species were observed to be basking on partially submerged logs on the islands of Lake Okonoka, with implementation of additional basking structures turtle species may utilize restored areas of the lake as well.

Additionally, two snake species known to occur on Belle Isle, that were not previously detected were found during the 2022 surveys. These species are the Northern Brown Snake and Eastern Garter Snake. Eastern Garter Snakes and Northern Brown Snakes both play an important role in the food web, acting as both a predator and prey species in their environment and can survive in urban and suburban settings (Harding and Mifsud 2017). Eastern Garter Snakes are also important indicators of environmental health and are known to be susceptible to chlorinated-hydrocarbon pesticides. Northern Brown Snakes are secretive and more commonly found in less intensively developed parks and residential areas. Observations of these two snake species in 2022 surveys indicates the LO Project area has successfully restored snake habitat and connectivity has allowed for migration of terrestrial species into the restored area.

Two species were observed in 2015 surveys that were not observed in 2022 including the Yellow-Bellied Slider, and Eastern Box Turtle. During 2015 surveys, an Eastern Box Turtle was found deceased adjacent to the Mesic Flatwoods habitat and appeared to have been killed by mowing activities on the west side of Lake Okonoka. Due to a lack of recent observations of this species on Belle Isle and the urban nature of the island, it is probable that the turtle may have been a released pet. However, Eastern Box Turtles historically occurred in the area and enough suitable habitat may remain to support a small wild population. The Yellow-bellied Slider is a subspecies from the southeastern United States that is commonly kept as a pet and is not native to Michigan (Ernst and Lovich 2009). It is possible that both species found in 2015 surveys, that were not found in 2022 surveys, were released pets. Further assessments are warranted to determine if habitat features on Belle Isle support native Eastern Box Turtles and other herpetofauna with similar habitat requirements.

Red-eared Sliders were found both in 2015 and 2022 surveys. These turtles are a native species to Michigan and the Detroit River population of Red-eared Sliders may be, at least in part, of native origin. However, occurrences of released pets are known to occur on Belle Isle. It is unknown if the Red-eared Sliders observed in Lake Okonoka were of a native origin, or were released pets.

Following the pre-restoration surveys in 2015, HRM assessed the LO Project area to be of relatively low quality overall (HRM 2015). The LO Project area contained several invasive plant species including *Phragmites* or Common Reed (*Phragmites australis*) and Eurasian Milfoil (*Myriophyllum spicatum*). Herpetofauna community composition was found to be overall relatively poor, consisting of possible non-native or likely released pet turtle species, widespread frog and toad species, and one snake species. Additionally, HRM documented several instances of herpetofauna mortalities due to

management and recreational activities (HRM 2015). The LO Project area also lacked landscape and habitat features required for herpetofauna such as connectivity between habitats, basking and nesting structures, and native vegetation. HRM proposed several recommendations following 2015 surveys to reduce herpetofauna mortalities and aid if recolonization of restored areas (HRM 2015). Many BMP's were successfully implemented during the LO Project which allowed for recolonization of several herpetofauna species. Following the restoration, there are still opportunities for improvement to encourage increased and continued species migration and utilization of this newly restored area.

One of the recommendations HRM proposed following 2015 surveys included restoration of the north lawn area to Lakeplain Prairie, or similar communities, by incorporating seasonal Wet Meadow habitat in low areas, which would benefit many of the rare species found on the island (HRM 2015). In 2022, restoration of both the north lawn, and west lawn areas were observed to contain seasonally inundated lowlands. These lowlands were observed to be used by several herpetofauna species including the Green Frog, Northern Leopard Frog, and Northern Water Snake. Surveys in 2022 noted some lack of native vegetation in west lawns and recommends implementation of the proposed BMP: floodplain/seasonal wetland restoration, to encourage growth of native floodplain plant species. Proposed BMP's are discussed in detail in the following section.

Following the 2015 surveys, HRM also proposed installation of habitat features that would benefit herpetofauna including nesting and basking sites, riprap, and hibernacula (HRM 2015). Surveys in 2022 noted several basking structures along the east and south shores of Lake Okonoka. These structures were observed to be used by multiple turtle species including the Midland Painted Turtle, Northern Map Turtle, Red-eared Slider, Eastern Spiny Softshell, and Eastern Snapping Turtle. The addition of basking structures to the north and west shores of Lake Okonoka would encourage use of these areas by herpetofauna. During 2022 surveys, HRM noted use of riprap on culverts leading into BHL and the Detroit River providing critical basking and refugia habitat for snakes including the Eastern Fox Snake and Butler's Garter Snake. Surveyors observed several Northern Water Snakes utilizing this new habitat feature. HRM recommends installation of several BMP's including: installation of turtle nesting sites, basking structures, and snake habitat/hibernacula, these additional habitat features would greatly benefit herpetofauna species and encourage occupation by additional species to these restored areas.

HRM also proposed management of predator populations on Belle Isle in 2015 including Raccoons (*Procyon lotor*) (HRM 2015). During 2022 surveys HRM team members observed Raccoon tracks and Common Carp (*Cyprinus carpio*) near the shores of Lake Okonoka. Raccoons and Common Carp can both act as predators to herpetofauna species. Raccoons can result in 100% turtle nest mortality rates and can lead to turtle population declines and possible long term population or species extinction (Mifsud 2014, Harding and Mifsud 2017). Adult Common Carp have been found to decrease amphibian diversity and abundance in ponds as they consuming eggs

and larvae (Kloskowski 2009). HRM recommends implementation of the BMP: predator management, to reduce predator populations and presence around Lake Okonoka.

Following the 2015 surveys, HRM found road related injury and mortality to be a significant threat to herpetofauna on Belle Isle (HRM 2015). The creation of two culverts during restoration has aided in connecting Lake Okonoka to the BHL and to the Detroit River. This has likely established connectivity for aquatic reptile and amphibian species. During 2022 surveys, several Northern Water Snake were observed on the riprap under the culvert connecting Lake Okonoka to BHL. The removal of Woodside Drive during restoration has also greatly increased connectivity for terrestrial herpetofauna species, now allowing for unrestricted movement between waterbody, floodplain, and forest habitat. Removal of Woodside Drive has not only increased connectivity between Wet-mesic Flatwoods and Lake Okonoka, but it has also created new habitat and decreased the number of possible wildlife injury and mortality occurrences due to vehicle collisions. Unfortunately, vehicle-wildlife collisions are still taking place on The Strand/Lakeside Drive on the east and north side of Lake Okonoka. Injuries and mortalities are likely appreciably influencing the rate of colonization, recruitment, and habitat use within the LO Project area. In 2012 HRM staff conducting spring surveys noted numerous deceased reptiles and amphibians on the roadway, and reports from park staff in 2015 indicated this is a common sighting during spring migration (HRM 2015). The high number of deceased individuals observed over the years during Belle Isle surveys indicates that The Strand/Lakeside Drive pose a fatal threat to local herpetofauna. HRM recommends several BMP's to allow for connectivity and safe passage of herpetofauna and other wildlife across these roads including: informative signage, speed reduction measures, removal/alteration of high curb, and under-road corridor/culverts (Figure 1).

The LO Project restoration area includes several moderately to significantly seasonally busy roadways including The Strand Road on the east side, Lakeside Drive on the north side, and two cul-de-sacs leading to pavilions on the west side. Movement is an important part of herpetofauna life history and roadways pose a major threat to these species. Seasonally, turtles and snakes migrate to find breeding, nesting, and foraging sites. Amphibians also travel across roads seasonally and during rain events to breed, find hibernation sites, and to seek new habitat. Connectivity between habitats is essential for gene flow, population viability, and completion of natural species life history (Mifsud 2014). Roads are a major contributing factor to herpetofauna population declines, causing vehicle-wildlife collisions and fragmenting habitat (Gunson et al. 2016; Gibbons et al. 2000). Fragmentation reduces genetic diversity, increases predation pressure, reduces habitat quality, and encourages invasive species colonization. Turtles are particularly susceptible to road mortality due to their innate slow movement and tendency for females to lay eggs in loose roadside gravel (Gibbs & Shriver 2002; Garrah 2012). Herpetofauna in Michigan rely on wetland and adjacent upland for specific habitat features and frequently move between these habitats communities on a seasonal basis (Mifsud 2014). Drainage culverts have been observed to allow herpetofauna a safe roadway crossing (Dodd et al 2004; Aresco 2005; Taylor et al. 2014).

