

# Hennepin South Marsh

## Amphibian and Reptile Post-Restoration Monitoring Report

August 2023



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**Suggested Citation:** Herpetological Resource and Management. 2023. Hennepin South Marsh Amphibian and Reptile Post-Restoration Monitoring Report. Herpetological Resource and Management, Chelsea MI. 35pp.

**Contents**

Executive Summary ..... 1

Introduction ..... 2

Site Description ..... 3

Herpetofaunal Regulations ..... 3

Methods ..... 4

Results ..... 5

Discussion ..... 6

Conclusion ..... 10

Maps ..... 11

Figures ..... 15

Tables ..... 18

Photos ..... 19

Species Summaries ..... 31

References ..... 35

## Executive Summary

In 2019, Herpetological Resource and Management, LLC (HRM) was contracted by Environmental Consulting and Technology (ECT) to conduct a baseline herpetological inventory and make recommendations for habitat rehabilitation targeting amphibians and reptiles in Hennepin Marsh. Work was funded through the National Oceanic and Atmospheric Administration (NOAA). A desktop review, followed by a preliminary survey and habitat assessment was conducted in 2019 to identify habitat restoration targets. Several opportunities were identified for improving amphibian and reptile (regionally referred to as herpetofauna) habitat and later incorporated into the overall restoration of Hennepin Marsh. Pre-restoration inventory was conducted in 2020 to establish baseline data of species richness, abundance, and distribution. Significant findings from these assessments included:

- A total of seven (7) species of herpetofauna comprising of three (3) amphibians and four (4) reptiles were documented within Hennepin Marsh North and South.
- One (1) state Special Concern species was observed: the Blanding's Turtle.
- Based on current conditions and historic records, three (3) additional rare species of herpetofauna were identified as having the potential to occur within Hennepin Marsh including the state Threatened Eastern Fox Snake and the state Special Concern Northern Mudpuppy and Butler's Garter Snake.

In 2023, HRM was contracted by ECT to conduct post-restoration monitoring targeting amphibians and reptiles focused on Hennepin South Marsh to evaluate restoration success. Significant findings from these assessments included:

- Six (6) species of herpetofauna comprising of two (2) amphibians and four (4) reptiles were documented within the project area. Prior surveys from 2020 resulted in a single species, observed within Hennepin Marsh South, the Northern Map Turtle.
- Two (2) new species, the Red-eared Slider and Eastern Snapping Turtle were observed in 2023.
- Restoration within Hennepin Marsh South focused upon the creation of shoals to address erosion concerns and protect shoreline habitat from wave action.
- Habitat structures including basking logs and underwater refugia were constructed as part of the restoration design.
- HRM staff actively observed turtles using the basking logs and shoals demonstrating the effectiveness of these structures as wildlife refugia.

Restoration of Hennepin South Marsh will likely increase herpetofauna species richness as well as the abundance of species already present. This project directly contributes to restoring lost habitats and degraded fish and wildlife populations within the Detroit River as well as address measures needed for the removal of Beneficial Use Impairments and delisting this region as an Area of Concern.

## Introduction

The Detroit River is an important international channel that links Lake St. Clair and the Upper Great Lakes to Lake Erie. Over 100 years of development have degraded the river by eliminating areas of suitable fish and wildlife habitat and introducing various sources of pollution which have contributed to high levels of bacteria, PCBs, and other contaminants in the system. As a result, the Detroit River is one of 43 contaminated sites designated as an Area of Concern (AOC) under the 1987 Great Lakes Water Quality Agreement. Listed among the multiple Beneficial Use Impairments (BUIs) is the loss of fish and wildlife habitat. The river historically supported extensive areas of coastal marsh with shorelines covered by beds of emergent and submergent aquatic vegetation. Urbanization in the watershed resulted in the loss of more than 90% of the river's coastal wetland. A majority of the remaining wetland habitat is found on the river's islands, which support a considerable amount of suitable habitat for resident and migratory fish and wildlife. Recently, several groups and agencies from both United States and Canada have spearheaded efforts to conduct restoration that will contribute to the removal of BUIs on the Detroit River and aid in the overall delisting as an AOC.

The Hennepin Marsh complex, located on Grosse Ile Island in the Trenton Channel of the Detroit River, was selected for restoration and enhancement work beginning in 2019. The natural habitat on the island has become degraded over the last twenty years due to erosion as well as invasive vegetation and restoring this unique Great Lakes ecosystem was identified as a high priority. In 2019, Herpetological Resource and Management (HRM) was contracted by Environmental Consulting and Technology (ECT) as part of a grant from the Friends of the Detroit River with funding provided by the National Oceanic and Atmospheric Administration (NOAA) to evaluate the Hennepin Marsh complex for restoration opportunities targeting amphibians and reptiles.

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 et al. 1986, Guilfoyle 2010, Herpetological Resource and Management 2022). Efforts to protect and minimize impacts to these species and their habitat are becoming increasingly important.

HRM completed a desktop review, conducted field assessments, and performed pre-restoration inventory of the Hennepin Marsh complex in 2020 to assist in guiding restoration actions targeting amphibians and reptiles within the project area. Following restoration activities, HRM conducted post-restoration inventory of the southern portion of the Hennepin Marsh project area (referred to as Hennepin South Marsh) from May through August of 2023. Surveys focused on recording overall amphibian and reptile presence, represented age classes, spatial distribution, and relative abundance to evaluate restoration success for herpetofauna. Given the time of year of monitoring initiation, Mudpuppy assessments were not included due to the natural history of these



species and poor tolerance of warmer water in the near shore habitats. This report summarizes HRM's 2020 pre-restoration inventory results and focuses upon the 2023 post-restoration inventory findings and additional BMP recommendations associated with Hennepin South Marsh.

## Site Description

Hennepin Marsh is a 154-acre wetland complex located in the Trenton Channel of the Detroit River along the western shore of Grosse Ile (Map 1). Grosse Ile was historically dominated by maple forest and hardwood swamp with abundant native emergent vegetation along the shoreline. Trenton Channel experiences heavy watercraft traffic resulting in significant wave action. This, coupled with high water levels, has led to a loss of natural vegetation and hardening of the shoreline causing substantial erosion and providing disturbance conditions suitable for invasive plants to colonize. The marsh complex is separated into two portions by the Grosse Ile Toll Bridge.

