

Surveys for the Eastern Massasauga (*Sistrurus catenatus*) in the Huron–Manistee National Forests: FY 2022 Report



Prepared By:
Yu Man Lee
Michigan Natural Features Inventory
Michigan State University Extension
P.O. Box 13036
Lansing, MI 48901-3036

Prepared For:
Michigan Department of Natural Resources
Forest Resources Division (DO 220000010165)

31 December 2022

MNFI Report No. 2022-53

Suggested Citation:

Lee, Y. 2022. Surveys for the Eastern Massasauga (*Sistrurus catenatus*) in the Huron-Manistee National Forests: FY 2022 Report. Michigan Natural Features Inventory, Report No. 2022-53, Lansing, MI. 21 pp.

Copyright 2022 Michigan State University Board of Trustees. MSU Extension programs and materials are open to all without regard to race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, marital status or family status.

The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the Huron-Manistee National Forests or the U.S. Forest Service. Mention of trade names or commercial products does not constitute their endorsement by the Huron-Manistee National Forests or U.S. Forest Service.

Cover:

Background Photo: Leatherleaf bog and suitable habitat for eastern massasaugas at a site in Lake and Mason counties in the Huron-Manistee National Forests.

Photo by Reine Sovey.

Snake Photo: Eastern massasauga rattlesnake (*Sistrurus catenatus*). Photo by Joseph Sage.

Table of Contents

Introduction	1
Project Objectives	1
Methods	2
Results	5
Discussion	19
Acknowledgements	20
References	21

List of Figures

Figure 1. Map of eastern massasauga survey areas in the Mio Ranger District of the Huron-Manistee National Forests (HMNF) in 2022	3
Figure 2. Map of eastern massasauga survey areas in the Cadillac/Manistee Ranger District and Baldwin/White Cloud Ranger District of the HMNF in 2022	4
Figure 3. Photos of eastern massasauga sightings and their habitat in the HMNF in 2022.....	15
Figure 4. Photos of suitable habitats for eastern massasaugas in the HMNF in 2022	16
Figure 5. Photos of rare reptile species found during eastern massasauga surveys in the HMNF in 2022	17
Figure 6. Photos of common/non-listed amphibian and reptile species found during eastern massasauga surveys in the HMNF in 2022.....	18

List of Tables

Table 1. Summary of eastern massasauga and other rare reptile observations and element occurrences (EOs) documented in the HMNF in 2022	6
Table 2. Description of sites/areas surveyed for eastern massasaugas in the HMNF in 2022.....	7

Introduction

The eastern massasauga (*Sistrurus catenatus*) has been listed as a federally threatened species by the U.S. Fish and Wildlife Service (USFWS) (USFWS 2016). As such the U.S. Forest Service (USFS), Huron-Manistee National Forests (HMNF) is managing habitats to conserve this species. This species also is currently listed as a species of special concern in Michigan and a priority Species of Greatest Conservation Need (SGCN) in Michigan's Wildlife Action (Derosier et al. 2015). Michigan is considered to be the last stronghold for this species with more historical and extant populations than any other state or province in the species' range (Szymanski 1998, Szymanski et al. 2015). However, eastern massasauga populations in Michigan have declined due to a number of threats including habitat loss, degradation and fragmentation as well as direct mortality or loss of individuals due to collection, persecution, vehicular traffic, habitat management activities, and disease (Szymanski 1998, Szymanski et al. 2015). Many of the remaining eastern massasauga populations in Michigan occur on public land including the HMNF. Efforts to manage and maintain massasauga populations within the HMNF are critical to conservation and recovery of this species in Michigan and rangewide.

Additional information on the status and distribution of eastern massasaugas within the HMNF is needed to inform and guide the Forests' efforts to manage and conserve this species as well as other forest and wildlife management activities. Eastern massasaugas have been documented at a small number of locations across the HMNF. However, the species has not been reconfirmed at several of these locations for over 10-20 years. Several of these locations are based on observations of a single snake which have not been verified with photo documentation. Potential exists for massasauga populations to still exist at these locations and for additional populations to occur given availability of suitable massasauga habitat in other areas within the HMNF. Additional targeted surveys for the eastern massasauga are needed to obtain current information and enhance our knowledge and understanding of the status and distribution of this species within the HMNF. Understanding the distribution will help the HMNF target habitat improvement activities. This project helps address these needs. This report summarizes project activities and results in 2022.

Project Objectives:

The goal of this project was to assist the HMNF with obtaining current information and enhancing knowledge and understanding of the eastern massasauga's status and distribution within the HMNF. This project addressed the following objectives:

- 1) Work with USFS HMNF staff to identify and select priority areas for massasauga surveys within the Forests.
- 2) Conduct targeted surveys for the eastern massasauga in select priority areas within the HMNF to determine and assess species presence and availability of suitable habitat for the species.
- 3) Provide results of surveys and any additional available information on the presence of eastern massasaugas and/or suitable habitat for the species to the HMNF to inform management.
- 4) Update information on populations of the eastern massasauga and other rare species within the HMNF in the Michigan Natural Heritage Database (NHD).

Methods

MNFI worked with HMNF staff to identify and select priority areas to survey for eastern massasauga rattlesnakes (EMRs) within the HMNF. MNFI and HMNF staff compiled and reviewed information on previously documented occurrences of massasaugas within the Forests, availability of suitable or potential habitat for the species, priority areas for management within the HMNF, and available resources (i.e., time and funding) for the surveys. Available information and resources that were reviewed to identify priority areas for surveys included the following: 1) eastern massasauga occurrences in the Michigan Natural Heritage Database, the Michigan Herp Atlas, and HMNF NRM Wildlife Database; 2) information or study results from other researchers working in the HMNF (i.e., Grand Valley State University); 3) population and/or habitat models for massasaugas that have been developed by MNFI, HMNF, and other researchers including population delineation and prioritization models and cost-weighted distance analysis developed by MNFI (Lee and Enander 2015, Lee 2019), EMR species distribution models developed by Eric McCluskey (McCluskey 2016 and 2020), an EMR Tier 1/Tier 2 habitat model developed by USFWS (USFWS 2017), and an EMR potential habitat model developed by the HMNF (HMNF 2019); 4) aerial imagery and land cover maps; and 5) maps of priority areas for surveys and/or management provided by HMNF including massasauga conservation habitat areas and oak savanna restoration areas. MNFI and HMNF staff identified and selected priority areas for massasauga surveys in the Mio, Cadillac/Manistee, and Baldwin/White Cloud Ranger Districts in 2022.