In 2015, HRM also proposed reduction of mowing, or restricting of mowing to recreational areas around Lake Okonoka (HRM 2015). Unfortunately, surveys in 2022 found mowing of critical herpetofauna habitat to still be actively occurring. Herpetofauna, including several rare species, are particularly susceptible to the threat of mowing, as they readily use tall grass or the edges of mowed areas, and are slow to escape from mowers. Active mowing was taking place during survey on June 2, 2022, and on June 7, 2022 additional areas were observed to have been mowed that were not previously. These areas included woody shrubs and high vegetation on Lake Okonoka's east side and grassland on Lake Okonoka's west side. Unfortunately, the areas mowed contained many important habitat elements for herpetofauna including cattail wetlands (Photo 23) and natural cover objects (Photo 24) that were lost (shredded) or moved to allow for mowing activity. Loss of this valuable habitat during restoration recovery of a habitat can impede restoration progress by effectively closing connectivity corridors for herpetofauna movement and limiting recruitment to new areas. HRM recommends implementation of the following BMP: restriction of mowing and mowed locations, to aid in species recolonization of the restored area and reduce injuries and mortalities to herpetofauna.

Following post-restoration surveys in 2022, HRM found the LO Project area to be of overall moderate quality for herpetofauna. Connectivity, increased habitat, and the incorporation of riprap and basking structures has vastly improved the LO Project area and herpetofauna are becoming more abundant and rich, with four species observed that were not found prior to the restoration. During surveys HRM documented several unfortunate instances of herpetofauna mortalities due to management and recreational activities including a juvenile Northern Water Snake and adult Northern Map Turtle. To avoid future injuries and mortalities, and aid in migration to the restored area, safe passage across roadways is imperative. The LO Project area would also greatly benefit from the incorporation of some landscape and habitat features that may encourage continued and increased colonization of the restored area. With the implementation of the proposed BMP's the LO Project area may reach high overall quality for herpetofauna.

With the recent LO Project area restoration and connectivity of corridors improved for migration, several species may be expected to colonize the area. This includes the Grey Tree Frog, Northern Red-bellied Snake, and Eastern Musk Turtle. This also includes several State protected species that have the potential to occur within the LO Project area such as the Mudpuppy, Butler's Garter Snake, Eastern Fox Snake, Eastern Box Turtle, and Blanding's Turtle. During 2022 surveys, no protected species were observed in the LO Project area, though they are present on Belle Isle and near the restoration, they may likely utilize this habitat in the future. Four (4) of these species, the Butler's Garter Snake, Eastern Fox Snake, and Blanding's Turtle were observed in the nearby BHL area, thus, with the implementation of additional BMP's and increased connectivity these species will likely migrate to the LO Project area.

## BMP Recommendations

Implementing appropriate BMPs is an effective way to minimize injury or mortality to amphibians and reptiles associated with wildlife-vehicle collisions, recreational activities, and management practices in and around Lake Okonoka. Employing BMP's recommended by HRM will also increase habitat features, reduce threats, and encourage the use of the restored area by herpetofauna.

Based on the results of the herpetofauna survey, HRM recommends the following Best Management Practices. The proposed recommendations are the professional opinion of HRM and based on our understanding of the scope of the LO Project.

**Informative Signage:** Signage should be near parking areas and recreational hot-spots to inform patrons of the importance of the restoration to their recreational activities. Signage would also be beneficial along roadways that transect herpetofauna habitat asking drivers to drive more cautiously such as signage that states: "Slow Down, Wildlife Area" or "Caution, Turtle Crossing" (Photo 25). Drivers and operators of vehicles should be encouraged to yield to crossing snakes, turtles, and other wildlife. Benefits of signage include driver awareness of wildlife and potential reduction in road mortality. Enhancement of signs (flashing, flags) seasonally during increased herpetofauna movements or high traffic periods can help to avoid driver habituation.

**Speed Reduction Measures:** Many cars were observed traveling at speeds above the 25 mph speed limit on The Strand and Lakeside Drive. Implementation of speed hump/bumps or rumble strips is recommended. A reduction in speed allows drivers more time to react and avoid wildlife on the road. Rumble strips also create both a visual and audible alert to drivers. Permanent speed humps/bumps may interfere with snow removal, so removable speed humps/bumps that can be placed on road seasonally may be more suitable. Rubber based self-adhesive strips (rumble strips) may need to be replaced yearly depending on use, so temporary, portable, rumble strips are a cost effective option to be placed seasonally.

**Removal/Alteration of High Curb**: The 90 degree, high curb located along The Strand Road impedes herpetofauna movement, particularly for turtle species that cannot easily traverse the obstacle (Photo 26). Removal or replacement of this curbing with a low-slope option would reduce the number of wildlife-vehicle collision events as wildlife will not be trapped by these barriers (Figure 2). This will also allow for more mobility of species which can greatly increase their reproductive success.

**Under-road Corridor/Culvert**: Installation of corridor/culverts (ecopassages) under The Strand Road and Lakeside Drive would allow for herpetofauna and other vertebrates to safely travel between habitats and underneath Belle Isle's busy roads (Figure 3). Typically, a culvert is a tunnel- like structure carrying water under a road or railway to provide cross drainage. For the LO Project, the culvert will act as a movement and migration corridor to

connect herpetofauna habitat and reduce road mortality (Photo 27 and Photo 28). Culverts can be constructed from High Density Polyethylene (HDPE), Structural Steel Plate (SSP), Corrugated Steel Pipe (CSP), or concrete. It should be noted metal is a less desirable material due to its conductivity, making the passage cold during spring migratory periods. It is important for the diameter to be wide enough so that light can penetrate through the length of the tunnel (Photo 2). For example, for tunnels < 50 ft, diameter should be 5 ft; for tunnels 50-82 ft a diameter of 6 ft should be used (Ontario Ministry of Natural Resources and Forestry, 2016). If well placed, this corridor could significantly reduce the frequency of road mortalities (Photo 29).

**Barrier Fences and Wildlife Direction**: Culverts commonly have wing walls in order to prevent erosion but these can also act as a funnel to direct species into the culvert. Barrier walls can be constructed from HDPE, SSP, or CSP pipe cut in half lengthwise, installed at the base of the road shoulder and held upright using ¾" steel rods of 5 ft and 6.6 ft lengths. Barrier wall should be 6.6 ft in height to discourage climbing snakes (Eastern Fox Snake) and have a lipped wall or overhang to prevent amphibians from jumping over. Earth should be removed to allow for the install of the barrier wall, and following installation, backfill consisting of earth and sand should be graded directly to the top of the barrier wall to ensure road drainage is not compromised. The barrier wall should extend from a culvert (middle point) and run parallel to the road 44 yd (132 ft) to the left and right of the culvert. The total length of a barrier wall should be approximately 87-98 yd (261-294 ft). At each end of the barrier wall a turnaround should be installed to orient herpetofauna and other wildlife back toward the culvert. This turnaround should consist of wall at a 135° angle for 20 ft, then a wall parallel to the roadside wall for another 20 ft. Man-made features, such as these, along road sides may influence species movement and access to crossing structures (Gartner Lee and Ecoplans 2009). Placement of barrier walls along roadsides to direct herpetofauna to culverts would reduce mortality and better maintain these areas as functionally connected habitats.