Hennepin North Marsh consists of 106 acres of shallow wetland area. Currently, this area is mainly submerged aquatic macrophyte with water levels ranging from 2 – 8 feet (Photos 1-3). Hennepin South Marsh is composed of 48 acres of coastal wetlands and multiple barrier islands (Photos 5-8). The vegetation composition of this site is similar to the habitat to the north. Three barrier islands along the southern tip of Grosse Ile have assisted in protecting the respective emergent shoreline from surge driven erosion (Photo 4). To address significant erosion of the three barrier islands, restoration efforts included the construction of two large shoals along the western boundary of the project area (Photos 9-10). The shoal structures were created to replace the pre-existing barrier islands and maximize protection against erosion. To increase the ecological function of the shoals to herpetofauna and other wildlife, multiple basking logs and submerged rock structures were placed along the eastern side of both shoals (Photos 11-12) (Figure 1-3). HRM's 2023 post-restoration surveys were focused upon the South Hennepin Marsh project area.

## 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).



The federal Endangered Species Act of 1973 protects Threatened and Endangered species by prohibiting *take* including harassing, harming, hunting, shooting, wounding, killing, trapping, capturing, or collecting individuals (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1973).

## Methods

### *Desktop Review*

Prior to initiating surveys in Hennepin Marsh, a desktop review was conducted in 2019 to determine herpetofauna species that may occur within the project area using GIS-based spatial framework for analysis. GIS resources included historical and recent observations of amphibian and reptile species from Michigan Herp Atlas submissions, HRM occurrence database, Michigan Natural Heritage database, and museum records.

Aerial photo interpretation was used to further evaluate potential species based on habitat types present, surrounding land use, and known ranges of species. Recent and historic aerial imagery was used spanning 1999 to 2022 to evaluate the corridor for potential herpetofauna.

### *Field Assessments*

Pre and post-restoration assessments were conducted during similar survey periods. Pre-restoration inventory surveys were conducted between June and July of 2020. Post-restoration inventory surveys of Hennepin South Marsh were conducted between May and August of 2023. Objectives were to assess herpetofauna community composition, relative abundance, represented age classes, and spatial distribution of amphibians and reptiles within Hennepin South Marsh to compare to that of the pre-restoration findings.

Aquatic surveys of Hennepin South Marsh were conducted by a team of two using non-motorized watercraft. Transect surveys conducted on foot were limited to the two constructed shoals. Both strategies were utilized to assess aquatic and terrestrial habitat and evaluate the restoration effectiveness for amphibians and reptiles. Methods to detect herpetofauna included visual encounter surveys which included the investigation of potential basking and nesting areas, as well as turning over natural and artificial cover (logs, boards, debris, etc.).

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, (5) reproductive condition (if it can be determined), and (6) location. Observational location data 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.





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 and the USFWS.

## 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 consistency. For the purposes of this report, this naming 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, authorities on herpetofauna within Michigan (Harding and Mifsud 2017).

### Desktop Review

Based upon the results of the 2019 desktop review, HRM identified four (4) rare amphibian and reptile species that may occur within the project area. These included the state Threatened Eastern Fox Snake (*Pantherophis gloydi*), two (2) state Special Concern reptiles, the Blanding's Turtle (*Emydoidea blandingii*) and Butler's Garter Snake (*Thamnophis butleri*), and one (1) state Special Concern amphibian, the Northern Mudpuppy (*Necturus maculosus maculosus*).

### Pre-Restoration

During the 2020 pre-restoration inventory, HRM documented one (1) rare species, the Blanding's Turtle, within the project area. In addition, six (6) species of herpetofauna were documented over the pre-restoration survey period. These species included the Bullfrog (*Rana* [*Lithobates*] *catesbeiana*), Green Frog (*Rana* [*Lithobates*] *clamitans melanota*), Eastern American Toad (*Bufo* [*Anaxyrus*] *americanus americanus*), Northern Water Snake (*Nerodia sipedon sipedon*), Midland Painted Turtle (*Chrysemys picta marginata*), and Northern Map Turtle (*Graptemys geographica*) (Map 2). Pre-restoration surveys of the Hennepin Marsh complex confirmed suitable habitat for the state Threatened Eastern Fox Snake and two (2) state Special Concern herpetofauna, Northern Mudpuppy and Butler's Garter Snake.

### Post-Restoration

HRM documented six (6) species of herpetofauna during the 2023 post-restoration monitoring. Species included the Bullfrog, Green Frog, Midland Painted Turtle (Photo 13), Red-eared Slider (*Trachemys scripta elegans*) (Photo 14), Northern Map Turtle (Photo 14-18), and Eastern Snapping Turtle (*Chelydra serpentina serpentina*) (Map 3). No rare species of herpetofauna were

observed during the 2023 field assessments. Including the results of both the 2020 and 2023 surveys, a total of nine (9) species of herpetofauna were documented within the Hennepin Marsh project area (Map 4).

Post-restoration surveys of Hennepin South Marsh confirmed suitable habitat for the state Threatened Eastern Fox Snake and the state Special Concern Blanding's Turtle, Northern Mudpuppy, and Butler's Garter Snake. An additional nine (9) species of herpetofauna are known to occur or may occur within the project area but were not detected during pre or post-restoration assessments. These species include the Gray Treefrog (*Hyla versicolor/chrysoscelis*), Northern Leopard Frog (*Rana [Lithobates] pipiens*), Wood Frog (*Rana [Lithobates] sylvatica*), Midland Chorus Frog (*Pseudacris triseriata*), Northern Spring Peeper (*Pseudacris crucifer*), Eastern Spiny Softshell Turtle (*Apalone spinifera*), Eastern Musk Turtle (*Sternotherus odoratus*), Eastern Garter Snake (*Thamnophis sirtalis sirtalis*), and Northern Brown Snake (*Storeria dekayi*). See Table 1 for total observed and potential herpetofauna species within the Hennepin Marsh project area.