Visual encounter surveys were conducted in 2022 to document presence of massasaugas and assess availability and quality of suitable habitat for massasaugas. Surveys were conducted in seven areas in Crawford and Oscoda counties in the Mio Ranger District, three areas in Manistee and Mason counties in the Cadillac/Manistee Ranger Districts, and four areas in Lake, Newaygo, and Oceana counties in the Baldwin/White Cloud Ranger Districts (Figures 1 and 2). Multiple locations or sites were surveyed within each of the survey areas. Surveys in 2022 were conducted from June 16–July 8 with additional surveys from August 2–30. Surveys in June focused on surveying for massasaugas in wetland habitats including northern wet meadows, northern shrub thickets, bogs, emergent marshes, and forested swamps. Surveys in August focused on the same wetland habitats as well as open, upland habitats, such as oak savannas, in which gravid females could utilize for gestation and/or parturition. Surveys were conducted during appropriate weather conditions when massasaugas would likely be basking and/or moving on the surface.

Visual encounter surveys primarily consisted of two–three observers, and occasionally four–seven observers, walking slowly through areas with suitable habitat looking for massasaugas basking, resting, or moving on the ground, in vegetation, and/or on or under woody debris or other cover objects. Due to the cryptic nature of this species, most survey areas were visited multiple times (i.e., 2–4 times) during the survey period. Information on survey effort (e.g., surveyor names, times and duration of surveys, and survey locations/routes), weather conditions, number and locations of massasaugas observed, observations of other amphibian and reptile species, and habitat conditions were recorded during surveys using a Survey 123 data form. Species and habitats observed during surveys were photographed. During the late summer surveys, massasaugas encountered in the field were captured, aged (i.e., adult, juvenile, neonate), marked by inserting a PIT tag under the skin (lower left side of the body), visually inspected for snake fungal disease, and released at initial capture site after processing was completed. Observations of eastern massasaugas and other rare amphibian and reptile

species documented during the massasauga surveys were entered into the Michigan NHD to identify new and update existing element occurrence records of these species.

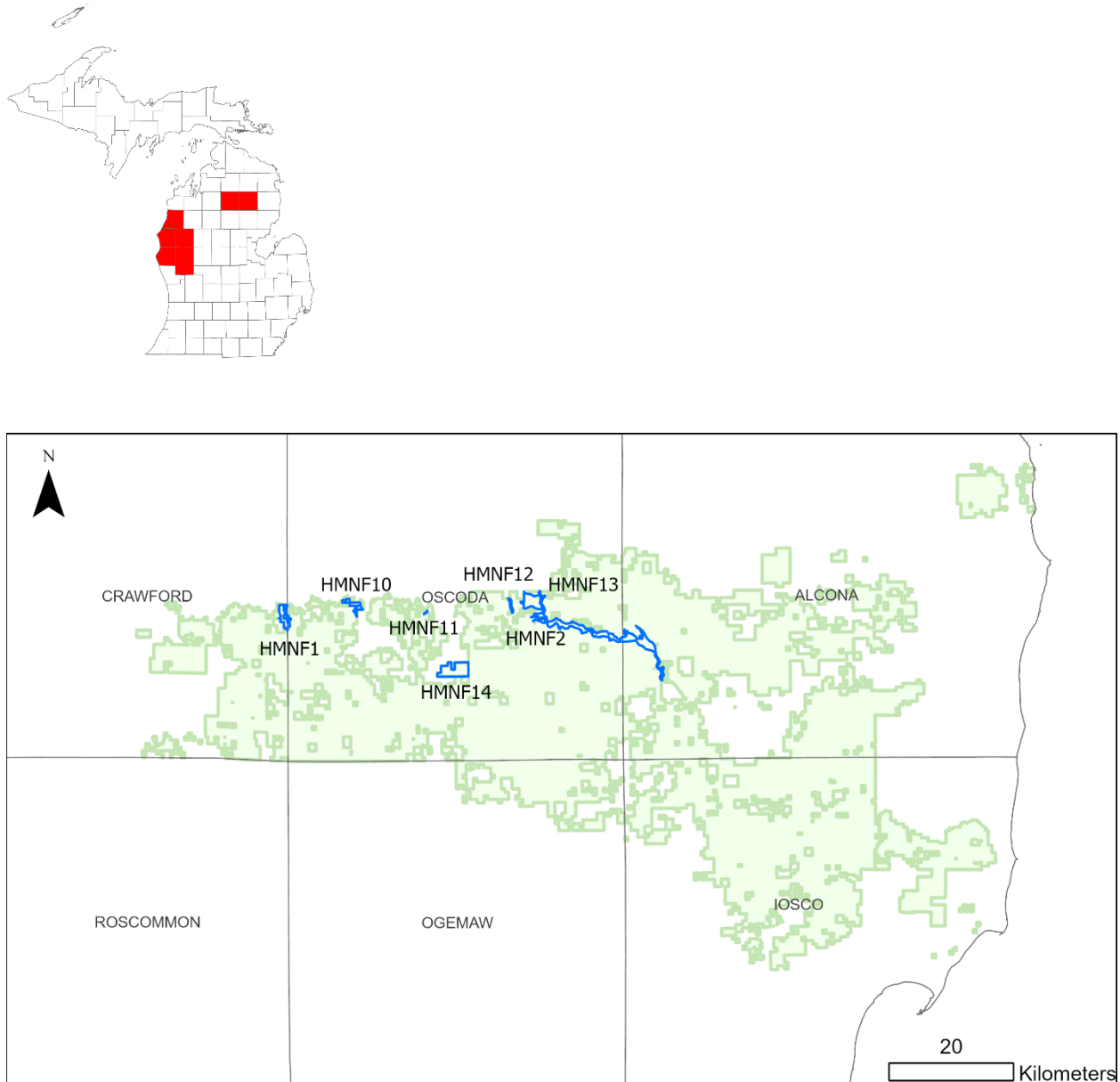


Figure 1. Map of eastern massasauga rattlesnake (EMR) survey areas (blue polygons) in the Mio Ranger District in the Huron-Manistee National Forests (green polygon) in 2022. (Names/site codes of the survey areas are indicated next to the survey areas.)