**Restriction of Mowing and Mowed Locations**: Mowing to the lake's edge was observed during surveys in select areas on all sides (north, south, east, and west) of Lake Okonoka, mowing was particularly damaging along Lake Okonoka's east edge (Photo 30). Lakeside edge vegetation provides critical habitat for herpetofauna species and should be avoided during mowing. Cattail wetlands were also observed to have been mowed, and natural cover objects had been moved to allow for mowing, both of these habitat features are critical to herpetofauna and loss can greatly inhibit restoration success (Photo 31). The transitional zone between upland and water provides basking opportunities and cover for frog, turtle, and snake species (Photo 32). A buffer of no less than twenty-five (25) foot from the water's edge around the entirety of Lake Okonoka should be left un-mowed to provide this crucial habitat. In recreational areas that are mowed several measures can be taken to reduce the impact of mowing on herpetofauna communities including mowing less frequently and adjusting mower decks higher (>6") in areas known to have herpetofauna. Alternatively, if

the presence of herpetofauna is not compatible with the use of a landscape area, consistently mowing grass short (<2") can discourage the movement of herpetofauna into mowed areas and will reduce mower related mortality of herpetofauna. Mowing outside of the active season is preferred.

**Installation of Turtle Nesting Sites:** HRM personnel or other wildlife professionals should install one or more piles of washed sand or old wood chips near to the water on a south-facing slope to provide turtle nesting areas (Figure 4). Steep slopes should be avoided to reduce erosion. Nesting areas should be approximately three (3) feet above summer water levels to reduce potential flood damage. When possible, locate nesting areas isolated from egg predators (e.g. raccoons) and human disturbance. Small islands are ideal for nesting sites. Nesting areas should be spaced at 1-2 mile intervals. These turtle nesting areas can also provide snake nesting sites. To maintain nesting sites, sand should be tilled in late spring to sustain loose soil ideal for nesting.

**Installation of Basking Structures:** Aquatic turtle species need to bask to thermoregulate to fight off infections and attain warmth and energy for digestion. Bringing existing, un-utilized logs on site to the water will provide suitable basking habitat. Logs should be placed horizontally in shallow waters. Snakes will also use these structures for basking, and amphibians may attach their eggs to submerged fine branches. A lack of basking structures was observed particularly on the north and west sides of Lake Okonoka.

**Additional Garbage Receptacles:** During surveys, large amounts of litter, including discarded fishing line were found along Lake Okonoka's edge (Photo 33). Installation of additional trash cans can help to discourage litter. Receptacles specifically designed for the disposal of fishing line should also be installed as discarded fishing line poses a threat to herpetofauna as well as other wildlife species.

**Excessive Nutrients**: A high amount of geese were observed with many areas covered in goose droppings (Photo 34). These droppings release excessive nutrients (nitrogen and phosphorus) into the water and can lead to harmful algal blooms and wildlife die-offs (Mifsud 2014). Excessive nutrients in waterbodies can also lead to deformities and can have lethal effects in amphibians (Mifsud 2014).

**Predator Management**: Discourage the feeding of raccoons and other mesopredators and implement measures to make sure food refuse is removed from garbage receptacles in a timely manner. High amounts of Common Carp were observed near the shores of Lake Okonoka (Photo 35). Common Carp can act as a predator to baby turtles and amphibian larvae (Kloskowski 2009; Mifsud 2014). There are several methods for deterring or eliminating Common Carp from a pond including using fences, sound, or harvest.

**Snake Habitat/Hibernacula**: Placement of brush piles will aid in providing small snake species with refugia. Brush piles can be easily created during management activities, such as

woody invasive removal, and be left or placed on site (Figure 5). Riprap with large gaps has created ideal Northern Water Snake habitat along the connecting culvert to BHL (Photo 36). Incorporating some areas where riprap is filled in with smaller stones or sand will allow for better migration between habitats by turtles and smaller snakes.

**Removal of Silt Fencing**: Remnants of silt fencing were observed on the north side of Lake Okonoka near the BHL culvert (Photo 37). Silt fence can create a barrier for herpetofauna and reduce connectivity, or can trap herpetofauna and result in injury or mortality. Silt fencing should be removed following restoration.

**Aquatic Vegetation**: There is limited submergent or emergent vegetation around the shoreline of the site, partially on the western side of Lake Okonoka. Improving the density and diversity of native aquatic vegetation in selected areas should greatly improve the function of these areas for herpetofauna and other aquatic organisms.

**Non-native Turtles:** Several species of turtles not native to Michigan have been reported from Belle Isle, including Yellow-bellied Slider, Eastern River Cooter (*Pseudemys concinna*) , and the Red-eared Slider. As Belle Isle is a popular park with easy access to the water, released pets may be common. Educational signs may help prevent releases of pet fish or reptiles, reducing the chances for the introduction of diseases or invasive species. Currently there is no known threat to the native species or ecosystem from the two observed non-native species and no recommendations are being made to remove them at this time.

**Floodplain/Seasonal Wetland Restoration:** Following recent rain events, it was observed that large areas of mowed grasses became muddy, barren floodplains with scattered pools of water (Photo 38). Introduction of floodplain vegetation would be very beneficial to these locations, stabilizing the soil, aiding hydrology, creating habitat, and making the area more ascetically appealing. Promoting the sustained presence of water on the landscape would increase local amphibian breeding habitat. Ceasing mowing activities and allowing the vegetation to grow would not only help in preserving these temporary wetlands but also provide habitat for recently metamorphosed frogs and toads.

**No Mow Zones:** Grassland or lakeplain prairie restoration on the east side of Lake Okonoka will benefit resident snakes and Northern Leopard Frogs, as well as small mammals, birds, plants and other wildlife. Mowing hinders the restoration of grassland areas, creating lawns. Reducing the amount of lawn area, especially in places where it is rarely used recreationally, can also save on maintenance costs and increase the aesthetic appeal. Creating no-mow zones and including signage will allow for these areas to maintain the natural vegetative growth height to provide beneficial ecosystem value.

**Continued Monitoring:** Due to the behavior and natural history of many species of amphibian and reptile, additional surveys should be conducted to assess long-term species use of the restored areas. Herpetofauna populations can fluctuate, and due to the cryptic

nature of many species of herpetofauna (Photo 37), continued monitoring is encouraged to better assess shifts in spatial distribution, species diversity and density following restoration.

## Conclusion

Restoration of the Lake Okonoka area is still within the earlier stages of restoration as some areas both within the lake and terrestrial lack suitable native plant diversity and abundance. Early results suggest that the restoration has been overall successful and resulted in an increase in herpetofauna richness. A total of four (4) species previously not detected within the project area were observed during the 2022 restoration monitoring. Implementation of the BMPs recommended by HRM in future restoration activities will improve overall habitat quality and reduce herpetofauna injury and mortality due to vehicle-wildlife collisions, management practices, and recreational activities. Mowing was observed along the east side of Lake Okonoka resulting in a reduction of herpetofauna habitat. The loss of this valuable habitat during restoration recovery can greatly impede restoration progress.

Implementing the recommended BMPs will minimize the potential for impact and improve the available habitat for rare and state protected species, including the Eastern Fox Snake, Mudpuppy, Butler's Garter Snake, and Blanding's Turtle.

## Photos

Photo 1. Pre-restoration photo of the old culvert connecting Lake Okonoka to Blue Heron Lagoon (HRM 2015).

Photo 2. Pre-restoration photo from the northwest side of Lake Okonoka showing maintained lawn (HRM 2015).

Photo 3. Pre-restoration photo of Lake Okonoka showing mowed grass and high traffic volumes (HRM 2015).

Photo 4. Pre-restoration photo of the west side of Lake Okonoka showing old concrete slabs and short lawn grass (HRM 2015).

Photo 5. Pre-restoration photo showing the Nashua Canal Bridge with little riprap material and limited snake habitat (HRM 2015).

