Endangered Species Modelling and Analysis to Inform Michigan Department of Transportation's Five-Year Transportation Plan

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Michigan Natural Features Inventory

MDOT

Michigan Natural Features Inventory (MNFI) is a program of Michigan State University Extension in partnership with the Michigan Department of Natural Resources (MDNR). Michigan Natural Features Inventory is Michigan's natural heritage program, and a member program of NatureServe and the Natural Heritage Network.

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Cover Photographs:

Top left – Eastern Massasauga (*Sistrurus catenatus*). Photo by Joseph Sage.
Top right – Blanding's Turtle (*Emydoidea blandingii*). Photo by James H. Harding.
Center bottom – M-53 (Van Dyke Road) construction, Macomb County. Photo by MDOT.

EXECUTIVE SUMMARY

Roads and road vehicle traffic can impact the demography, genetic structure, and ecology of animal populations, including reptile and amphibian populations (Forman and Alexander 1998, Jackson 2000, Trombulak and Frissell 2000, Steen and Gibbs 2004, Row et al. 2007). Road and bridge construction and maintenance also can impact animal populations by causing direct take of individuals and/or habitat loss, disturbance, and/or fragmentation. To help identify and assess potential impacts of future road and bridge projects, the Michigan Department of Transportation (MDOT) received a T2 grant through the Federal Highway Administration to model "emerging" species that may be listed under the federal Endangered Species Act. Primary among these is the eastern massasauga (*Sistrurus catenatus*) which was proposed for listing in 2015. Other species include a number of turtles that were petitioned for federal listing in the recent past. These include the Blanding's turtle (*Emydoidea blandingii*), spotted turtle (*Clemmys guttata*), and wood turtle (*Glyptemys insculpta*). By planning early for these species, MDOT will be in a better position to accommodate project schedules while fulfilling MDOT's Section 7 consultation obligations. This also provides more time for planning and finding ways to minimize or mitigate potential adverse impacts to species of concern if needed and possible.

To assist with this effort, MDOT contracted with the Michigan Natural Features Inventory (MNFI) to conduct Geographic Information System (GIS)-based modelling and analysis of emerging species of concern that may be listed under the federal Endangered Species Act and of MDOT's Five-Year Transportation Plan to identify proposed or future projects that may impact these species. We used GIS, available species information and environmental data layers, and expert opinion to model, analyze, and identify future projects in the five-year plan that may impact species of concern based on where these species have been documented and where they have potential to occur based on suitable habitat. These areas of potential impact were ranked based on the scope of work, site and landscape level habitat, proximity of the species EO, and probability or likelihood of the species occurring at the project site based on these and other factors. A matrix or tiered assessment of upcoming road projects and potential impact on emerging species of concern was developed based on this analysis. Because of the pending listing decision and limited time and resources, the GIS modelling and analysis conducted for this project focused on the eastern massasauga and Blanding's turtle. Element occurrences (EOs) in the Michigan Natural Heritage Database, inferred extent and massasauga population delineations that were generated from these EOs, and a massasauga species distribution or habitat model developed by McCluskey (2016) were used for this analysis.

Only a small number of the road and bridge projects in MDOT's five-year transportation plan were located in the vicinity of sites where eastern massasaugas have been documented or have potential to occur. The total number of road and bridge projects that were located within 30.5 m (100 ft) of a massasauga inferred extent and/or population delineation was 30 projects, and 66 projects within 0.8 km (0.5 mi). Most of these projects were ranked as having low impact or level of disturbance on the right-of-way and presumably on the species of concern as well. Furthermore, the projects that were near massasauga EOs, inferred extent, and/or populations and were ranked as having high impact on the ROW only had moderate to low potential for massasaugas to occur in the ROW. As a result, based on information currently available, the likelihood these high disturbance projects would impact massasaugas is probably moderate to low.

The Blanding's turtle results were similar to the massasauga results in that only a small number of road (n=29) and bridge (n=9) projects in the 5-year plan intersect or were located within 30.5 m (100 ft) of a 2-km inferred extent around documented occurrences in the NHD. Only seven (18%) of these projects were ranked as having high impact on the ROW. However, unlike the massasauga results, all seven projects were ranked as having high to moderate potential for Blanding's turtle to occur along the project site, based on proximity to EOs and available habitat according to the IE models and air photo interpretation. Based on the project disturbance rankings and potential for the species to occur along the project sites, these projects have high to moderate potential for impacting Blanding's turtles.

Overall, at this time, it appears that only a small number of future road and bridge projects identified in MDOT's five-year transportation plan have potential for impacting eastern massasaugas and Blanding's turtles. This approach (using inferred extent and population delineations) seems to be a useful planning tool for helping to identify future projects that may impact these species, which could be applied to other species of conservation concern. This approach not only takes into account where species have been documented but also considers where they have potential to occur, based on the species' ecology and available information and data layers on the presence/likely presence of suitable habitat near project sites. Identifying and assessing projects within 30.5 m (100 ft) of inferred extent and/or population delineations seemed to be an adequate and efficient approach. Species distribution or habitat models, such as McCluskey's habitat model for the eastern massasauga, also can be useful but may require more time and manual evaluations due to potential for false positives. Other approaches also may be effective for identifying or predicting project sites that may impact these species, and should be considered and utilized. Field surveys around these project sites could help clarify habitat conditions and whether the species does occur or have potential to occur along the project sites. Finally, it is important to revisit and update this analysis in the future as information on occurrences of these species continues to change and get updated in the Natural Heritage Database, and as new, additional information on the status, distribution, and ecology of these species becomes available over time.