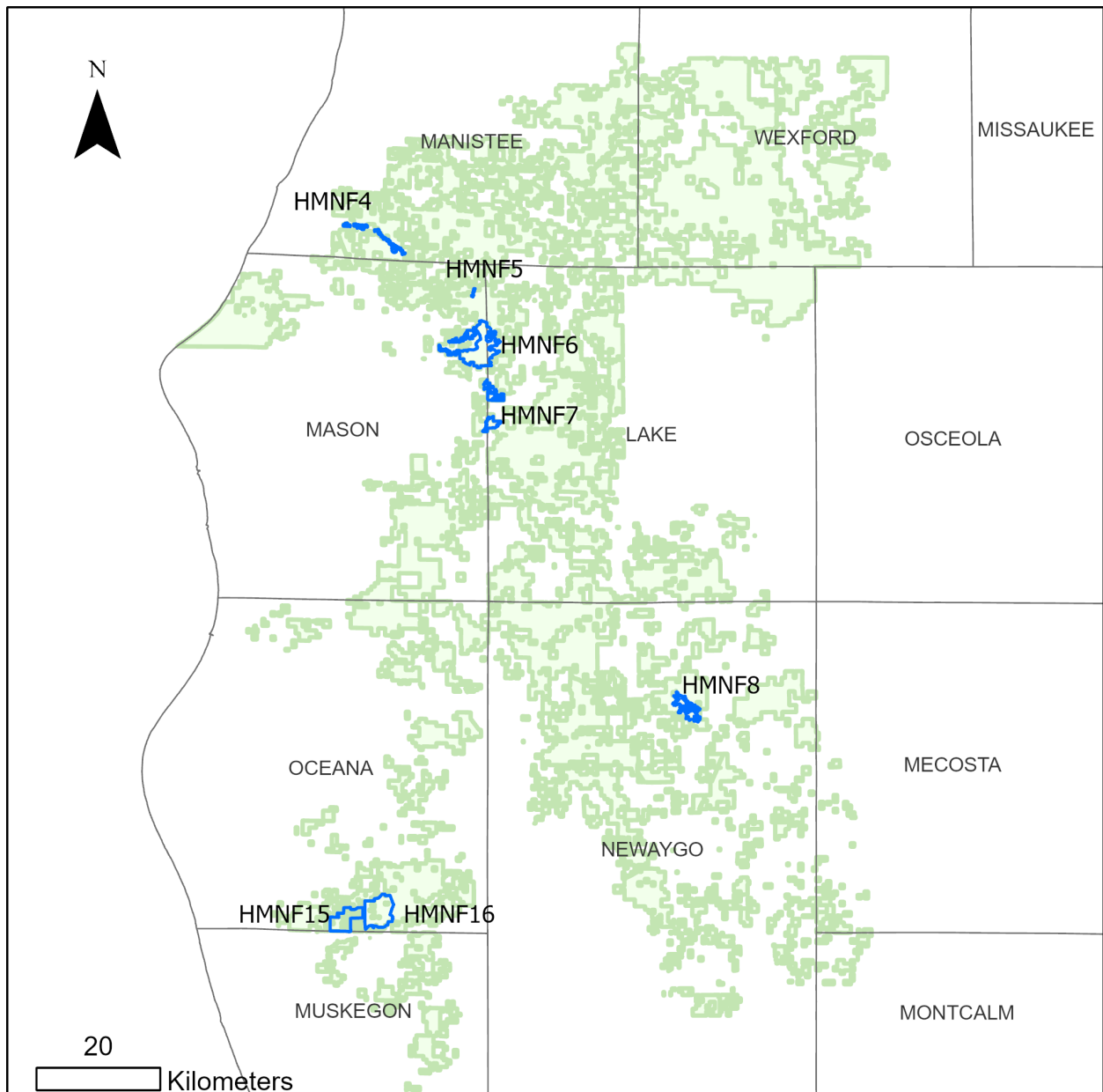


Figure 2. Map of eastern massasauga rattlesnake (EMR) survey areas (blue polygons) in the Cadillac/Manistee Ranger District and Baldwin/White Cloud Ranger District in the Huron-Manistee National Forests (green polygon) in 2022. (Names/site codes of the survey areas are indicated next to the survey areas.)

Results

A total of 18 eastern massasaugas were documented in three survey areas during MNFI's 2022 surveys in the HMNF (Table 1, Figure 3). Thirteen massasaugas were found at two locations within the HMNF4 survey area, with two adult snakes and four neonates/juveniles found on August 24 at one location and two adults and five neonates found on August 26 at a second location within this survey area (Table 1). These snakes were found in wet meadow habitats. These observations updated a known element occurrence (EO) of eastern massasaugas that had been documented in the area (EO ID 2882) in the Michigan Natural Heritage Database (NHD), which had been recently updated in 2021 (Table 1) (MNFI 2022).