Photo 6. Pre-restoration photo showing a paved road (Woodside Drive) fragmenting habitat on the west side of Lake Okonoka (HRM 2015).

Photo 7. HRM conducting rapid habitat field assessment at Lake Okonoka on Belle Isle.

Photo 8. Riprap made up of large rocks on the sides of a culvert connecting Lake Okonoka to Blue Heron Lagoon. This area supported several Northern Water Snakes.

Photo 9. Mowed vegetation extending from the road to the water's edge on Lake Okonoka's west side. Fragmented patches of potential habitat scattered throughout (fallen tree on the left and small patch of cattails on the right).

Photo 10. Mowed vegetation extending from old Woodside Drive (now lawn) to water's edge on Lake Okonoka's east side.

Photo 11. High curb along The Strand Road near the South Fishing Pier on the eastern side of Lake Okonoka.

Photo 12. Trash observed during rapid habitat field assessment near Lake Okonoka.

Photo 13. HRM team member using binoculars to identify turtle species basking on islands and logs in Lake Okonoka.

Photo 14. Eastern American Toad found during rapid habitat field assessment in the Lake Okonoka restoration area.

Photo 15. Bullfrog eggs found in Lake Okonoka.

Photo 16. Large adult male Bullfrog observed near egg mass.

Photo 17. Northern Leopard Frog observed near Lake Okonoka's edge utilizing the taller restored herbaceous vegetation. .

Photo 18. Six Red-eared Sliders observed basking on a log on a Lake Okonoka island.

Photo 19. Female Eastern Spiny Softshell turtle observed basking on a log on a Lake Okonoka island.

Photo 20. Adult Eastern Snapping Turtle and Midland Painted Turtle observed basking on a log on a Lake Okonoka island.

Photo 21. Adult Northern Water Snake found under a large piece of plywood located on the edge of Lake Okonoka.

Photo 22. Eastern Garter Snake found in the Lake Okonoka Project area.

Photo 23. A wetland area that previously contained cattails, an important habitat structure for several species of herpetofauna, recently mowed near Lake Okonoka's edge.

Photo 24. A fallen log, an important herpetofauna habitat structure, moved to allow for mowing near Lake Okonoka's edge.

Photo 25. An example of a wildlife crossing sign. Flashing lights or flags can be used seasonally, to make the signage more eye-catching to drivers. Photo credit: "Concerned citizen helps bring awareness to public about turtle road mortality in area" by Ausable Bayfield Conservation Authority, 2022.


Photo 26. High curb observed along The Strand Road creating a barrier to herpetofauna movement.

Photo 27. Culvert example showing an Eastern Snapping Turtle using a culvert to avoid a busy road. Photo credit: "Turtle Road Mortality Mitigation Project Final Report" by Glenside Ecological Serviced Limited, Project 14006.


Photo 28. An example of a culvert in use: a Painted Turtle using a under-road culvert. Photo credit: "More aquatic wildlife culverts for Long Point Causeway" by LPCIP News, 2015.

Photo 29. Shell of a deceased Northern Map Turtle found near The Strand Road, a likely road mortality.

Photo 30. Mowed grass bordering Lake Okonoka's edge.

Photo 31. Remains of a deceased juvenile Northern Water Snake found on Lake Okonoka's east side, likely died due to mowing activity.


Photo 32. Loss of lakeside herpetofauna habitat on the east side of Lake Okanona. The image on the left (A) shows this location before it was mowed containing high vegetation, suitable for herpetofauna habitat with cover from the elements and protection from predation. The image on the right (B) shows this same location after it was mowed containing very low vegetation offering no habitat for herpetofauna or other wildlife.

Photo 33. Discarded ball of fishing line observed near edge of Lake Okonoka.

Photo 34. Large amounts of goose feces located near Lake Okanonka's edge. Large amounts of feces can cause nutrient loading into a water system and can lead to algal blooms and wildlife die-offs.

Photo 35. Common Carp observed in shallow water on the edge of Lake Okonoka.

Photo 36. Baby Northern Water Snake found near the Blue Heron Lagoon culvert riprap.

Photo 37. Soil erosion fencing still in place in the Lake Okonoka restoration area.

Photo 38. Muddy pools following a rain event on Lake Okonoka's west side.