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INTRODUCTION

Roads and road vehicle traffic can impact the demography, genetic structure, and ecology of animal populations, including reptile and amphibian populations (Reh and Seitz 1990, Forman and Alexander 1998, Jackson 2000, Trombulak and Frissell 2000, Steen and Gibbs 2004, Row et al. 2007, Langen et al. 2008). These impacts include mortality of individuals (e.g., Ashley and Robinson 1996, Hels and Buchwald 2001, Smith and Dodd 2003, Aresco 2005b, Lee 2005, Langen et al. 2007), reduced population sizes (e.g., Rosen and Lowe 1994, Fahrig et al. 1995, Vos and Chardon 1998, Marchand and Litvaitis 2002, Boarman and Sazaki 2006), skewed sex ratios (Steen and Gibbs 2004, Aresco 2005b), habitat loss and fragmentation, barriers to movement, and reduction or loss of connectivity within and/or between populations (Reh and Seitz 1990, Forman and Alexander 1998, Jackson 2000, Trombulak and Frissell 2000, Steen and Gibbs 2004, Row et al. 2007, Langen et al. 2008). Road and bridge construction and maintenance also can impact animal populations by causing direct take of individuals and/or habitat loss, disturbance, and/or fragmentation. When designing new or managing existing roads and bridges, transportation planners need information on where animal populations occur, particularly of rare and declining species, and where animals will attempt to cross, so that mitigation practices can be implemented to reduce take of these species.

To help identify and assess potential impacts of future projects, the Michigan Department of Transportation (MDOT) received a T2 grant through the Federal Highway Administration to model "emerging" species that may be listed under the federal Endangered Species Act. Primary among these is the eastern massasauga (*Sistrurus catenatus*) which was proposed for listing in 2015. A final decision on the listing is expected sometime in late fall 2016. All indications suggest this species will be listed as federally threatened. Other species include a number of turtles that were petitioned for federal listing in the recent past. These include the Blanding's turtle (*Emydoidea blandingii*), spotted turtle (*Clemmys guttata*), and wood turtle (*Glyptemys insculpta*). By planning early for these species, the Michigan Department of Transportation will be in a better position to accommodate project schedules while fulfilling MDOT's Section 7 consultation obligations. This also provides more time for planning and finding ways to minimize or mitigate potential adverse impacts to species of concern if needed and possible.

To assist with this effort, the Michigan Department of Transportation contracted with the Michigan Natural Features Inventory (MNFI), a program of Michigan State University Extension (MSUE), to conduct Geographic Information System (GIS)-based modelling and analysis of emerging species of concern that may be listed under the federal Endangered Species Act and of MDOT's Five-Year Transportation Plan to identify proposed or future projects that may impact these species. The Michigan Natural Features Inventory houses and maintains Michigan's Natural Heritage Database (NHD), the State's only comprehensive, single database of occurrences of rare, threatened, and endangered plant and animal species and natural communities in Michigan. This database includes occurrences of emerging species of concern that may be listed under the federal Endangered Species Act, including the eastern massasauga, Blanding's turtle, spotted turtle, and wood turtle. In addition to maintaining the Michigan NHD, Michigan Natural Features Inventory has staff with knowledge and expertise with these species of concern and with GIS-based modelling and analysis.

To identify future projects in MDOT's 5-year statewide transportation plan that may have an impact on emerging species of concern and assess their level of impact, the general approach we used was to overlay the locations of future projects in the 5-year plan onto known element occurrences (EOs) or locations where the species of concern have been documented in the Michigan NHD and where they have potential to occur. These areas of potential impact were ranked based on the scope of work, site and landscape level habitat, proximity of the EO, and probability or likelihood of the species occurring at the project site based on these and other factors. A matrix or tiered assessment of upcoming road projects and expected or potential impact on emerging species of concern was developed based on this analysis. Because of the pending listing decision and limited time and resources, the GIS modelling and analysis conducted for this project focused on the eastern massasauga and Blanding's turtle. This assessment provides MDOT with information to initiate planning and discussions with regulators on how to avoid, minimize, and/or mitigate adverse impacts of future projects on these species. Additionally, this project will help develop a programmatic approach to consultation for projects that have potential to impact these and other emerging species of concern.

Species Background

Eastern Massasauga

The eastern massasauga is a small, thick-bodied rattlesnake, with an average adult length of approximately 0.6 m (two feet) and maximum length of approximately one meter (three feet) (Harding 1997, Szymanski et al. 2015). Adult massasaugas are gray or light brown with large, light-edged, dark brown saddle-shaped blotches on the back and smaller blotches on the sides, although some individuals may be completely black in color (Figure 1). The belly is marbled dark gray or black. The head is triangular-shaped (i.e., widens at the back of the head and narrows at the neck) with vertical slit-shaped pupils and large, heat-sensing pits or openings between the nostrils and the eyes (Figure 1). A black stripe bordered by a narrow, white stripe extends from each eye down the side of the head. Its tail has several dark brown rings, and is tipped by a segmented, gray-yellow rattle (Figure 1).