Eastern massasaugas also were documented within HMNF7 and HMNF8 survey areas in 2022. Within the HMNF7 survey area, two massasaugas were documented on June 27, one massasauga was documented on July 1, and one snake was found on August 8 (Table 1, Figure 3). These snakes were found at three different locations within the survey area. These observations updated and expanded a known massasauga EO in the NHD (EO ID 17114) that had been recently reconfirmed in 2021 (Table 1) (MNFI 2022). Additionally, one massasauga was found in the HMNF8 survey area on July 6 (Table 1, Figure 3). This observation reconfirmed and expanded a known EO of this species in the NHD (EO ID 14035) that had been last documented or reported from this site twenty years ago in 2002 (Table 1) (MNFI 2022). The massasaugas found within the HMNF7 and HMNF8 survey areas were observed in bogs dominated by sphagnum moss, leatherleaf (*Chamaedaphne calyculata*), and *Vaccinium* shrubs. Suitable habitats for massasaugas were found in many of the areas surveyed in 2022 (Table 2, Figure 4).

Additionally, three rare reptile species were documented during the HMNF eastern massasauga surveys in 2022 (Table 1, Figure 5). Five adult wood turtles (*Glyptemys insculpta*, state special concern) were documented at several locations within two of the survey areas (HMNF1 and HMNF4) (Table 1). One spotted turtle (*Clemmys guttata*, state threatened) was found in one survey area (HMNF7) (Table 1, Figure 5). Seven smooth green snakes (*Opheodrys vernalis*, state special concern) were observed at several locations within two survey areas (HMNF10 and HMNF13) (Table 1). All these observations represented updates of previously documented element occurrences of these species in the Michigan Natural Heritage Database except for the smooth green snake observation in HMNF10 and the spotted turtle observation in HMNF7 which represented new EOs (Table 1) (MNFI 2022).

In addition to rare species, over 200 observations of nineteen common or non-listed amphibian and reptile species were documented during the massasauga surveys in 2022. These included eastern garter snakes (*Thamnophis sirtalis sirtalis*), northern ribbon snakes (*Thamnophis saurita septentrionalis*), eastern hog-nosed snakes (*Heterodon platirhinos*), ring-necked snakes (*Diadophis punctatus*), blue racers (*Coluber constrictor foxii*), northern water snakes (*Nerodia sipedon sipedon*), a northern red-bellied snake (*Storeria occipitomaculata*), a DeKay's brown snake (*Storeria dekayi*), an eastern milk snake (*Lampropeltis triangulum triangulum*), five-lined skinks (*Plestiodon fasciatus*), blue-spotted salamanders (*Ambystoma laterale*), a four-toed salamander (*Hemidactylium scutatum*), eastern red-backed salamanders (*Plethodon cinereus*), green frogs (*Lithobates [Rana] clamitans*), wood frogs (*Lithobates [Rana] sylvaticus*), spring peepers (*Pseudacris crucifer*), an eastern gray treefrog (*Hyla versicolor*), northern leopard frogs (*Lithobates [Rana] pipiens*), and American toads (*Anaxyrus americanus*) in wetland and upland habitats that were surveyed (Table 2, Figure 6).

Table 1. Summary of observations and element occurrences (EOs) of eastern massasaugas and other rare reptile species documented during MNFI's surveys for eastern massasaugas in the Huron-Manistee National Forests in 2022.

EO ranks are defined as follows: AB – Excellent or good estimated viability; AC – Excellent, good or fair estimated viability; BC – Good or fair estimated viability; BD – Good, fair, or poor estimated viability; and E – Extant, insufficient information to estimate viability.

Species	Scientific Name	Federal Status	State Status	HMNF Survey Area Site ID	Dates and Number of EMR Observations	EO ID	EO Number	First Observed Date	Last Observed Date Prior to MNFI's 2022 Surveys/ Observations	EO Rank
Eastern Massasauga	<i>Sistrurus catenatus</i>	LE	SC	HMNF7	6/27/2022 - 2 7/1/2022 - 1 8/8/2022 - 1	17114	283	2001	2022 (HMNF)	BC
Eastern Massasauga	<i>Sistrurus catenatus</i>	LE	SC	HMNF8	7/6/2022 - 1	14035	259	2002	2002	BD
Eastern Massasauga	<i>Sistrurus catenatus</i>	LE	SC	HMNF4	8/24/2022 - 6 8/26/2022 - 7	2882	138	1989	2022 (HMNF)	AB
Wood Turtle	<i>Glytemys insculpta</i>		SC	HMNF4	8/24/2022 - 1 8/25/2022 - 2 8/29/2022 - 1	9559	43	1979	2022	AC
Wood Turtle	<i>Glytemys insculpta</i>		SC	HMNF1	6/19/2022 - 1	26165	321	2022	2022	E
Spotted Turtle	<i>Clemmys guttata</i>		T	HMNF7	7/1/2022 - 1	26381	191	2022	-	E
Smooth Green Snake	<i>Opheodrys vernalis</i>		SC	HMNF13	06/17/2022	24947	24	2021	2021	E
Smooth Green Snake	<i>Opheodrys vernalis</i>		SC	HMNF10	8/18/2022 - 1 8/19/2022 - 5	26380	25	2022	-	E

Table 2. Description of the sites/areas surveyed for eastern massasaugas in the Huron-Manistee National Forests in 2022.