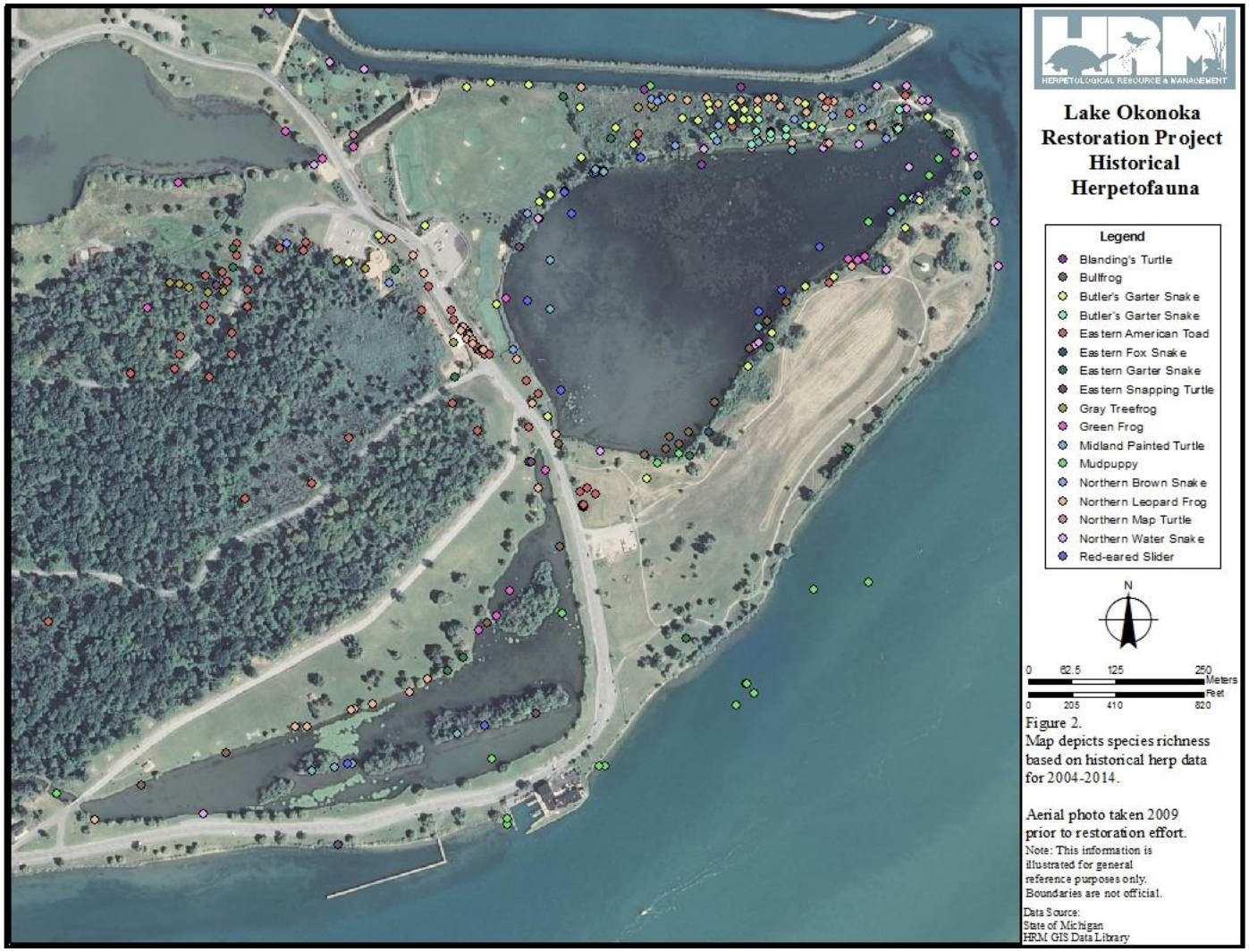
## Tables

| Belle Isle's Lake Okanoka Herpetofauna Species Observed | | | | | |
|---|---|---|---|---|---|
| Common Name | Species Name | Belle Isle Historic Observations | 2015 LO Observations | 2022 LO Observations | Potential Unobserved Species |
| **Salamanders** | | | | | |
| Mudpuppy | Necturus maculosus maculosus | X | | | |
| **Frogs and Toads** | | | | | |
| Bullfrog | Rana catesbeiana | X | X | X | |
| Eastern American Toad | Bufo americanus americanus | X | X | X | |
| Gray Treefrog | Hyla chrysoscelis/versicolor | X | | | |
| Green Frog | Rana clamitans melanota | X | X | X | |
| Northern Leopard Frog | Rana pipiens | X | X | X | |
| **Snakes** | | | | | |
| Butler's Garter Snake | Thamnophis butleri | X | | | |
| Eastern Fox Snake | Pantherophis gloydi | X | | | |
| Eastern Garter Snake | Thamnophis sirtalis sirtalis | X | | X | |
| Northern Brown Snake | Storeria dekayi dekayi | X | | X | |
| Northern Red-bellied Snake | Storeria occipitomaculata occipitomaculata | | | | X |
| Northern Water Snake | Nerodia sipedon sipedon | X | X | X | |
| **Turtles** | | | | | |
| Blanding's Turtle | Emydoidea blandingii | X | | | |
| Eastern Spiny Softshell | Apalone spinifera spinifera | X | | X | |
| Eastern Musk Turtle | Sternotherus odoratus | | | | X |
| Midland Painted Turtle | Chrysemys picta marginata | X | X | X | |
| Northern Map Turtle | Graptemys geographica | X | X | X | |
| Eastern Snapping Turtle | Chelydra serpentina serpentina | X | | X | |
| Red-eared Slider | Trachemys scripta elegans | X | X | X | |
| Yellow-bellied Slider | Trachemys scripta scripta | X | X | | |
| Eastern Box Turtle | Terrepene carolina carolina | X | X | | |

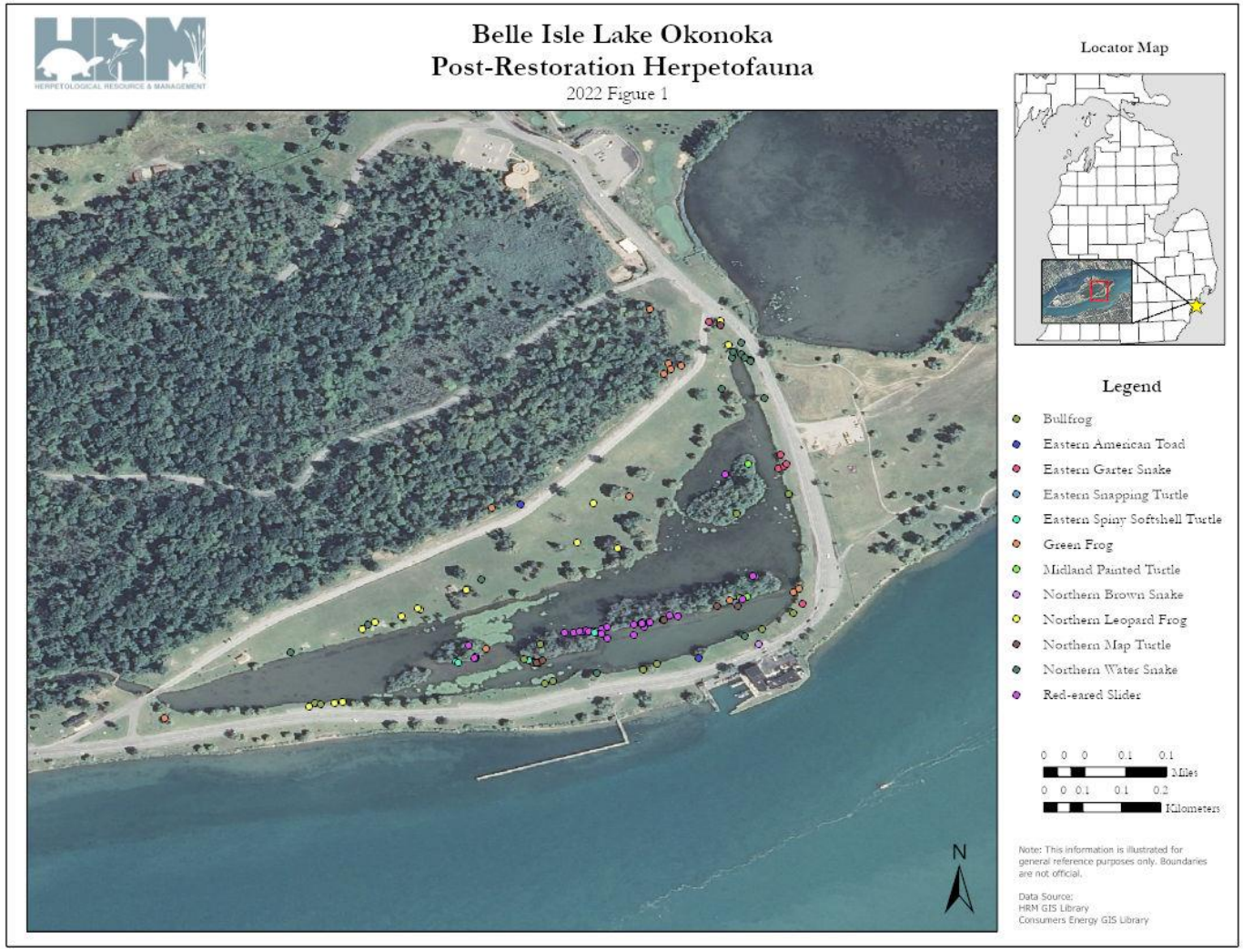
Table 1. Amphibian and reptile diversity observed on Belle Isle in/around Lake Okonoka.*Belle Isle Historic Observations includes data from 2004-2015 for the whole of Bell Isle, not just in the area surrounding Lake Okonoka.

**X** – Marks potential or observed species

## Maps




Map 1. Historic data of herpetofauna observations for the eastern end of Belle Isle. Data from 2004-2015.




Map 2. Herpetofauna observations recorded during 2022 post-restoration surveys.