Eastern massasaugas are generally active between April and October in the middle and northern part of its range, which includes Michigan (Beltz 1993, Mauger and Wilson 1999, Smith 2009, Szymanski et al. 2015). Habitat types used during the active season generally consist of open canopy wetlands and adjacent drier, upland habitats (Sage 2005, Lipps 2008). Eastern massasaugas utilize a variety of wetland habitats, including bogs, fens, peatlands, shrub carr/thickets, wet meadows, emergent marshes, moist grasslands, wet prairies, floodplain forests, and forested swamps (Figure 1, Reinert and Kodrich 1982, Hallock 1991, Weatherhead and Prior 1992, Johnson 1995, Harding 1997, Johnson et al. 2000, Ernst and Ernst 2003, Bissell 2006, Harvey and Weatherhead 2006, Marshall et al. 2006, Moore and Gillingham 2006, Smith 2009, Bailey 2010, DeGregorio et al. 2011). Drier, upland habitats range from prairies, savannas, barrrens, and old fields to upland forests and forest openings (Figure 1, Reinert and Kodrich 1982, Harding 1997, Szymanski 1998, Johnson et al. 2000, Bissell 2006, Bailey 2010, DeGregorio et al. 2011). Massasaugas use upland habitats for foraging, basking, giving birth to young, and dispersal (Szymanski et al. 2015). In general, structural characteristics of a site appear to be more important than vegetative composition for determining habitat suitability for massasaugas (Beltz 1992). Massasaugas require the following: (1) open, sunny areas intermixed

with shaded areas, for thermoregulation (basking sites), abundant and available prey (foraging sites), and the ability to escape both temperature extremes and predators (retreat sites); (2) presence of the water table near the surface for overwintering; and (3) connectivity between these habitats (Beltz 1992, Szymanski 1998, Johnson et al. 2000, Szymanski et al. 2015).

Figure 1. Photos of eastern massasauga, including melanistic individual (upper right), heat sensing pit and vertical slit-shaped pupils (center left), gray-yellow rattle (center right), open wetland habitat in southern MI (lower left), and open upland habitat in northern MI (lower right).

The eastern massasauga was once considered common throughout its range but its populations have severely declined. Historically, eastern massasaugas were known from western New York, western Pennsylvania, southeastern Ontario, Michigan's Lower Peninsula, northern Ohio and Indiana, northern Illinois, southern Wisconsin, extreme southeast Minnesota, east central Missouri, and eastern Iowa (Szymanski et al. 2015). Most states or provinces within the species' range have lost over 50% of their historical populations, and less than one-third of extant populations are considered secure (Szymanski 1998). As a result, the eastern massasauga was listed as a federal candidate species by the U.S. Fish and Wildlife Service (USFWS) in 1999 (USFWS 1999), and proposed for listing as federally threatened in 2015 (USFWS Federal Register 2015a). Michigan is considered to be the last stronghold for the massasauga, although this species has declined in the state as well (Szymanski et al. 2015). In Michigan, the eastern massasauga has been designated a species of special concern and a Species of Greatest Conservation Need (SGCN) in Michigan's Wildlife Action Plan (WAP) (Derosier et al. 2015).

The primary factors that have contributed to the decline of the eastern massasauga in Michigan and across the species' range include habitat loss and fragmentation due to conversion to agricultural land, development, vegetative succession, exotic plant species invasion, hydrologic alterations, and other factors; management practices (e.g., prescribed fire and mowing); road mortality; persecution; and collection (Szymanski et al. 2015). Roads, bridges, and other structures constructed in eastern massasauga habitat fragment the habitat, and can impact the species directly through direct mortality (Shepard et al. 2008a and 2008b) and indirectly by serving as a barrier to snake movement and preventing access to different habitats needed for the snakes' life cycle and survival and reducing population connectivity (Kingsbury 2002, Szymanski et al. 2015). Recent studies have found that paved roads represent almost complete barriers to massasauga movement and dispersal due to behavioral avoidance/reluctance to cross roads and/or road mortality (Seigel 1986, Weatherhead and Prior 1992, Hammerson 2002, Kingsbury 2002, Shepard et al. 2008a, Shepard et al. 2008b, Dreslik pers. comm., Kingsbury pers. comm.). Paved roads and other roads (e.g., gravel and dirt roads) occur within or around over 90% of the known massasauga populations in Michigan (Lee and Enander 2015).

Blanding's Turtle

The Blanding's turtle is a medium-sized turtle with a high-domed carapace (upper part of shell) ranging from 15 – 28 cm (6 to 11 in) in length, a bright yellow, unmarked chin and throat, and a very long neck (Figure 2, Harding 1997). The elongated, dome-like, and smooth carapace is neither keeled nor serrated (i.e., not having raised ridges or pointed projections). The carapace is usually black with yellow spots and lines. The plastron (underside of shell) is hinged, and typically is yellow with a dark blotch at the outer edge of each scute or scale (Figure 2).

Blanding's turtle are generally active from April to October/early November (Harding 1997). Blanding's turtles typically require wetland complexes, and move overland among multiple wetlands throughout the season (Compton 2007). Wetlands used by Blanding's turtles are usually productive, clean, shallow (typically <2 m), stagnant or slow-moving, with abundant aquatic vegetation and soft muddy bottoms over firm substrates (Ross and Anderson 1990, Ernst et al. 1994, Joyal et al. 2001, Compton 2007). This species has been found in shrub swamps, marshes, vernal pools, bogs, ponds, lakes, wet prairies, fens, forested wetlands, low-gradient

streams and rivers, river backwaters, embayments, and sloughs (Figure 2, Harding and Holman 1990, Van Dam 1993, Harding 1997, Compton 2007). Blanding's turtles use terrestrial or upland habitats for parts of their life cycle, including nesting, moving among wetlands, basking, aestivation, and possibly feeding (Compton 2007). They prefer to nest in open, sunny, unvegetated or sparsely vegetated areas with moist but well-drained sandy or loamy soil (Harding 1997). They also will use lawns, gardens, plowed fields, gravel pits, powerlines, or even gravel road edges if suitable natural nesting habitat is not available (Harding 1997, Compton 2007). Blanding's turtles typically travel considerable distances overland during interwetland movements and to nesting sites (Compton 2007). These movements can include crossing roads. In Maine, 50 radio-tracked adult turtles crossed paved roads 40 times, and unpaved roads 34 times, for an average of 1.54 road crossings (any type) per turtle, per year, and females crossed roads more often than males (Beaudry et al. 2006, Beaudry unpublished data in Compton 2007).