Site Name	Dates Surveyed	Notes
HMNF1	6/19 - 6/20	Surveyed northwest portion of survey area. Excellent site condition. Suitable habitat for EMRs. Other herp species found included wood turtle, northern water snake, eastern garter snakes, eastern hog-nosed snakes, American toads, wood frogs, northern leopard frog, and green frog. Recommend for further surveys.
HMNF2 (West)	8/16, 8/19	Cedar swamp dominated by white cedar and balsam fir. The cedar swamp was carpeted with sphagnum moss, which forms large hummocks in some areas. Northern wet meadow pockets with adjacent open uplands/old farm fields and forested uplands including a red pine plantation and northern hardwoods. Suitable habitat for EMRs. Average to excellent site condition. Other herp species found included green frogs and eastern garter snake. Recommend for further surveys.
HMNF4	8/24 - 8/26, 8/29 - 8/30	Cedar swamps adjacent to wet meadows with fine sedges, grass of Parnassus, and sphagnum moss. Open sedge meadows with grasses, cattails, alder, Joe-pye weed, some cedar trees. Some areas with goldenrod, thistle, stinging nettle, grass, milkweed, occasional alder, cedar, white pine, and some woody debris. Some open uplands nearby including oak-pine barrens. Survey locations ranged from average, good, to excellent condition. Other herp species found included wood turtles, northern water snake, northern ribbon snake, brown snake, eastern garter snake, eastern hog-nosed snake, northern ring-necked snake, American toads, five-lined skinks, and red-backed salamander. Recommend for further surveys.
HMNF5	6/29 - 6/30	Bottomland hardwood swamp that was periodically flooded and surrounded by jack pine and fine sedges. Sparse open areas with sedges and plenty of fallen logs/woody debris. Many areas of bordering woods had fairly sparse jack pine stands with potential basking and cover opportunities. Lot of snake observations. Other herp species found included eastern hog-nosed snakes, ring-necked snake, northern ribbon snakes, blue racer, five-lined skinks, American toads, and blue-spotted salamander. Good to excellent site condition. Recommend for further surveys.

HMNF6	8/11	<p>Hardwood swamps and emergent marshes consisting mainly of cattails and reeds, with Joe-pye weed, various ferns, scattered and sparse hardwoods. Middle of cattail marsh has water and muck greater than ankle deep. Vegetation was dense and there were very few exposed dry areas. Snakes might be able to get up into cattails to bask. Forested areas and wetland edges might be more suitable for EMRs. Uplands to the east consisted of sugar maple, hemlock, and eastern white pine, paper birch, oak, and bigtooth aspen. Wetland edge was a mix of cattail and cinnamon fern. Crayfish burrows were present. Farther north along this edge was a nice pocket of lowland hemlock forest that transitions into the swamp to the east. Lots of sphagnum hummocks, woody debris, and exposed root systems. Dappled sunlight. Western edge of swamp consisted of a brief hemlock lowland adjacent to uplands that transitioned into a hardwood swamp along a creek with white pine, yellow and paper birch, and sugar maple, which provided a good mix of shade and dappled sun. Lots of sphagnum hummocks and downed trees. Ground cover is mostly cinnamon fern, sedges, and forbs. Crayfish burrows present. Good to fair site condition. Other herp species found included blue racer, green frog, spring peeper, and red-backed salamander. Recommend for further surveys.</p>
HMNF7	8/10	<p>Surveyed multiple locations/sites within this survey area. This location consisted of a hardwood swamp with mostly sugar and silver maple, with some oaks, basswood, musclewood, and elm. Very few shrubs. Ground cover was an open mix of sedges, ferns, and forbs. Crayfish burrows were observed. Several pockets of buttonbush swamp. Not sure if there enough refugia here for EMRs and how high the water level gets in the swamp. Uplands were oak-maple and quaking aspen with thick bracken fern. The lowlands surveyed were completely dry. The ground in the lowland spots was covered in dense sedge. Average to fair site conditions. Other herp species found included northern ribbon snake, blue racer, wood frog, American toad, green frogs, spring peeper, and eastern red-backed salamander. Recommend for further surveys.</p>

HMNF7

6/27 - 6/28, 7/1,
8/8, 8/12

Surveyed multiple locations/sites within this survey area. Large leatherleaf-sphagnum moss bog towards the center of the survey area, with a portion of the bog west of an open central pond. Sphagnum, leatherleaf and Vaccinium bog, excellent basking opportunities on hummocks and good refugia among sphagnum and shrubs. Portions of the bog with a much larger sedge/rush component, with tawny cotton grass and three way sedge becoming quite dominant in some areas. Forested area adjacent to bog is comprised mostly of jackpine with a thin carpeting layer of sphagnum moss, small more elevated pockets with blueberries, cinnamon fern, and sedges. This area was very dry at the time of the survey but appears to get pretty wet at some point in the year. Southwesternmost bog was a sphagnum bog with leatherleaf and tawny cotton grass. Center of bog looked decent, with good leatherleaf thicket and big hummocks but area was small. Most of the bog was more open, with grasses/sedges rather than leatherleaf. The hummocks here were much less pronounced and were farther apart. Most of the bog was relatively flat, not offering much potential refuge. This portion of the bog seemed less suitable for massasaugas, but may still be used. Average, good to excellent condition depending on the location. Other herp species observed included spotted turtle, blue racers, northern ribbon snakes, eastern garter snake, eastern milk snake, northern leopard frogs, American toads, green frog, and wood frog. Recommend for further surveys.

HMNF7	7/1, 8/9, 8/12	<p>Surveyed multiple locations/sites within this survey area. One location comprised of maple, speckled alder, poison sumac, birch, aspen, ferns, sedge, sphagnum moss, cedar, spruce, cattail forming a complex matrix with plenty of open patches for EMRs. Excellent EMR habitat. Another location was a large U-shaped sphagnum bog with leatherleaf and tawny cotton grass, some young white pine, tamarack, and black spruce. Sphagnum hummocks were shorter than in other bogs in the area, and the shrubs were less dense. The southern edge of the bog was much wetter, with some thin floating vegetation mats. The sparser shrub cover and reduced hummock complexity was the reason for this bog being good and not excellent. Another location surveyed consisted of a swamp with open areas of thick cattail and fern, poison sumac, willow, and dogwoods. Habitat looked suitable for massasaugas although chances of observation seemed low given how thick vegetation was. Dense southern part of the swamp was comprised of large tamaracks and white cedars with musclewood, basswood, maple, and alder present in understory. Ground was very nice and open with small sedge tussocks and ferns. Lots of woody debris, moss hummocks, and exposed roots could provide ample shelter for EMRs. Very promising EMR habitat. Great dappled sunlight. Had a pocket of cedar swamp forest. Good to excellent site conditions. Other herp species found included northern ribbon snakes, wood frogs, American toads, and a red-backed salamander. Recommend for further surveys.</p>
HMNF8	7/5 - 7/8	<p>Surveyed multiple locations within this survey area. Wetland mosaics with fen-like areas, peat bogs, and sedge meadow mosaics near the road. One location was a forested area along creek with sedge tussocks, sparse speckled alder, and tamarack plus downed woody debris for cover. Another location was a nice speckled alder stand grading into cedar with frequent open patches. A third location had thick, waist-high sedge and speckled alder saplings, with average-good conditions for EMR but difficult to survey effectively. Forest was dry red pine in upland, graded into wet cedar stand with a corridor of large ferns that might seasonally flood. Also couple of leatherleaf-sphagnum bogs and a marsh with no standing water dominated by sedges, seasonally flooded. Average, good to excellent site condition depending on location. Other herp species observed included northern ribbon snake, eastern hog-nosed snake, wood frogs, American toads, four-toed salamander, red-backed salamander, and spring peepers. Recommend for further surveys.</p>