## Figures

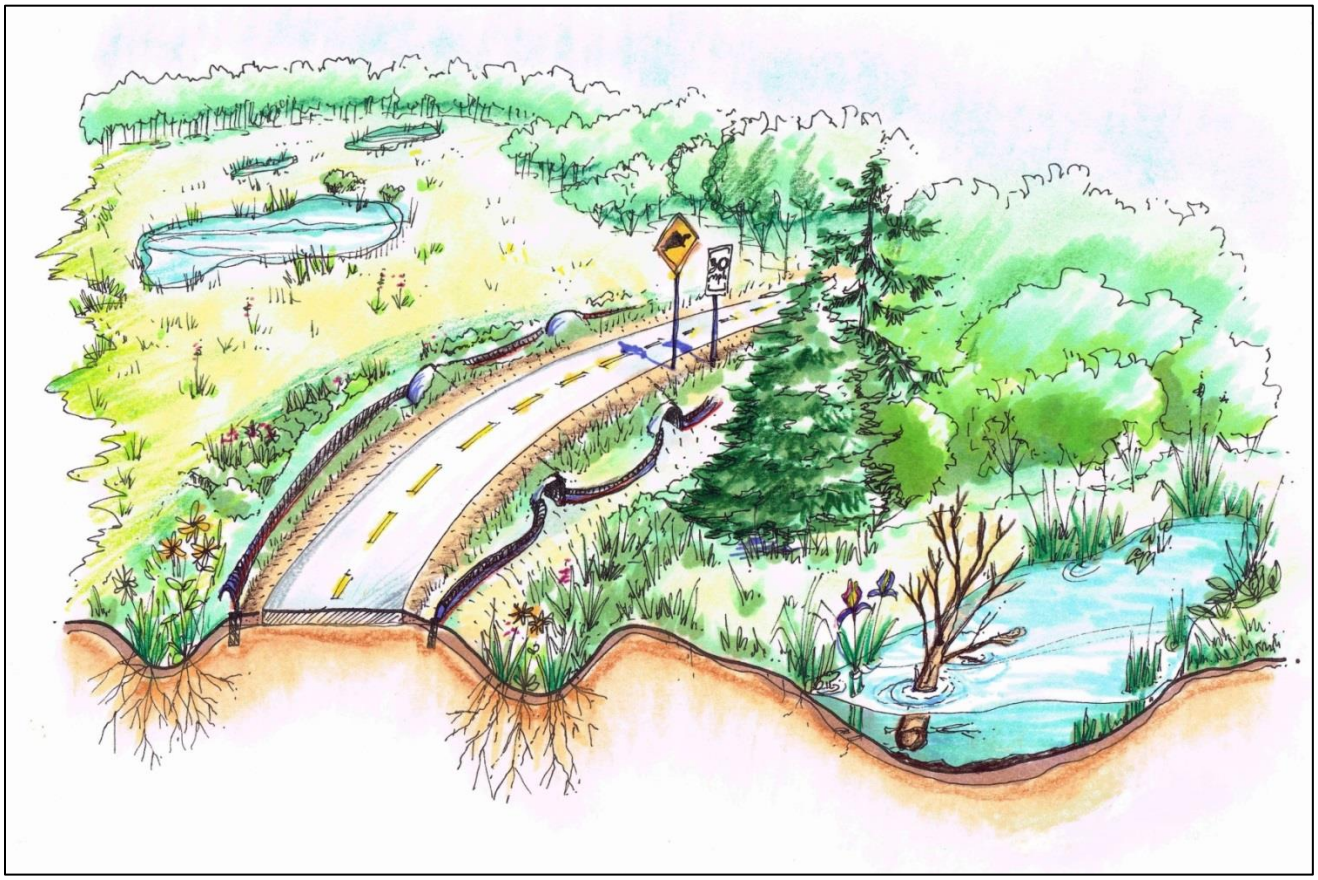


Figure 1. Conceptual drawing depicting a landscape modified to incorporate low or non-existent curbs, crossing structures and associated barrier fencing, reduced mowing, and wildlife crossing signs. Figure source: Michigan Amphibian and Reptile Best Management Practices manual (Mifsud 2014).

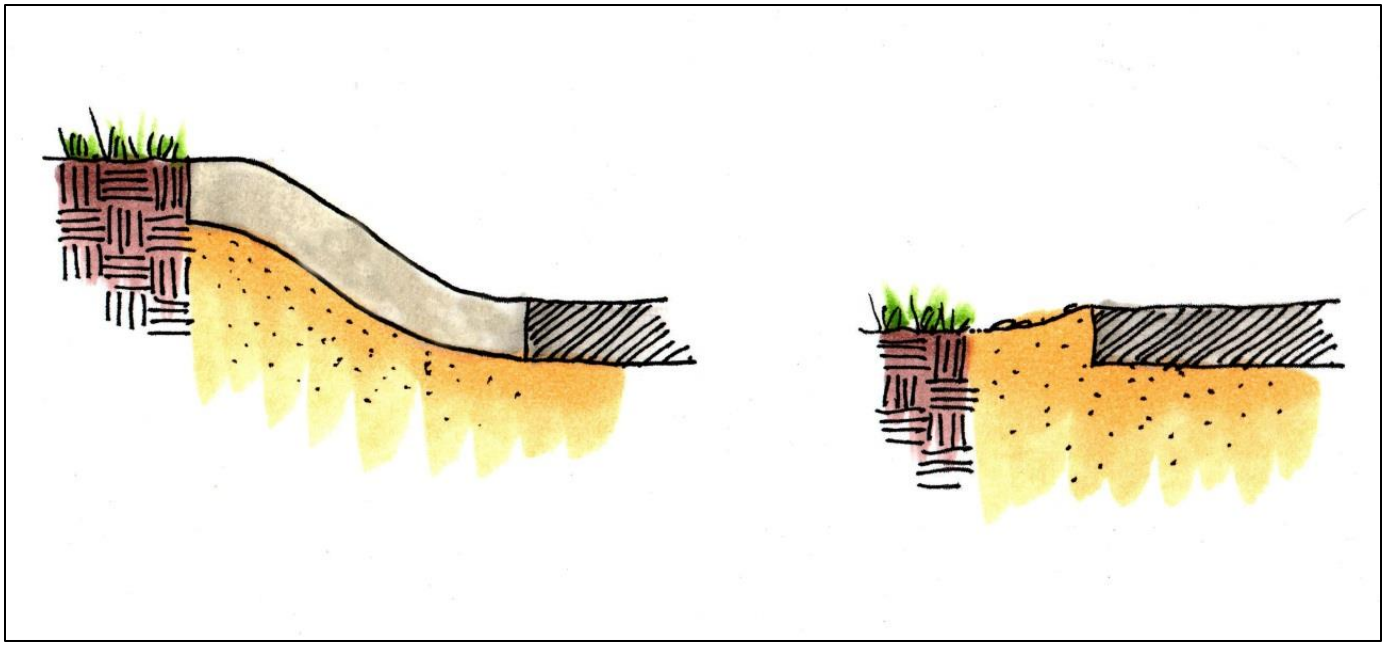


Figure 2. Instillation of a curb with a gentle slope can reduce vehicle-wildlife collisions. Figure source: Michigan Amphibian and Reptile Best Management Practices manual (Mifsud 2014).