Blanding's turtles occur from southwestern Quebec and southern Ontario south through the Great Lakes region to central Illinois and west to central Nebraska, including parts of Missouri, Iowa, South Dakota, and Minnesota (Ernst et al. 1994). Disjunct populations occur in Maine, New Hampshire, Massachusetts, New York, and Nova Scotia. Within the Great Lakes region, Blanding's turtles are found throughout southern Ontario, Michigan and Wisconsin, and in northern Ohio, northern Indiana and northern Illinois (Harding 1997). Blanding's turtles are listed as Threatened or Endangered in nine of 13 states where they occur, and all three Canadian provinces (Compton 2007). In 2012, the Center for Biological Diversity petitioned the USFWS to list 53 species of reptiles and amphibians, including the Blanding's turtle, as endangered or threatened and designate critical habitat for these species under the federal Endangered Species Act (USFWS Federal Register 2015b). In 2015, the U.S. Fish and Wildlife Service found that the petition presented substantial scientific or commercial information to indicate that listing may be warranted for the Blanding's turtle (USFWS Federal Register 2015b). The U.S. Fish and Wildlife Service will conduct a full status review of the species to determine if the species should be listed under the federal Endangered Species Act. In Michigan, the Blanding's turtle has been designated a species of special concern and a SGCN in Michigan's WAP (Derosier et al. 2015).

Figure 2. Photo of an adult Blanding's turtle with key identifying features – yellow throat, high-domed and yellow flecked shell, and plain head, and an example of Blanding's turtle habitat.

Project Objectives

This project addressed the following specific objectives:

1) Meet with MDOT and USFWS staff to discuss the purpose, goals, schedule, and methodology of the project, and review and discuss the draft analysis and results, addressing any questions or changes as needed.

2) Using ArcGIS, conduct an analysis of MDOT's Five-Year Transportation Plan and emerging species of concern, focused on the eastern massasauga and Blanding's turtle, to identify future projects which have potential to impact these species and assess or rank these projects in terms of level of impact. Identify and develop or compile spatial data layers for analysis.

3) Develop a matrix that provides a tiered assessment of upcoming road and bridge projects and expected or potential impact level on emerging species of concern.

4) Produce a final report summarizing results and findings, and other deliverables including the matrix or table or upcoming projects and potential impact level, and GIS maps/shapefiles of developed and/or used in the analysis.

METHODS

Identifying Potential Impact Areas/Projects

To identify future projects in MDOT's 5-year statewide transportation plan that may impact the eastern massasauga and/or Blanding's turtle, we obtained a GIS data layer of the locations of proposed projects in the 5-year plan from MDOT, and superimposed or intersected this data layer with layers indicating locations where these species have been documented or have potential to occur based on element occurrences of these species currently available in the Michigan NHD. An Element Occurrence (EO) is an area of land and/or water in which a species or natural community is, or was, present (NatureServe 2002). For species, an element occurrence typically represents or corresponds to a local population (NatureServe 2002). Each element occurrence is comprised of one or more source features, or individual locations or areas where the species was observed (Figure 3). Each source feature is mapped in the NHD with a point, line, or polygon that represents the spatial extent or locational uncertainty of the source feature. Source features that are separated by suitable habitat within a specified separation distance (i.e., 5 km for eastern massasaugas and Blanding's turtle) are part of the same EO or population (Figure 3, NatureServe 2016).

To better represent the extent of eastern massasauga and Blanding's turtle EOs/populations and where these species occur or potentially occur on the landscape, we modeled where these species may occur using inferred extent (IE), population model delineations, and/or a species habitat model. Although EOs in the NHD represent local populations, element occurrences and associated source features can only include and map areas in which the species was actually observed, and cannot include available suitable habitat in which the species was not observed or

An Element Occurrence (EO) in yellow hatch, composed of 36 Source Feature polygons, two quite large and historic, and the rest (in red) more recent and location more precise.

After removing the two large source features, the remaining polygons are used as source features in cost distance modeling.

The green area is the Inferred Extent generated from the model (based on the source features and a cost-weighted raster of land cover classes).

Figure 3. General example illustrating an Element Occurrence, Source Features, and Inferred Extent.

was not surveyed even though the species may occur or likely occurs in at least some of these areas. The inferred extent distance is an approximate spatial requirement for a particular species, typically based on the average home range (NatureServe 2002). The inferred extent distance generally does not exceed the maximum known single-year migration distance for the species (assuming nonvolant species) or the EO separation distance (NatureServe 2002). Inferred extent for the eastern massasauga and the Blanding's turtle EOs were generated by buffering the underlying source feature(s) of the EOs by a specified IE distance for each species. Habitat known to be unsuitable and/or unused was edited or removed from the IE features after they were generated. The NOAA Coastal Change Analysis Program (C-CAP) 2010 land cover layer was used to edit or remove unsuitable/unused habitat from the IE features. For the eastern massasauga, in addition to inferred extent, we also were able to incorporate in the analysis massasauga population delineations that had been modelled and mapped by Lee and Enander (2015) for a previous project, and a massasauga species habitat model that had been developed by Eric McCluskey from Ohio State University (McCluskey 2016) to identify areas where massasaugas occur or potentially occur in Michigan.