HMNF8

8/2, 8/4 - 8/5

Surveyed multiple locations within this survey area. Westernmost open upland along the road was an open sand prairie with sweet fern and choke cherry. Area was decently far from nearby wetlands and had limited shrub cover. Another small open uplands adjacent to the road had mediocre habitat for EMRs. North of the road through the woods a few hundred feet was an intermittent wetland with mostly sedges or rushes in the center, sphagnum moss, and interspersed pockets of leatherleaf. The south side of the wetland was a glade of jack pine with open sedgy ground cover. Habitat looked promising for massasaugas, although the wetland was completely dry at this time of year. Potentially could be used by massasaugas. Third location surveyed was a sphagnum bog with leatherleaf that seemed to be suitable EMR habitat with open areas for basking as well as thicker shrubs for refuge. Small portion at center of bog had water lillies and is floating. Fourth survey location was a lowland forest / shrub wetland matrix. Forested areas had white cedar, maple, oak, quaking aspen for canopy cover with sphagnum moss, dogwood, cinnamon and bracken fern, and sedges on the ground. Shrubby areas varied between speckled alder thickets and cattail/fern swamp with aspens interspersed. Sphagnum hummocks and good root systems were abundant. There appeared to be suitable habitat for massasaugas. Surveying was difficult in many spots due to shrub or fern density, either physically or visually obstructing surveys. Fifth survey location was a huge leatherleaf bog with tamaracks and several other conifers throughout the bog, and the margin of the bog was much shrubbier, containing alder, cinnamon and sensitive ferns, cattails, and blueberries. The northern and western margins of the bog transitioned into a diverse cattail marsh with poison sumac, dogwood, cinnamon fern, sapling maples and aspens, and sphagnum hummocks. Habitat looks great for EMRs. Average, good to excellent site condition depending on location. Other herp species observed included northern ribbon snakes, blue racer, spring peepers, wood frogs, American toads, and red-backed salamander. Recommend for further surveys.

HMNF10	6/16, 8/17 - 8/19	<p>Surveyed multiple locations within this survey area. Surveyed habitats included upland jack pine barrens, lots of downed logs and shrubs for cover, mostly open interspersed with jack pine, probably good habitat for gestating females. Also typical red pine stand with bracken fern and Vaccinium. Could be good gestation habitat. Another location had red pine, jack pine, cherry, oak, and spruce dominant and lot of woody debris. Potential massasauga habitat. A couple locations with abundant woody debris and downed trees to provide cover and gestation/parturition habitat for EMRs but no wetlands nearby. Poor, fair, average to good site condition depending on survey location. Other herp species observed included smooth green snakes, red-backed salamanders, blue-spotted salamander, and American toad. Recommend further surveys in sites near wetlands.</p>
HMNF11	6/17	<p>Dense reed canary grass along margin of creek to the south. Lots of tall, sparse alder and open forest pockets along creek. Average site condition. Other herp species observed included red-bellied snake, northern leopard frog, and American toad.</p>
HMNF12	6/18, 6/20, 8/15	<p>Habitats surveyed included conifer swamp with sphagnum moss hummocks, wet meadow, and open scrub shrub. Also upland conifer forested hill with nice open patches, possible gestation habitat. Excellent site condition. Other herp species found included eastern hog-nosed snake, eastern garter snake, wood frogs, and American toads. Recommend for further surveys.</p>
HMNF13	6/17	<p>Some good open spots along creek, but many areas overgrown with dense shrubs or reed canary grass. Nice upland jack pine in forested area with moss hummocks and open glades. One of the good looking open spots toward the middle was actually a flooded beaver dam. Average site condition. Other herp species observed included smooth green snake, eastern hog-nosed snake, wood frog, and gray treefrog. Recommend for further surveys but lower priority.</p>

HMNF14

6/22 - 6/24

Surveyed multiple locations within this survey area. Priority 1 stands consisted of 1a) a shallow scrub-shrub swamp dominated by tall tag alders near the road, becoming drier and more forested with periodic openings farther from the road; 1b) matrix of wet open and shrubby habitat with much of this habitat flooded with a few inches to a foot of water, with several deeper channels as well as a few isolated dry pockets that could provide suitable EMR habitat but likely not sufficient to support EMRs; may be seasonally suitable for Blanding's turtles if it was a little deeper in the spring. There also was a cedar swamp with abundant sphagnum hummocks and small openings in the canopy within and just north of 1b, which was the best potential EMR habitat we located within the survey area. Along the road in the southern part of 1b was mainly thick cattail marsh, potential habitat for EMRs but mostly flooded, making it less than ideal. Stand 1c was a small stream corridor, mostly dense with shrubs and young trees with a few small open pockets scattered along the stream. The stream widened into shrubby wetlands with approximately ankle-deep, mucky water at either end of the unit. This area was likely too wet and shaded to be suitable for EMR. Priority 2 stands that were surveyed consisted of 2a) small open patch of sedge and reed canary grass along a stream, which looked decent for EMRs but its small size and relative isolation likely limits its value as EMR habitat; 2b) open areas in this stand heavily dominated by 4-6' tall reed canary grass, at least some of which appeared to be flooded earlier in the season, with a few smaller areas dominated by shorter sedges and look more suitable for EMRs and some of the surrounding forest was wet coniferous forest which could be suitable for EMRs as well; and 2c and 2d were similar, both consisting of a strip of sedge-dominated open habitat surrounding small areas of open water, and like 2b, these areas are likely more inundated earlier in the season. The terrestrial habitat here looked good for EMR, but these areas are small and isolated enough that occupation by EMR seems unlikely. Priority 3 stands were likely vernal pools or thick, shrubby swamps based on aerial imagery and field reconnaissance of some of these areas and were not likely suitable habitat for EMRs. Mostly poor to fair site conditions. Overall, our assessment is that EMR use of the surveyed stands is possible but unlikely. However, private property along a creek to the west of the surveyed stands and nearby cedar swamp may contain suitable habitat for EMRs. Other herp species observed included eastern garter snakes, wood frogs, green frogs, American toad, and blue-spotted salamanders.