## Discussion

Initial pre-restoration field work conducted by HRM within Hennepin Marsh in 2020 focused on assessing habitat conditions and restoration opportunities targeting reptiles and amphibians. Objectives were placed on determining amphibian and reptile relative abundance and spatial distribution in order to advise ECT and FODR on restoration strategies to enhance and improve habitat conditions for these organisms. Recommendations for Hennepin Marsh included the creation of basking structures and underwater Mudpuppy habitat, diversifying shoal rip rap and cobble sizes to maximize functionality and safety for wildlife, and the usage of wildlife-friendly soil erosion control material. Findings of the pre-restoration inventory surveys resulted in total of seven (7) species of herpetofauna observed including one (1) rare species: the state Special Concern Blanding's Turtle. In addition to the Blanding's Turtle, three (3) rare species of herpetofauna were identified as potentially occurring within the Hennepin Marsh complex: the Eastern Fox Snake, Northern Mudpuppy, and Butler's Garter Snake. All three species are known to occur on Grosse Ile and reports have been documented in the last 10 years for all three species. Only one (1) species of herpetofauna, the Northern Map Turtle, was observed within Hennepin South Marsh during HRM's pre-restoration surveys. Lack of available habitat was believed to be a contributing factor.

Based on HRM's pre-restoration surveys of Hennepin Marsh in 2020, the overall available habitat for herpetofauna was considered to be limited, resulting in a relatively low observed abundance and species diversity. Given the relatively small size of Hennepin Marsh and Grosse Ile's isolated location, it is expected to have an overall lower diversity compared to communities on mainland habitats. Pre-restoration, Hennepin Marsh supported a few features beneficial for local herpetofauna. The three barrier islands located just south of the Grosse Ile Toll Bridge, in the northern half of Hennepin South Marsh, provided critical basking structure and habitat refugia within the project area. However, amplified wave action from the Detroit River and continuous erosion had steadily degraded the remaining habitat and functionality of the barrier islands. The core



objective of the Hennepin Marsh restoration project was the creation of the two large shoal structures to simultaneously provide the required wave and erosion protection while increasing the amount of available habitat for herpetofauna and other wildlife.

As directed by ECT, HRM focused upon Hennepin South Marsh during post-restoration surveys due to the location experiencing the focus of the restoration work, specifically the creation of the shoal structures. Post-restoration monitoring of Hennepin South Marsh resulted in the observation of a total of six (6) species of herpetofauna. Five (5) new species of herpetofauna were documented within Hennepin South Marsh during 2023 surveys including the Bullfrog, Green Frog, Midland Painted Turtle, Red-eared Slider, and Eastern Snapping Turtle. Two (2) species, the Red-eared Slider and Eastern Snapping Turtle, were not previously documented in 2020 within the overall Hennepin Marsh complex during pre-restoration inventory. No rare species of herpetofauna were observed during the 2023 post-restoration monitoring. Including pre and post-restoration surveys, a total of nine (9) species of herpetofauna have been observed within the Hennepin Marsh project area. Based on known species occurrences, currently available habitat, and continued restoration progression and establishment, an additional nine (9) species of herpetofauna have the potential to occur or colonize the Hennepin Marsh project area. These species include the Gray Treefrog, Northern Leopard Frog, Wood Frog, Midland Chorus Frog, Northern Spring Peeper, Eastern Spiny Softshell Turtle, Eastern Musk Turtle, Eastern Garter Snake, and Northern Brown Snake.

Based on HRM's post-restoration surveys of Hennepin South Marsh, the basking logs and habitat structures created provide a significant increase in the overall available habitat for herpetofauna within the project area. Large quantities of Northern Map Turtles were observed utilizing the created basking log structures on both the northern and southern shoal (Photo 14-15). The rip-rap and cobble banks of the shoals were also observed to be utilized by Northern Map Turtles for thermoregulatory purposes (Photo 16-17). Utilizing various-sized rip-rap and cobble to eliminate large crevices and gaps along the banks of the shoal helps significantly reduce threat of entrapment of turtles that usually leads to death that can occur when only large rip-rap is used. In addition to the created shoals, the eastern shoreline of Hennepin South Marsh currently contains a large quantity of natural basking logs and structures in the form of fallen tree limbs and woody vegetation, providing additional habitat for amphibians and reptiles. A large portion of the eastern shoreline is also undeveloped and contains both emergent and aquatic vegetation providing habitat for a variety of herpetofauna species. Midland Painted Turtles, Red-eared Sliders, and Eastern Snapping Turtles were observed utilizing this area. Bullfrogs and Green Frogs were also documented calling within emergent marsh habitat in proximity to the shoreline indicating breeding activity.

The Blanding's Turtle is a species of Special Concern in Michigan and is currently being evaluated for federal protection under the Endangered Species Act (U.S. Fish & Wildlife Service 2015). While observed during the 2020 pre-restoration surveys of the overall Hennepin Marsh complex, the Blanding's Turtle was not observed within Hennepin South Marsh during post-restoration monitoring. However, suitable habitat for the Blanding's Turtle was documented within

Hennepin South Marsh during post-restoration surveys. Given the proximity to HRM's 2020 occurrence within Hennepin North Marsh, suitable habitat currently present onsite, and the overall landscape connectivity, the Blanding's Turtle likely occurs or is currently capable of colonizing the Hennepin South Marsh project area.

Several rare and sensitive amphibians and reptiles known to historically occur in or near Hennepin Marsh were not observed during HRM's 2020 or 2023 assessments, specifically the Eastern Fox Snake, Northern Mudpuppy, and Butler's Garter Snake. The Eastern Fox Snake is a state Threatened species whose range lies entirely within the Great Lakes basin where it is found in coastal marshes and other near shore habitats. While no observations of this species have been recorded directly in Hennepin Marsh, Eastern Fox Snakes are well documented on Grosse Ile and in the surrounding area in recent years. Their strong swimming ability, adaptation to urban and suburban landscapes, and tendency to travel long distances indicate the species is capable of colonizing Hennepin Marsh. The completed restoration activities, specifically the rip-rap and cobble structure along the shoal banks will help to provide additional habitat required by the Eastern Fox Snake to potentially support this rare species within the project area.