MDOT's 5-year transportation plan (Figure 4) was superimposed or intersected with the inferred extent models for the eastern massasauga and Blanding's turtle, the massasauga population delineations (Lee and Enander 2015), and the massasauga habitat model developed by McCluskey (2016) to identify future projects that may impact these species. Road or bridge projects that were within 30.5 m (100 ft) of the massasauga and Blanding's turtle inferred extent models, the massasauga population delineations, and suitable massasauga habitat predicted by McCluskey's model were identified and evaluated for potential for impacting these species. Projects that were within 0.8 km (0.5 mi) of eastern massasauga inferred extent, population delineations, and areas with suitable massasauga habitat predicted by McCluskey's habitat model also were identified and/or evaluated to investigate the utility of using this distance (0.8 km/0.5 mi) for this analysis.

Inferred Extent Model for the Eastern Massasauga

For the eastern massasauga, 1-km and 2-km inferred extent models were generated. We defined the inferred extent distances based on maximum distances massasaugas moved during radio-telemetry studies in Michigan and other states (Table 1 and Appendix 1). A total of 1,006 source features associated with 272 EOs were used to generate the models (Figure 5). Element occurrences that were ranked as historical records were included if they were more precise than a general record and suitable/potential habitat for massasaugas was present within the source feature, according to the current land cover layer. The NOAA C-CAP 2010 land cover layer was used in this analysis. Only about 13 historical records were excluded from the analysis based on these criteria. For historical EO records with a source feature size already larger than the inferred extent area (i.e., >= 200 acres), the source feature was first subset to include only suitable habitat for massasaugas. For massasauga EOs and inferred extent models in the southern Lower Peninsula (LP), suitable habitat included all wetland types, and for the northern LP, suitable habitat also included upland forest and upland shrub habitats in addition to wetlands. Figure 6 shows an example of eastern massasauga 1-km and 2-km inferred extent features, population delineation, and road project sites within 30.5 m (100 ft) and 0.8 km (0.5 mi) from these features.

Table 1. Summary of information on maximum distances moved, average home range size, and maximum home range size for eastern massasaugas based on radio-telemetry studies in Michigan and other states within the massasauga's range.

Geographic Region	Maximum distance moved/individual	Average home range size/individual	Average home range size/individual
Southern MI[1]	~300-500 m	~ 1 – 6 ha	~ 20 – 30 ha
Northern MI[2]	~1 km	~ 4 - 17 ha	~ 40 – 95 ha
Other states[3]	~500 m to 1- 2 km	~ 3 – 26 ha	~ 5 – 140 ha

[1]Moore 2004, Sage 2005, Bissell 2006, Bailey 2010

[2]DeGregorio 2008

[3]Reinert and Kodrich 1982 (PA), Weatherhead and Prior 1992 (ONT), Johnson 2000 (NY), Phillips et al. 2002 (IL), Kingsbury et al. 2003 (IN), Dreslik 2005 (IL), Marshall et al. 2006 (IN), Durbian et al. 2008 (MO & WI)

Inferred Extent Model for the Blanding's Turtle

Only a 2-km inferred extent model was generated for the Blanding's turtle. We selected 2 km as the inferred extent distance based on maximum overland distances Blanding's turtles moved during radio-telemetry studies in Michigan and other states, ranging from about 1.4 km to 3.7 km (Table 2). A total of 563 source features associated with 291 EOs were used to generate the model (Figure 7). As with the massasauga inferred extent models, Blanding's turtle element occurrences that were ranked as historical records were included if they were more precise than a general record and suitable/potential habitat for massasaugas was present within the source feature, according to the current land cover layer. The NOAA C-CAP 2010 land cover layer was used in this analysis. No historical records were excluded from the analysis based on these criteria. For historical EO records with a source feature size already larger than the inferred extent area (i.e., >= 200 acres), the source feature was first subset to include only suitable habitat for Blanding's turtles. For Blanding's turtle EOs and inferred extent models, suitable habitat included all wetland types, and upland forest and upland shrub habitats. Congdon and Keinath (2006) report that the Blanding's turtle has the largest terrestrial component to the core habitat, and both sexes use terrestrial corridors for movements among wetlands and for nesting migrations. Figure 8 provides an example of a 2-km inferred extent for a Blanding's turtle EO.

Table 2. Summary of information on maximum distances moved, average home range size, and maximum home range size for Blanding's turtles based on radio-telemetry studies in the northeastern and midwestern U.S.