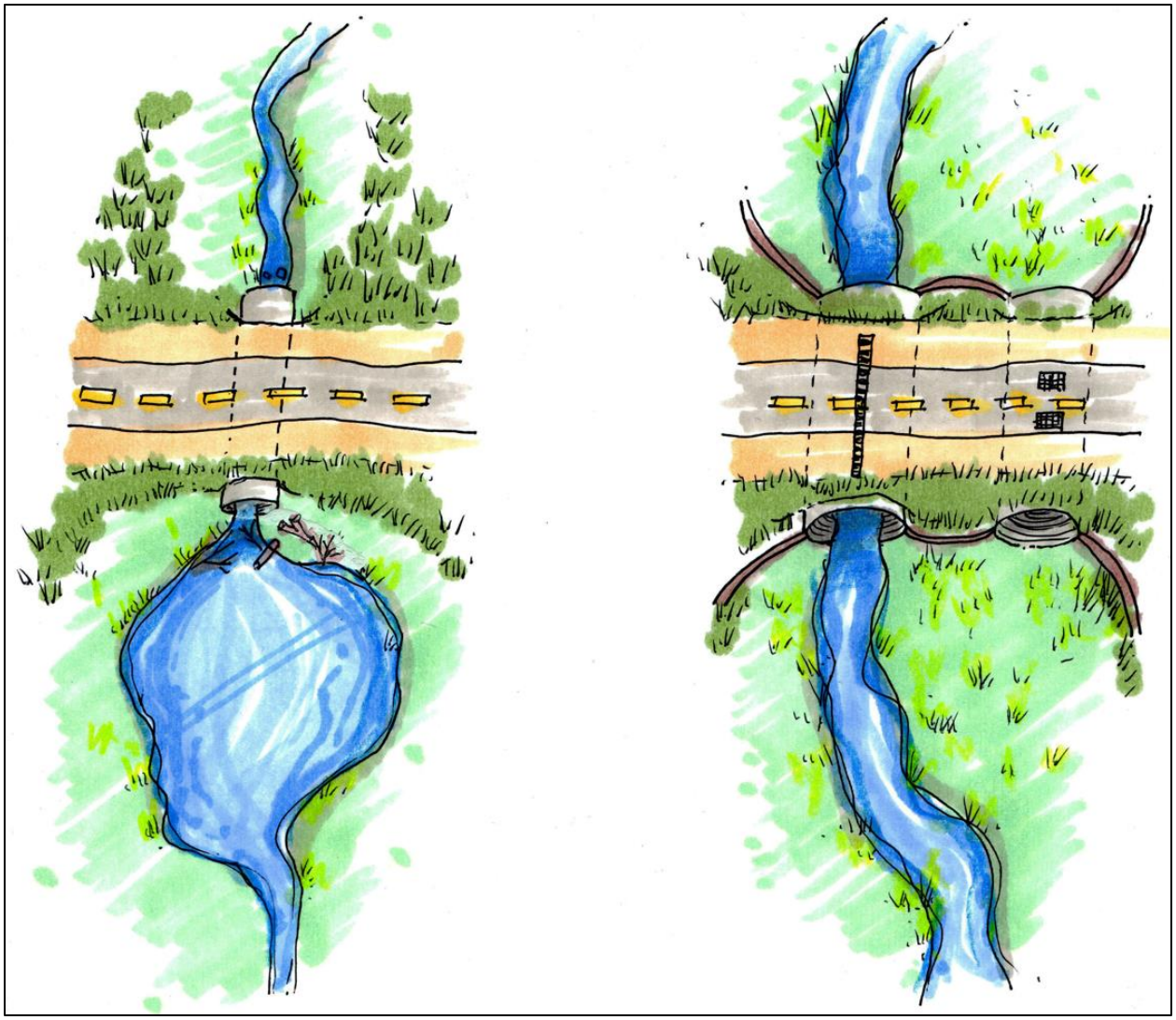


Figure 3. Conceptual drawing showing small (left) and large (right) culverts. The large culvert example shows both a aquatic and terrestrial culvert. Figure source: Michigan Amphibian and Reptile Best Management Practices manual (Mifsud 2014).

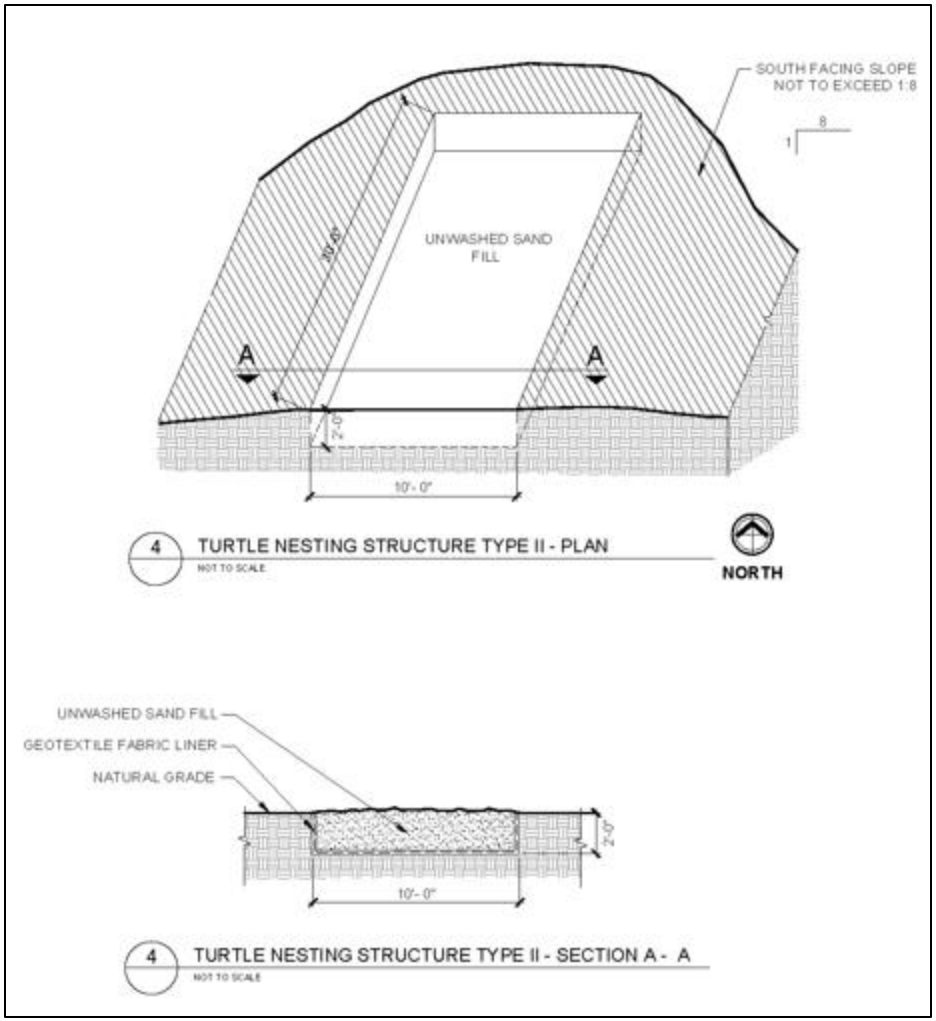



Figure 4. Design for reptile nesting structure to be built on the edge of a waterbody. Figure Source: HRM Wildlife Habitat Designs, Nesting and Basking Structures.