The Northern Mudpuppy, a species of Special Concern in Michigan, should remain a major target for herpetofauna restoration and monitoring at Hennepin Marsh. Mudpuppies are a fully aquatic salamander species and are also the obligate host to the state Endangered Salamander Mussel (*Simpsonais ambigua*), making it an integral component of this aquatic ecosystem. Additionally, Mudpuppies are one of few native Michigan species to have adapted to include invasive species in their diet. Mudpuppies prey on both of the invasive Round Goby (*Neogobius melanostomus*) and Zebra Mussel (*Dreissena polymorpha*) and act as a natural form of management which benefits the Great Lakes ecosystem as a whole and the communities that benefit from this resource (Stapleton et al. 2018). Mudpuppies were last documented by HRM in Hennepin Marsh in 2012, but were last observed in the Detroit River as recent as 2023. Due to the timing of surveys, targeted trapping was not conducted as it is outside of the active season. Capture efforts for this species should be conducted in early spring when the species is still active in nearshore habitats and submerged traps do not pose the risk of capturing turtles that may drown. The limestone slab groupings placed underwater adjacent to the shoals to serve as fish and Mudpuppy habitat and refugia were unable to be assessed for their efficacy as a result. However, these structures were observed during surveys and likely are providing essential habitat for a variety of species and potential Mudpuppies. Due to their largely cryptic nature and seasonal activity, conducting surveys over multiple seasons would provide greater opportunity for detection and a more accurate depiction of Mudpuppy community compositions and spatial distribution in Hennepin Marsh post-restoration.

The Butler's Garter Snake is also known to occur on Grosse Ile and has a high probability of currently inhabiting the Hennepin Marsh complex in the near shore and upland edge. This species is listed as Special Concern in Michigan and faces population declines due to habitat loss and fragmentation. Butler's Garter Snakes are a burrowing species, so much of their time is spent underground (Harding and Mifsud 2017). The compacted shoreline of Hennepin Marsh makes

burrowing activities much more difficult. Butler's Garter Snake habitat is currently extremely limited within Hennepin South Marsh. However the restoration and creation of the two shoals will help to combat compaction and erosion in the area, potentially benefiting Butler's Garter Snakes and encouraging colonization. Butler's Garter Snakes are known to utilize a variety of habitat compositions and therefore travel between habitat types often seeking open grass fields to bask, marshy wetlands to forage, or hibernacula in the fall. Urban development, such as that within Grosse Ile, fragments the habitat mosaic that this species requires which strains and segments the population and may inhibit or slow potential colonization within the project area.

No evidence of turtle nesting activity was observed on the shoals during the 2023 post-restoration surveys. Turtle nesting could have been limited by various shoreline bird species' heavily utilizing the shoals as the presence of the birds and the resulting guano can create an unfavorable nesting environment for turtles (Photo 19-20). As the habitat continues to evolve and improve, establishment of vegetation and evolving upland plant communities, will likely decrease the disproportionate usage of the shoals by shoreline birds. At the peak of the 2023 growing season, during HRM's later season surveys, fewer shoreline bird species were observed utilizing the shoals. This shift in plant composition and density will promote habitat for herpetofauna as well as various vertebrate and invertebrate pollinator species, such as the Monarch Butterfly (*Danaus plexippus*) which HRM observed during our August survey (Photo 21-22).

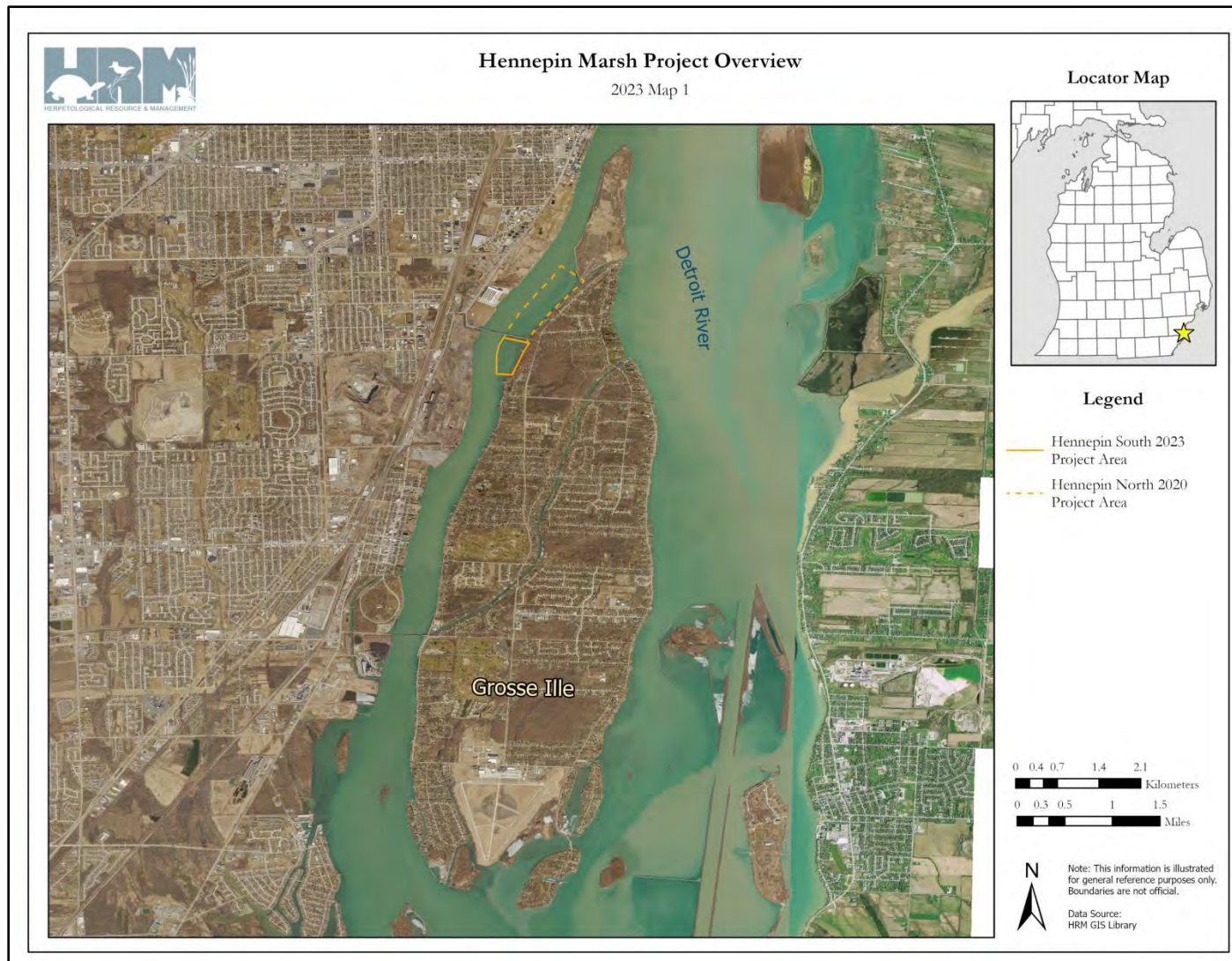
While erosion concerns within the Hennepin South Marsh project area have been addressed with the creation of the shoals, a remaining major contributing factor of the degradation of habitat in Hennepin Marsh is the excessive presence of invasive vegetation. Problematic invasives observed during HRM's assessments included European frog's-bit (*Hydrocharis morsus-ranae*), Eurasian honeysuckle (*Lonicera* spp.), European Buckthorn (*Rhamnus cathartica*), Eurasian common reed (*Phragmites australis* ssp. *australis*), multiflora rose (*Rosa multiflora*), and White mulberry (*Morus alba*). Several of these species can negatively impact herpetofauna populations through habitat alteration, competition, and added predation pressure. Additionally, the shade from densely established plants can eliminate sunny basking areas for reptiles reducing critical thermoregulatory opportunities. Of these invasives observed in Hennepin, *Phragmites* likely poses one of the largest threats. Large expanses dominate several plant communities and its presence threatens coastal marsh habitat throughout the Detroit River. Besides eliminating suitable habitat directly, this and other invasive species severely fragment amphibian and reptile habitat by creating physical barriers and preventing their dispersal through the landscape (Westbrooks 1998, Tulbure et al. 2007). Dense, mature stands of *Phragmites* were observed along a significant portion of the shoreline of the overall Hennepin Marsh complex (Photo 23-24). The barrier presented by *Phragmites* currently prevents herpetofauna from moving between land and open water as well as moving between sunny and shaded areas needed for optimal thermoregulation. Additionally, the plant has been shown to shade out nesting habitat with the lower temperatures leading to reduced turtle hatching success (Bolton and Brooks 2010). Efforts to restore connectivity throughout the Grosse Ile's segmented habitats and the Detroit River will provide immense value for herpetofauna as well as other wildlife species.