Geographic Region	Maximum distance moved/individual	Max home range lengths/individual	Average home range size/individual
Northeast U.S.[1]	~1.9 km – 3.7 km	~2.6 km – 8.9 km	~2.6 - 134.2 ha
Midwest U.S.[2]	~1.4 km – 2.9 km	~0.24 km – 2.9 km	~0.6 – 63 ha

[1]Compton 2007 and unpublished data (MA), Joyal et al. 2001 (ME), Beaudry et al. 2006 and unpublished data 2004 (ME) [2]Rowe and Moll 1991 (IL), Piepgras and Lang 2000 (MN)

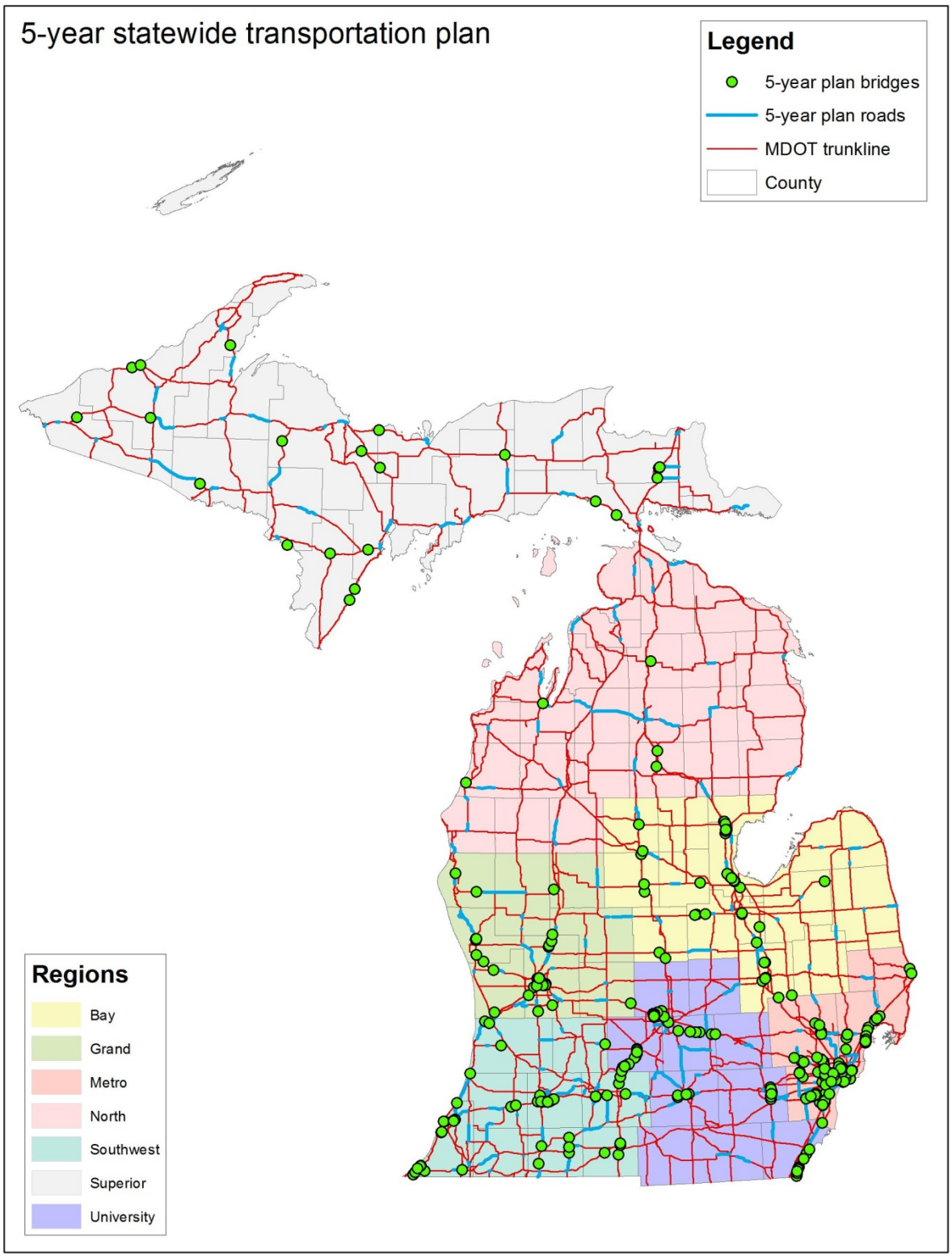

Figure 4. MDOT's 5-year statewide transportation plan for road and bridge projects. These were the projects included in this project's analysis.