HMNF15	8/23	Large barrens restoration. First stand was recently cut pine stand. Second survey location had oak, pine, aspen, bracken fern, and tall grass with woody debris piles. Short and sparse vegetation surrounded by pine stands. Average to good site condition. Unsure if EMRs occur in nearby wetlands or if they provide suitable wetlands for EMRs. Other herp species observed included a blue racer, five-lined skink, and red-backed salamanders. Recommend survey of nearby wetlands and further surveys of open uplands if nearby wetlands house EMRs and/or suitable habitat.
HMNF16	8/22	Surveyed upland areas. Lots of open areas with grass, ferns, with some aspen and oak and woody debris. Some areas more forested with oak and maple and small canopy gaps and pockets of adjacent wetlands. Other herp species observed included American toads and five-link skink. Poor, average to good site conditions for EMRs.

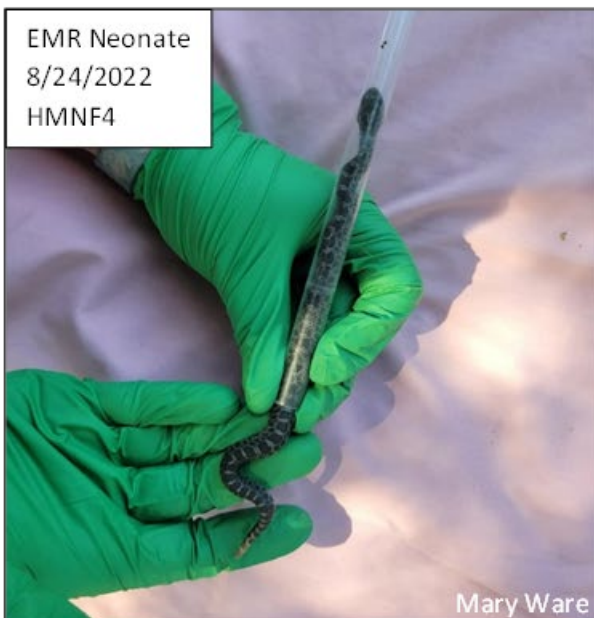


Figure 3. Photos of select eastern massasaugas observed during surveys in the Huron-Manistee National Forests in 2022 and the habitats in which some of them were observed.



Figure 4. Photos of suitable/potential wetland habitats for eastern massasaugas in the Huron - Manistee National Forests in 2022. These include a wet meadow (top left) and cedar swamp (top right) in HMNF2; a wet meadow in HMNF12 (center left); dry marsh in HMNF5 (center right); and wet meadows in HMNF14 (bottom left) and HMNF1 (bottom right). Photos taken by Justin Florkowski.



Figure 5. Photos of other rare reptiles found during eastern massasauga surveys in the Huron-Manistee National Forests in 2022. These include a smooth green snake found in HMNF13 (brown phase, top left), spotted turtle found in HMNF7 (top right), and a wood turtle found in HMNF4 (carapace and plastron, bottom left and right). Photos were taken by Reine Sovey and Justin Florkowski.



Figure 6. Photos of examples of common/non-listed amphibians and reptiles found during eastern massasauga surveys in the Huron-Manistee National Forests in 2022. These include an eastern hog-nosed snake (top left), northern ring-necked snake (top right), and five-lined skink (center left) found in HMNF5, American toad (bottom left) found in HMNF13, and adult blue racer (bottom center) and juvenile blue racer (bottom right) found in HMNF7. Photos were taken by Reine Sovey and Justin Florkowski.

Discussion

Surveys in the HMNF in 2022 were able to detect 18 eastern massasaugas in 3 (HMNF4, HMNF7, and HMNF8) of the 14 areas that were surveyed. These observations reconfirmed and expanded the known distributions of massasaugas in all three of these areas. The massasauga observation in HMNF8 was particularly significant because the species had not been reported from this site since 2002 prior to the surveys and observation in 2022. All three of these sites were surveyed in 2021 but surveys were more limited in the HMNF7 and HMNF8 survey areas. These results reiterate the need for repeated surveys over multiple years to detect massasaugas at some sites.

Documenting massasaugas in leatherleaf bogs also was an important and interesting finding from the massasauga surveys in the HMNF in 2022. The massasauga observed in the HMNF7 and HMNF8 survey areas were basking or resting on sphagnum moss hummocks in leatherleaf bogs. Massasaugas have been documented inhabiting bogs across the species' range (e.g., in Ohio, New York, and Ontario) but documented or verified massasauga observations in bogs in Michigan have been limited. Future surveys should continue looking for massasaugas in bogs.