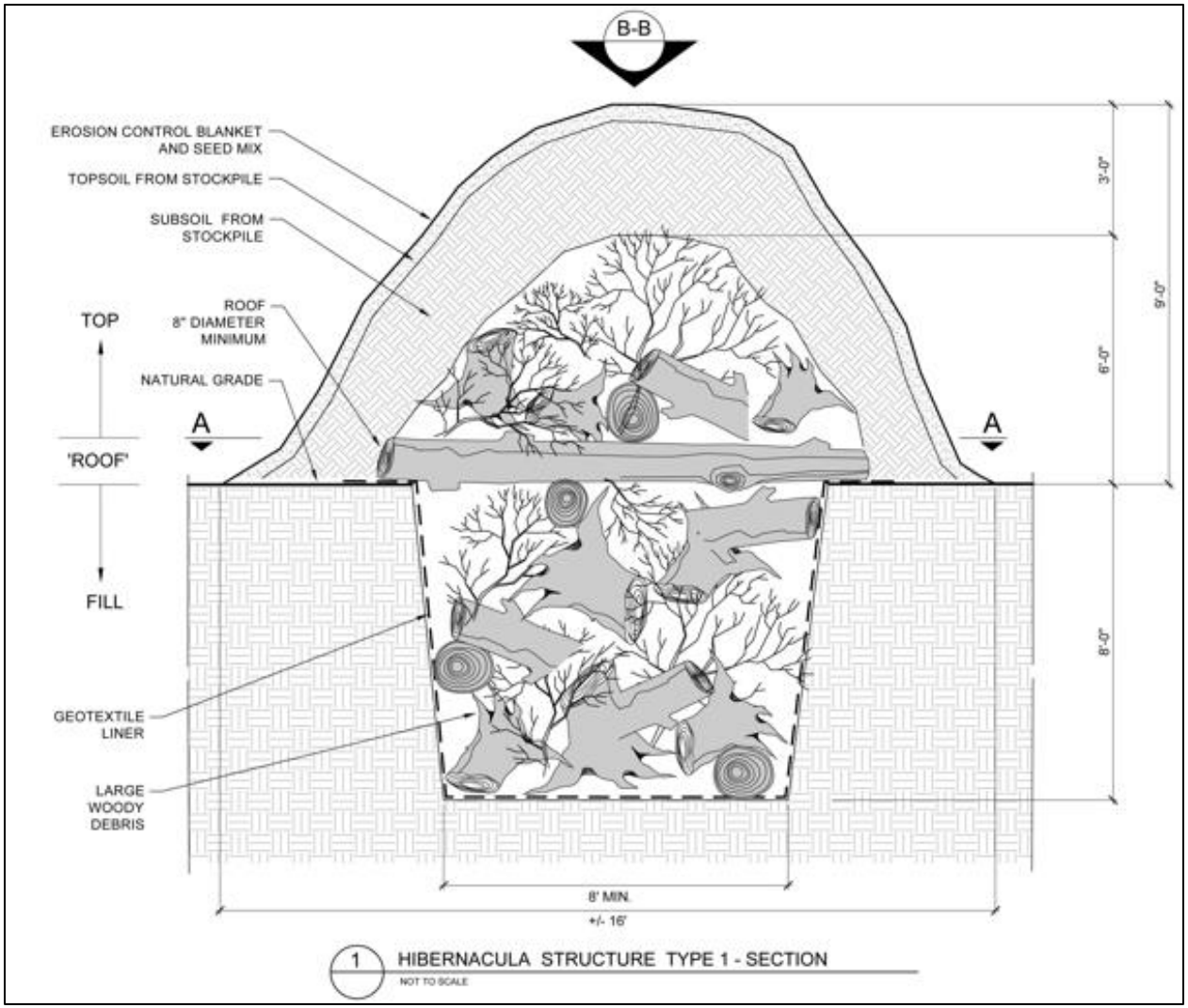



Figure 5. Depiction of the elements and approximate size requirements for snake hibernacula. Figure source: HRM Wildlife Habitat Designs, Structure Type I.

## Species Profiles

### Eastern Fox Snake (*Pantherophis gloydi*)

Eastern Fox Snakes have a small range that is restricted to areas along and adjacent to the shores of Lake Huron and Lake Erie (Harding and Mifsud 2017). It is a state threatened species in Michigan (Michigan Natural Features Inventory 2010) and is listed as endangered in Canada. A large-bodied snake species, Fox Snakes require grassland habitat that is rarely mowed or burned, and often prefer to shelter and overwinter in adjacent riprap or similar habitat. Although they spend much of their time in uplands feeding on small mammals, they are very strong swimmers, and it is not uncommon for them to use waterways to travel significant distances. Despite their size, these snakes are often preyed upon by large raptors and medium-sized mammals. In the fall, Fox Snakes enter hibernacula, which sometimes include communal sites, and do not emerge until mid-April or May. Breeding occurs in spring, eggs are laid in June or July, and the eggs hatch about two months later. Fox Snakes are often senselessly killed because they are mistaken for Copperheads (*Agkistrodon contortrix)* (a U.S. species that is not present in Michigan) because of their orange heads, or for rattlesnakes because they will vibrate their tail against dry vegetation when threatened, producing a loud buzz. This species is also uniquely vulnerable to habitat loss because of its restriction to a thin strip of shoreline, where it must compete with intense road development (COSEWIC 2008).

## Mudpuppy (*Necturus maculosus maculosus*)

Mudpuppies are large, entirely aquatic salamanders that are listed as a species of special concern in Michigan. They are easily recognized by their large size (up to 1.5 feet long) and large external gills just behind the head (Harding and Mifsud 2017). Juvenile Mudpuppies resemble some of the larvae of other salamanders, but they have only four toes on each foot instead of five. In Michigan, this species is the only amphibian that normally inhabits the open water of large lakes and rivers, spending most of its time hiding under flat rocks. They are highly carnivorous and are often caught by fishermen, even during winter. Because of their unique appearance and unjustified reputation as predators of game fish, they are often killed when captured, despite being harmless. Mudpuppies breed in fall, entering shallow water as the temperatures cool, but they do not nest until the following spring. Females require moderately shallow water with plenty of large, flat rocks on the bottom, beneath which they can deposit their eggs. Mudpuppies are the obligate host species for the larvae of the Salamander Mussel (*Simpsonaias ambigua*), a state endangered species (Derosier, Hanshue et al. 2015). This species has been recorded eating invasive round gobies (*Apollonia melanostomus*) and invasive mussels, making them potentially helpful for controlling invasive species and maintaining healthy aquatic habitats.

## Butler's Garter Snake (*Thamnophis butleri*)

In Michigan, the Butler's Garter Snake is listed as a species of special concern, which affords it protection under MDNR Fisheries Order 224.16 (Michigan Department of Natural Resources 2016). In Canada however, the species is currently listed as endangered. Ranging from 15 to 30 inches long, these yellow/orange striped snakes are found only in the southeastern half of the state. The Butler's Garter Snake requires wet grassy habitats including meadows prairies, waterbody shores, as well as old fields, and is commonly found under debris in these locations outside of its mating season, which occurs in early spring. Movement of this species tends to be restricted to the vicinity of water and parallel to the margins of marsh habitat. Butler's Garter Snakes are rarely observed in woodland habitat, and thus wooded areas likely act as natural barriers. The primary prey for Butler's Garter Snakes is earthworms, which they typically forage for in fairly small ranges of less than 2.5 acres. Being a relatively small snake, the Butler's Garter Snake faces predation from a variety of wildlife. The greatest growing threat for this snake is the development of urban and suburban lands which can devastate populations of the species. Butler's Garter Snakes rely on open fields in which are particularly likely to be developed and are attracted to gravel roads and walking/biking trails for basking leaving them particularly vulnerable to mortality (COSEWIC 2010; Harding and Mifsud 2017).

## Blanding's Turtle (*Emydoidea blandingii*)

In Michigan, the Blanding's Turtle is listed as a species of special concern and protected under the MDNR Fisheries Order 224.16 (Michigan Department of Natural Resources 2016). While still locally common in some parts of Michigan, this species is listed as threatened or endangered in other portions of its range, and it is currently being considered for federal protection. This species requires a mosaic of wetland habitats for its survival. For much of the year, they prefer open water areas with structures such as logs or stumps on which to bask. Females require well drained soils, usually with southern exposure, for nesting and will travel long distances to find a suitable nesting location. Hibernation occurs within open water bodies, where the animals burrow into the substrate below the frost line. The Blanding's Turtle has a life span of approximately 80 years and does not reach sexual maturity until around 20 years of age. Adults have few natural predators, but hatchlings and juveniles suffer very high mortality rates. Local annual nest predation, especially by raccoons, is often 100%. For this reason, it may take one adult female decades to produce enough offspring to replace herself and her mate and, thus, maintain a stable population. Due to their very low reproductive rate, it is extremely important to maintain ample nesting areas as well as the shrub swamp wetland habitat that Blanding's Turtles rely upon to survive and reproduce (Carl H. Ernst 2009; Harding and Mifsud 2017).

## Eastern Box Turtle (*Terrapene carolina carolina*)

The Eastern Box Turtle is listed in Michigan as a species of special concern and is protected under the MDNR Fisheries Order 224.16 (Michigan Department of Natural Resources 2016). These turtles are primarily terrestrial, favoring wooded areas consisting of deciduous or mixed trees with sandy soils, but can also be found utilizing nearby open habitats such as fields and marshes. They require some form of access to water, including streams, ponds, or bogs, and spend most of the summer buried in leaf litter or, when temperatures are high, near a source of water. This species is diurnal, and peak periods of activity are typically in the morning or after a rain event. During the winter, Eastern Box Turtles hibernate by burrowing under leaf litter and into the ground. These turtles have relatively small ranges and have an omnivorous diet consisting of plants, berries, invertebrates, and some small vertebrates. Major predators include raccoons, skunks, foxes and other mid-sized carnivores; however, road mortality of these animals is an even larger threat. These long lived animals (40-50 years in the wild but occasionally up to 100 years) can take around 10 years to reach sexual maturity, and, as a result, it takes time for adults to replace themselves in the population because of the high mortality rates of young Eastern Box Turtles. The largest threats facing the Eastern Box Turtle come from humans, ranging from habitat destruction and road mortality to collection for the pet trade (Harding and Mifsud 2017).

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