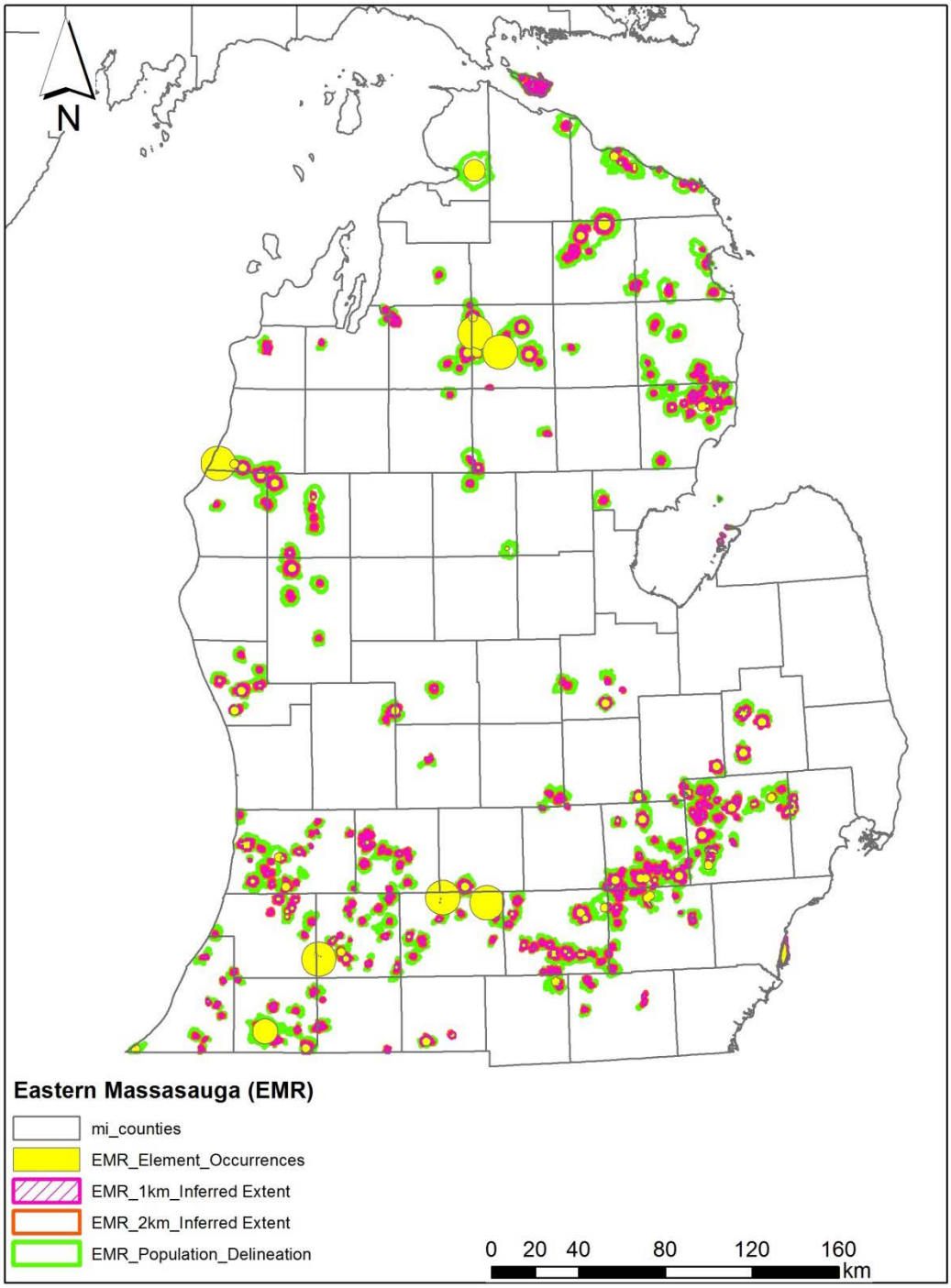

Figure 5. Map of eastern massasauga 1-km and 2-km inferred extent models and population delineations across the entire state that were utilized in the analysis to identify road and bridge projects in MDOT's 5-year plan that may impact massasaugas.