Additional surveys in many of the areas that were surveyed in 2022 are warranted. Suitable habitat for massasaugas appears to be available and extensive in many of these areas. The eastern massasauga species distribution model developed by McCluskey (pers. comm.) also indicates additional areas within the HMNF with potential habitat for massasaugas including areas in which the species has not been documented. Based on availability and apparent quality of suitable habitat, potential exists for massasaugas to occur at these sites. Additional surveys also are warranted given the cryptic nature and low detectability of massasaugas, extensive available habitat, timing of the surveys, search effort, and/or shaded air temperatures during the surveys. Shaffer (2018) found that detection probability of eastern massasaugas was highest when surveyors spent over 90 minutes searching within a 2-ha area, and when minimum air temperatures ranged between 12.8 and 21.1°C (55-70°F). She also found that massasaugas were almost non-detectable on hot days (i.e., >25°C/77°F) (Shaffer 2018). Thacker (2020) found that shaded substrate temperature, survey Julian day of year, total search effort, and the total area of surveyed habitat have the greatest influence on detection of massasaugas. She recommended a minimum of 20 total person-hours/survey during spring egress when shaded substrate temperatures at the start of the survey are between 16-18°C (60-64°F) (Thacker 2020). She also found higher massasauga detection rates at sites with larger total areas (Thacker 2020). Crawford et al. (2020) reported reduced basking activity in massasaugas when shaded air temperatures are greater than 24°C (75°F). They recommended surveying with substrate temperatures between 16.7 and 30.2°C (62-86°F), mean minimum three-day average air temperatures of 15.9-19.7°C (60-67°F); and increased survey effort to a point (Crawford et al. 2020). These recommendations warrant further investigation across the massasauga's range and in different habitat types, but they provide some general guidelines to try to enhance detectability of this species. Additional surveys can help clarify the eastern massasauga's distribution within the HMNF. This information can help guide habitat management and conservation efforts for the eastern massasauga within the HMNF.

Acknowledgements

Funding for this project was provided by the Michigan Department of Natural Resources (MDNR) Forest Resource Division (FRD) under the Good Neighbor Authority agreement with the Huron-Manistee National Forests. I would like to acknowledge and thank Derek Cross with the MDNR FRD for serving as the project sponsor and providing support and assistance to help facilitate and ensure the success of this project. I also would like to acknowledge and thank Phil Huber, Scott Warsen, Patrick Laarman, Dana Meder, and Heather Keough with the USFS Huron-Manistee National Forests (HMNF) for their assistance with implementation of this project including identification of priority survey areas and providing maps and additional information on the survey areas. I would like to gratefully acknowledge and express my sincere appreciation to MNFI seasonal field technicians, Reine Sovey, Justin Florkowski, Mary Ware, Brianna Hukill, and Abigail Allen, as well as wildlife field technicians with the Baldwin/White Cloud and Mio Ranger Districts and other volunteers for assisting with massasauga surveys in the field. Finally, I would like to thank the following individuals for providing administrative and technical support and assistance with this project: Brian Klatt, Michael Monfils, Ashley Adkins, Sarah Carter, Deborah Richardson, and Courtney Ross with MNFI; Michigan State University Office of Sponsored Programs and Contract and Grant Administration; and Michigan State University Extension Grant Services Office. This project would not have been possible without the assistance and support provided by all the individuals included in this acknowledgement.

References

- Crawford, J.A., M.J. Dreslik, S.J. Baker, C.A. Phillips, and W.E. Peterman. 2020. Factors affecting the detection of an imperiled and cryptic species. *Diversity* 12(5):177.
- Derosier, A.L., S.K. Hanshue, K.E. Wehrly, J.K. Farkas, and M.J. Nichols. 2015. Michigan's Wildlife Action Plan. Michigan Department of Natural Resources, Lansing, MI.
- Huron-Manistee National Forests (HMNF). 2019. Shapefile of Massasauga Rattlesnake Potential Habitat and Conservation Habitat – NFS and Non-NFS Lands. Huron-Manistee National Forests, Supervisor's Office, Cadillac, MI.
- Lee, Y. 2019. Developing Management Plans for Core Eastern Massasauga Populations in Michigan – Phase II. Michigan Natural Features Inventory Report No. 2019-29, Lansing, MI. 50 pp.
- Lee, Y. and H.D. Enander. 2015. Developing an EMR Conservation Plan for Michigan – Phase I. Michigan Natural Features Inventory Report No. 2015–10, Lansing, MI. 51 pp.
- McCluskey, E.M. 2016. Landscape ecology approaches to Eastern Massasauga Rattlesnake conservation. Dissertation, Ohio State University, Columbus, USA.
- McCluskey, E.M. 2020. Shapefiles of Eastern Massasauga Species Distribution/Niche Models for Northern and Southern Michigan. Grand Valley State University, Allendale, MI.
- Michigan Natural Features Inventory (MNFI). 2022. Michigan Natural Heritage Database, Lansing, MI.
- Shaffer, S.A. 2018. Eastern massasauga rattlesnake population and habitat ecology in southern Michigan. Dissertation, Michigan State University, East Lansing, MI. 189 pp.
- Szymanski, J. 1998. Status Assessment for the Eastern Massasauga Rattlesnake, U.S. Fish and Wildlife Service, USA.
- Szymanski, J., C. Pollack, L. Ragan, M. Redmer, L. Clemency, K. Voorhies, and J. JaKa. 2015. Special status assessment for the Eastern Massasauga Rattlesnake (*Sistrurus catenatus*), U.S. Fish and Wildlife Service, USA.
- Thacker, A.J. 2020. Great Lakes snake: Estimating the occupancy and detection probabilities of the Eastern Massasauga Rattlesnake (*Sistrurus catenatus*). M.S. Thesis, Grand Valley State University, Allendale, MI. 111 pp.
- U. S. Fish and Wildlife Service (USFWS). 2016. Endangered and threatened wildlife and plants: threatened species status for the Eastern Massasauga Rattlesnake. Federal Register 80:58688-58701.
- U.S. Fish and Wildlife Service (USFWS). 2017. Shapefile of Eastern Massasauga Tier 1 Habitat and Tier 2 Habitat in Michigan. East Lansing Ecological Services Office, East Lansing, MI.