## Conclusion

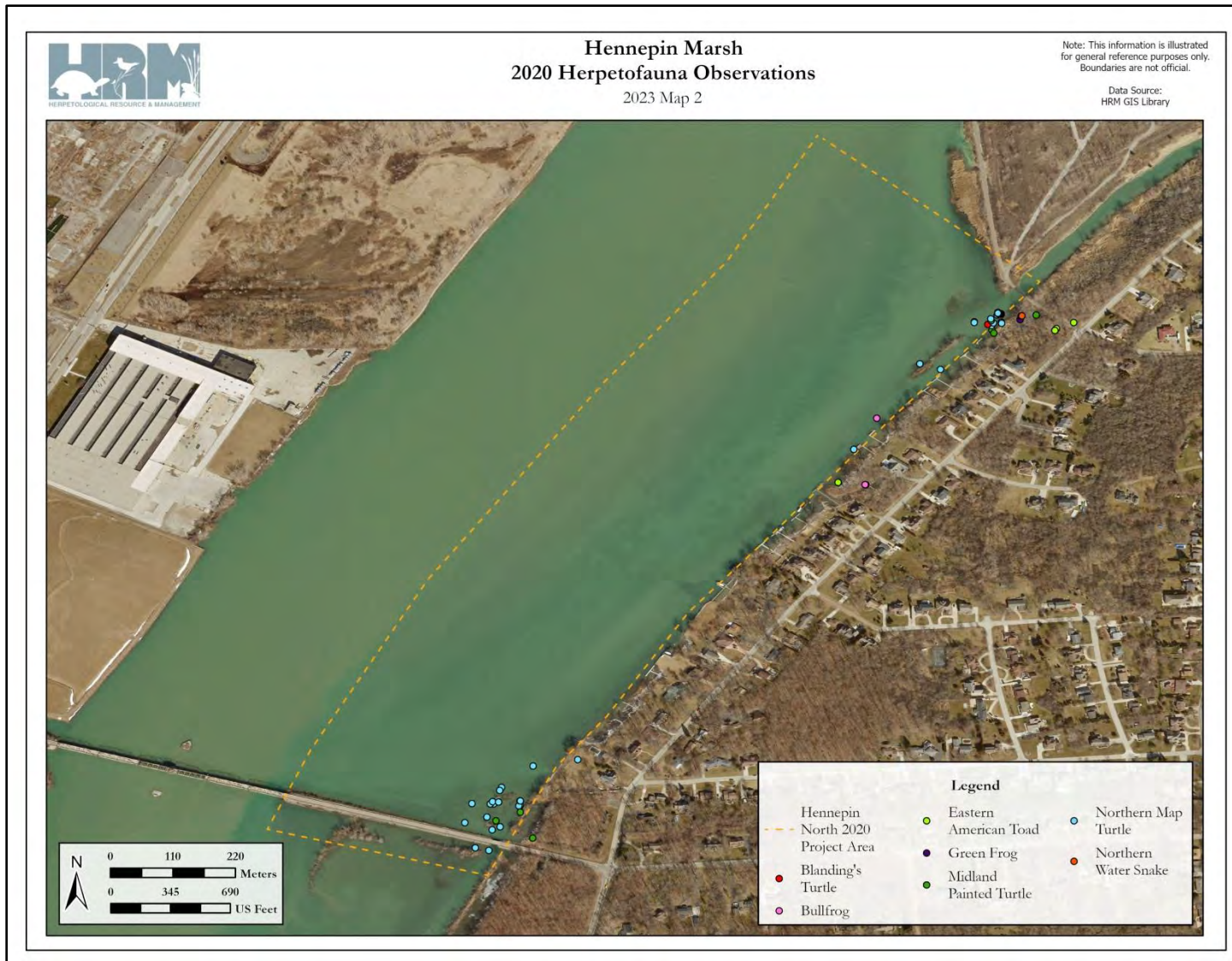
The Detroit River Watershed supports a number of rare and sensitive species and restoration in the area is essential to the long-term viability of the region's ecological function. Pre-restoration, the natural communities of Hennepin Marsh were considered degraded and available herpetofauna habitat was very limited. The area historically supported diverse communities of amphibians and reptiles and though several species are currently present, overall richness has decreased from historic levels and population size and spatial distribution is limited. The restoration of the three barrier islands into two large shoals both significantly improved the area's protection against erosion and increased habitat available to herpetofauna and other wildlife. The effects of erosion protection will likely aid in increasing the overall ecosystem function of Hennepin Marsh. Continued monitoring of Hennepin South Marsh will be critical in evaluating the restoration's long-term success for herpetofauna and the system as a whole. This work will also be a valuable step towards the ecological recovery of the overall region and the removal of the loss of fish and wildlife habitat Beneficial Use Impairment, ultimately leading to the delisting of the area as an Area of Concern.



# Maps

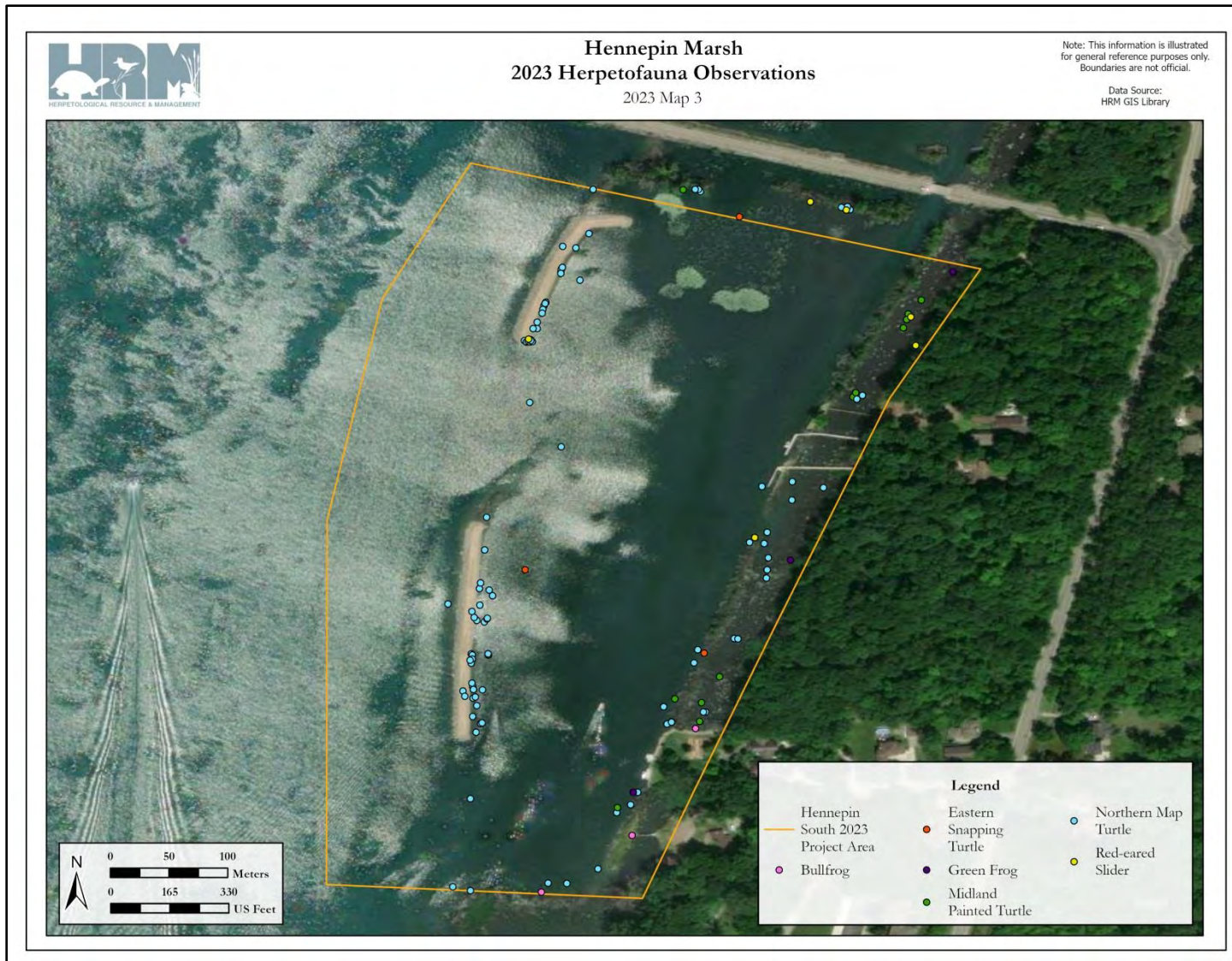


Map 1. Overview of the Hennepin Marsh project.



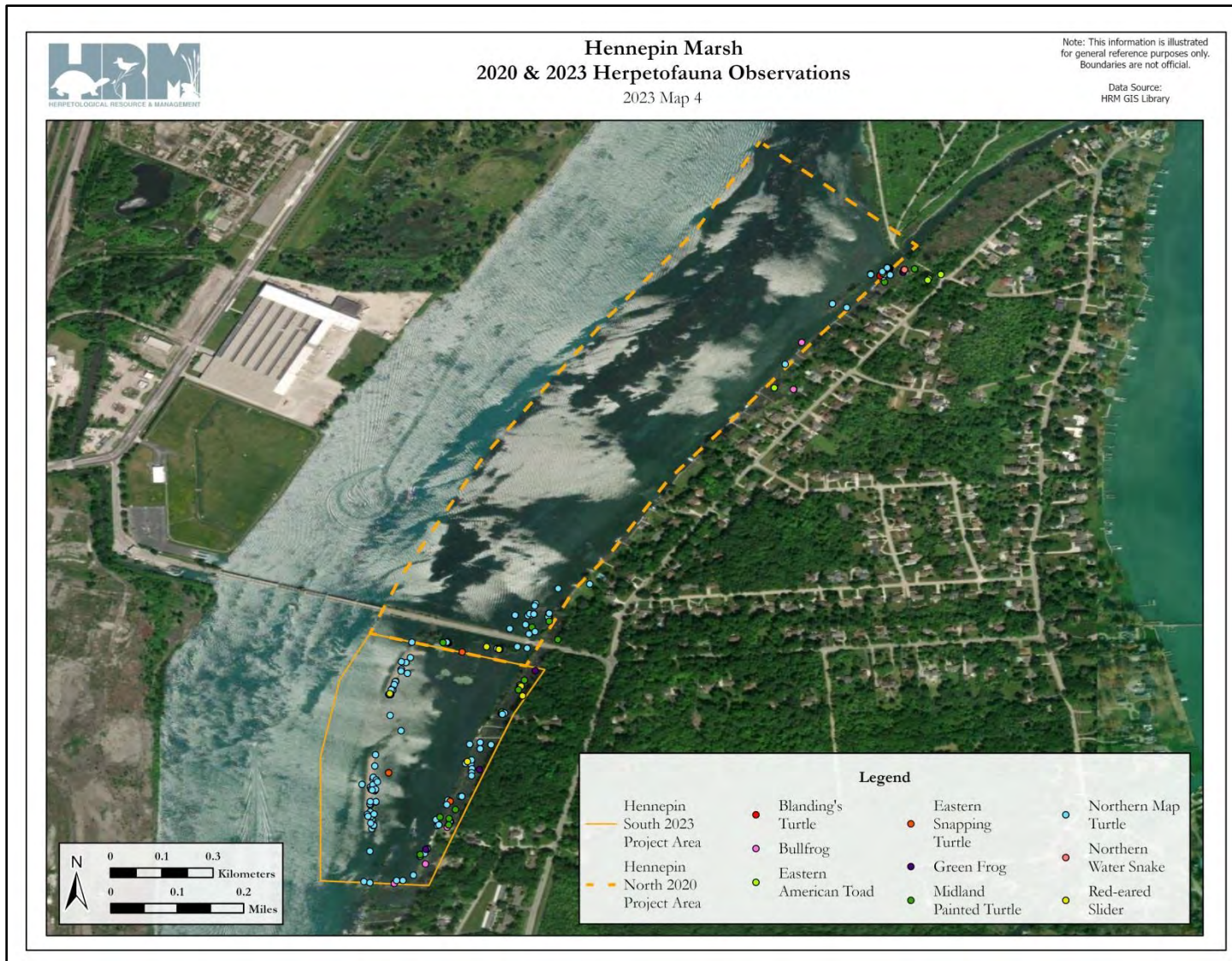
Map 2. Herpetofauna observed during the 2020 pre-restoration field assessments of Hennepin Marsh.





Map 3. Herpetofauna observed during the 2023 post-restoration field assessments of Hennepin South Marsh.





Map 4. Herpetofauna observed during both the 2020 pre-restoration and 2023 post-restoration field assessments of Hennepin Marsh.

# Figures

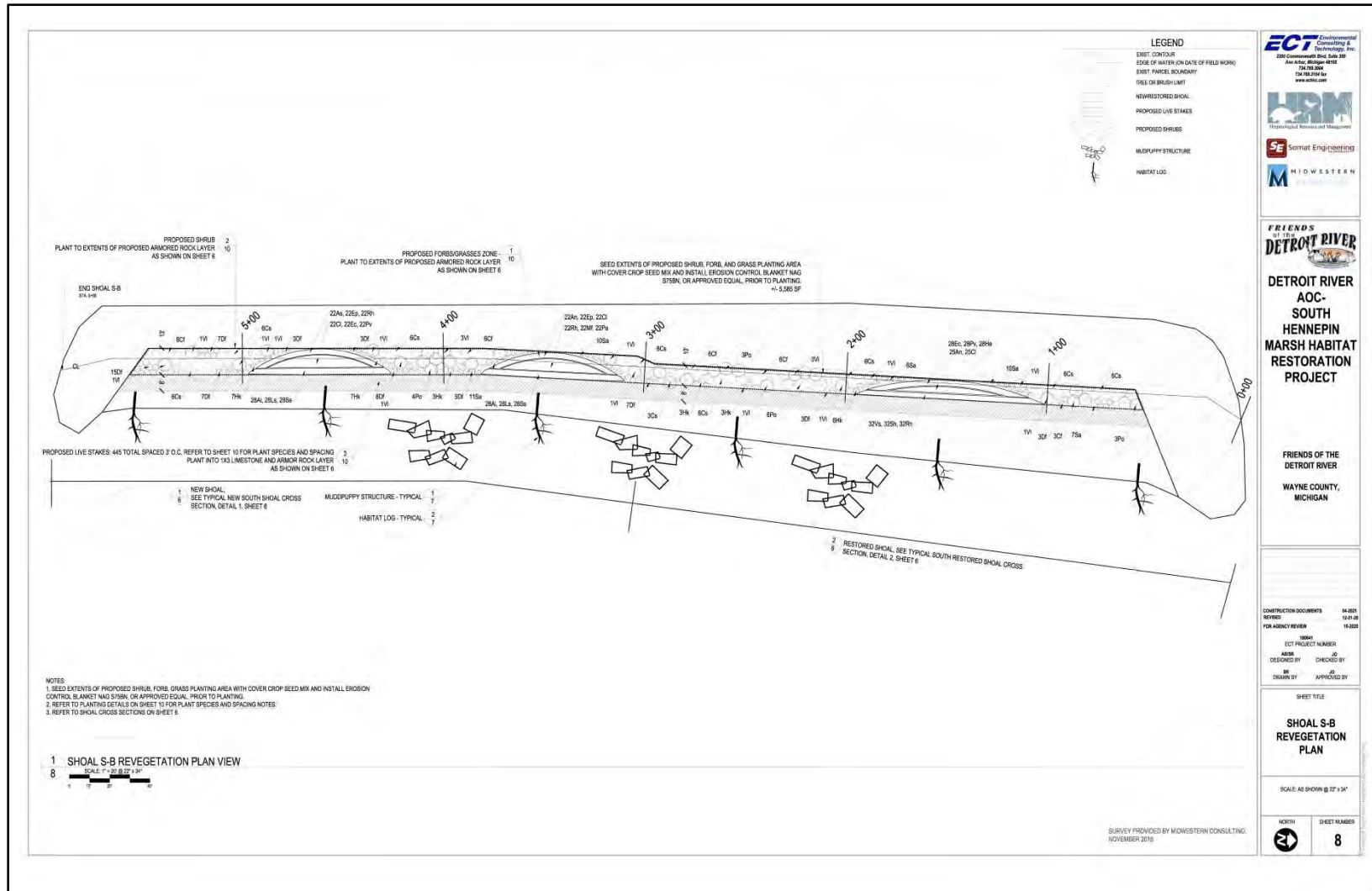


Figure 1. Construction design of the southern Hennepin Marsh shoal restoration including basking log and habitat refugia placement.







## Tables

Table 1. Hennepin Marsh potential herpetofauna, species observed during the 2020 pre-restoration and 2023 post-restoration surveys, and their respective conservation status.

Common Name	Species Name	Potential	Observed 2020	Observed 2023	Status
Bullfrog	<i>Rana [Lithobates] catesbeiana*</i>	-	X	X	-
Green Frog	<i>Rana [Lithobates] clamitans*</i>	-	X	X	-
Wood Frog	<i>Rana sylvatica*</i>	X	-	-	-
Northern Leopard Frog	<i>Rana [Lithobates] pipiens</i>	X	-	-	-
Eastern American Toad	<i>Bufo [Anaxyrus] americanus americanus**</i>	-	X	-	-
Northern Spring Peeper	<i>Pseudacris crucifer crucifer</i>	X	-	-	-
Midland Chorus Frog	<i>Pseudacris triseriata</i>	X	-	-	-
Gray Treefrog	<i>Hyla versicolor/ chrysoscelis</i>	X	-	-	-
Northern Mudpuppy	<i>Necturus maculosus maculosus</i>	X	-	-	Special Concern
Butler's Garter Snake	<i>Thamnophis butleri</i>	X	-	-	Special Concern
Eastern Garter Snake	<i>Thamnophis sirtalis sirtalis</i>	X	-	-	-
Eastern Fox Snake	<i>Pantherophis gloydi</i>	X	-	-	State Threatened
Northern Brown Snake	<i>Storeria dekayi dekayi</i>	X	-	-	-
Northern Water Snake	<i>Nerodia sipedon sipedon</i>	-	X	-	-
Eastern Spiny Softshell Turtle	<i>Apalone spinifera spinifera</i>	X	-	-	-
Eastern Snapping Turtle	<i>Chelydra serpentina serpentina</i>	-	-	X	-
Midland Painted Turtle	<i>Chrysemys picta marginata</i>	-	X	X	-
Northern Map Turtle	<i>Graptemys geographica</i>	-	X	X	-
Blanding's Turtle	<i>Emydoidea blandingii</i>	-	X	-	Special Concern
Red-eared Slider	<i>Trachemys scripta elegans</i>	-	-	X	-
Eastern Musk Turtle	<i>Sternotherus odoratus</i>	X	-	-	-



## Photos



Photo 1. Hennepin North Marsh showing emergent marsh vegetation establishing.



Photo 2. Hennepin North Marsh submergent and floating leaf vegetation provide critical habitat for herpetofauna.



Photo 3. Presence of invasive *Phragmites* within Hennepin North Marsh.



Photo 4. Eroded barrier island observed in 2020 providing little ecological value.





Photo 5. Hennepin South Marsh following restoration activities.



Photo 6. Emergent and floating leaf vegetation observed post restoration in Hennepin South Marsh.



Photo 7. Hennepin South Marsh habitat present for herpetofauna.



Photo 8. Upland edge, emergent marsh, floating leaf vegetation and submergent vegetation present within Hennepin South Marsh. This area provides additional critical amphibian and reptile habitat.





Photo 9. Vegetated shoal within restoration area providing refugia for herpetofauna and other wildlife.



Photo 10. Throughout the course of HRM's 2023 surveys, the shoal botanical richness increased and provided additional cover for species.





Photo 11. Upland herbaceous vegetation and basking logs provide cover and thermal regulatory opportunities for herpetofauna.



Photo 12. Flat sections of limestone observed in the water alongside a shoal providing cover and nesting habitat for the Northern Mudpuppy (*Necturus maculosus maculosus*) and various fish species.





Photo 13. A Midland Painted Turtle (*Chrysemys picta marginata*) basking within the restoration area.



Photo 14. A Red-eared Slider (*Trachemys scripta elegans*) observed basking amongst several Northern Map Turtles (*Graptemys geographica*) on a habitat log placed alongside a shoal.





Photo 15. Even small branches can provide much needed basking opportunities for turtles and other reptiles, such as this male Northern Map Turtle.



Photo 16. A female Northern Map Turtle observed on a shoal. This individual may have been searching for a nesting site.





Photo 17. Male Northern Map Turtle basking on large limestone riprap.



Photo 18. Large female Northern Map Turtle observed basking on a fallen tree limb.





Photo 19. Heavy usage of the shoals by shoreline bird species prior to vegetation establishment may have limited the use of the area for herpetofauna early season.



Photo 20. Heavy use of shoals by waterfowl and shoreline birds results in excessive guano or fecal loading of the land.





Photo 21. Abundant wildflowers and diverse upland plant communities observed on the created shoals following growing season development.



Photo 22. A Monarch Butterfly (*Danaus plexippus*) and bumblebee (*Bombus* spp.) observed pollinating wildflowers on a shoal.





Photo 23. *Phragmites* continues to be problematic and continued restoration targeting this invasive species is encouraged.



Photo 24. Habitat complexity is an important part to maintaining diverse communities.



## Species Summaries

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



The Eastern Fox Snake is a state threatened species in Michigan protected by Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act, administered by the Michigan Department of Natural Resources (Michigan Department of Natural Resources 1994). The species is listed as endangered throughout Canada. 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). As a large-bodied snake species, Eastern 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, Eastern 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. Eastern 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).

## 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 is currently being considered for federal protection (U.S. Fish & Wildlife Service 2015). 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 (Ernst and Lovich 2009, Harding and Mifsud 2017).

## Northern Mudpuppy (*Necturus maculosus maculosus*)



In Michigan, the Mudpuppy is listed as a species of special concern and protected under the MDNR Fisheries Order 224.16 (Michigan Department of Natural Resources 2016). Mudpuppies are an entirely aquatic salamander that 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 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).

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