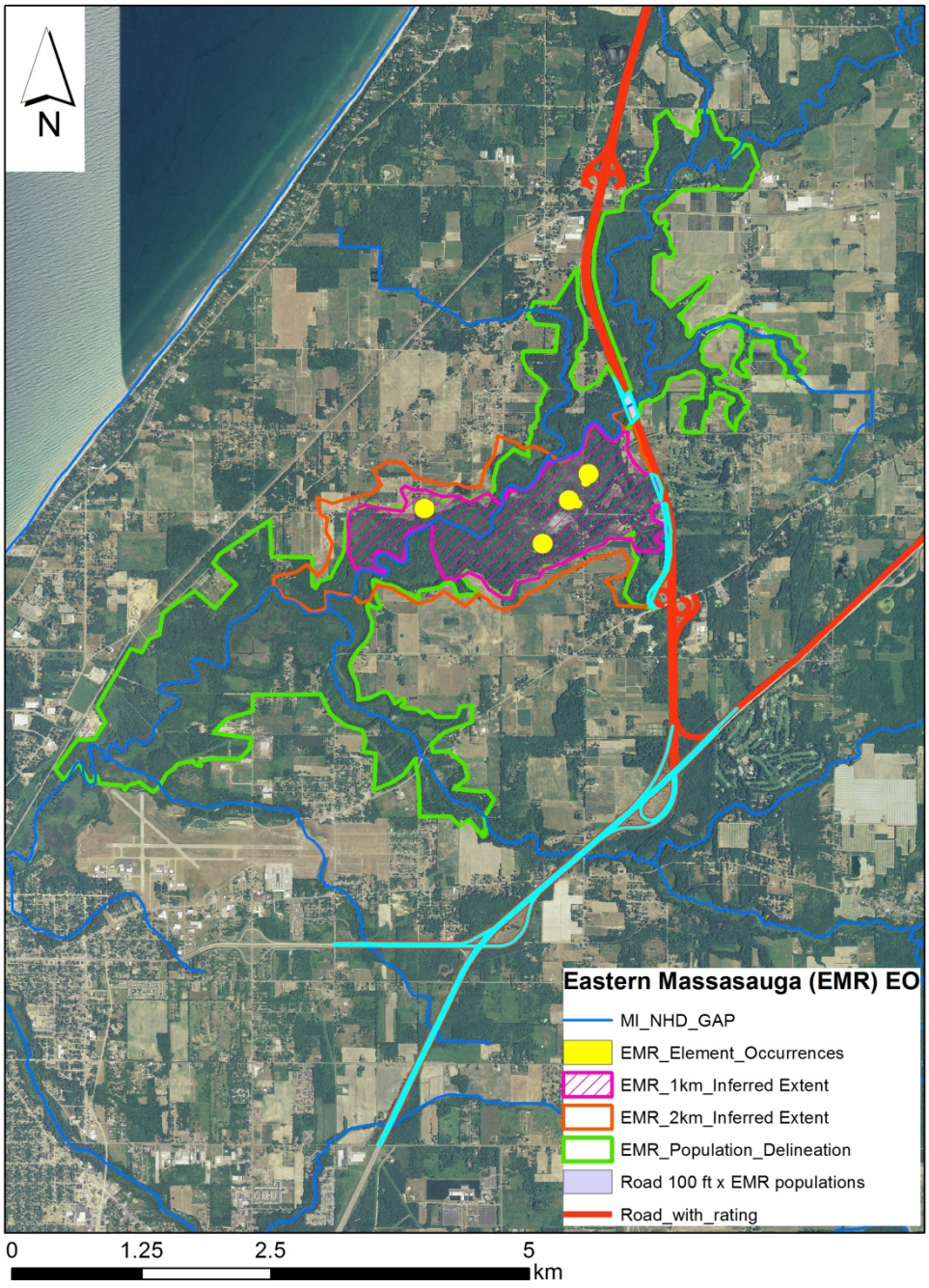

Figure 6. Eastern Massasauga element occurrence (EO) (yellow circles), 1-km inferred extent (pink), 2-km inferred extent (orange-red), and population delineation (green). Road segments and future road projects are shown in red. Road segments highlighted in light blue are project sites that were located within 30.5 m (100 ft) or 0.8 km (0.5 mi) of massasauga inferred extent and/or population delineations.

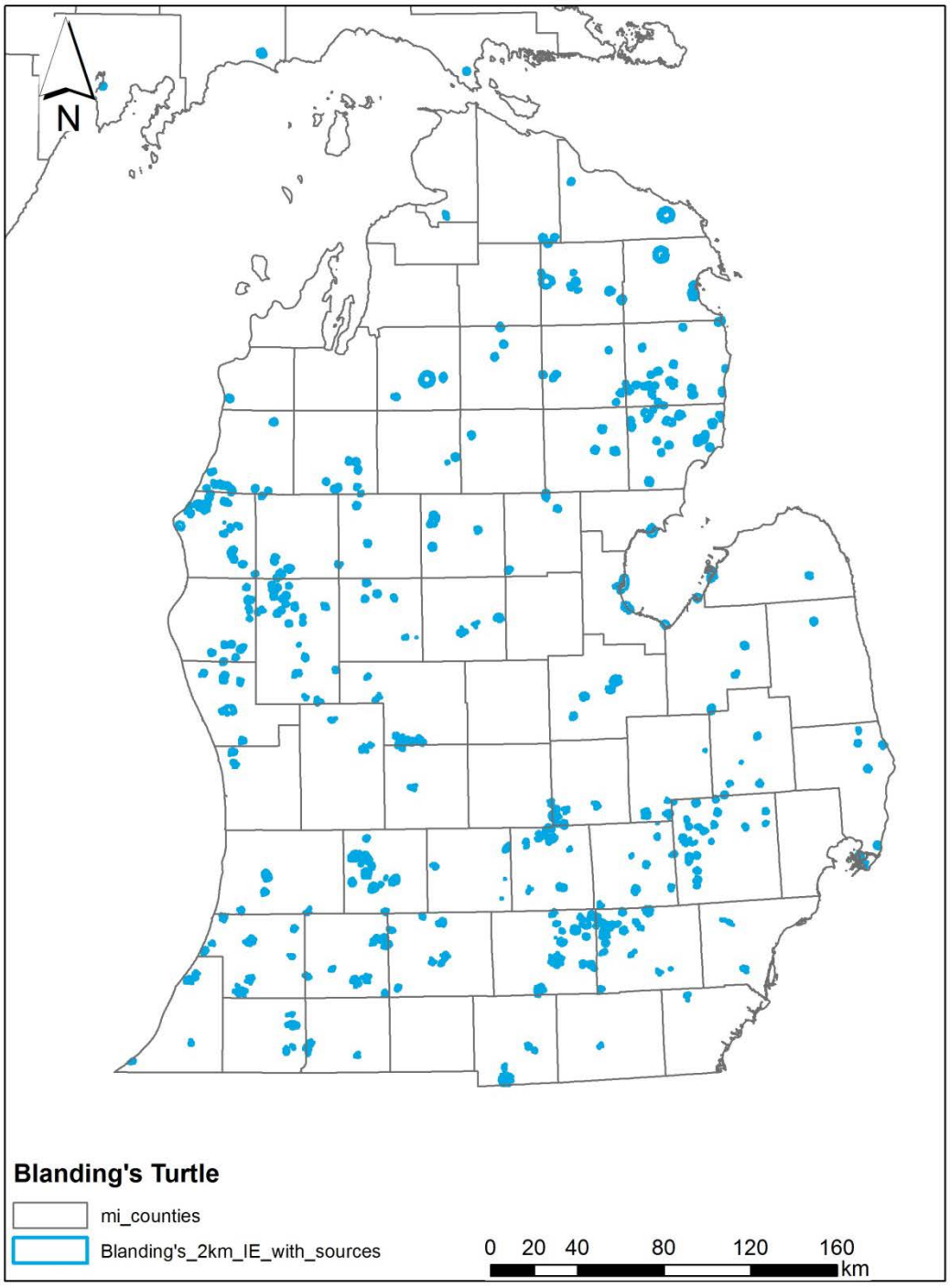

Figure 7. Map of Blanding's turtle 2-km inferred extent models that were utilized in the analysis to identify road and bridge projects in MDOT's 5-year plan that may impact this species.

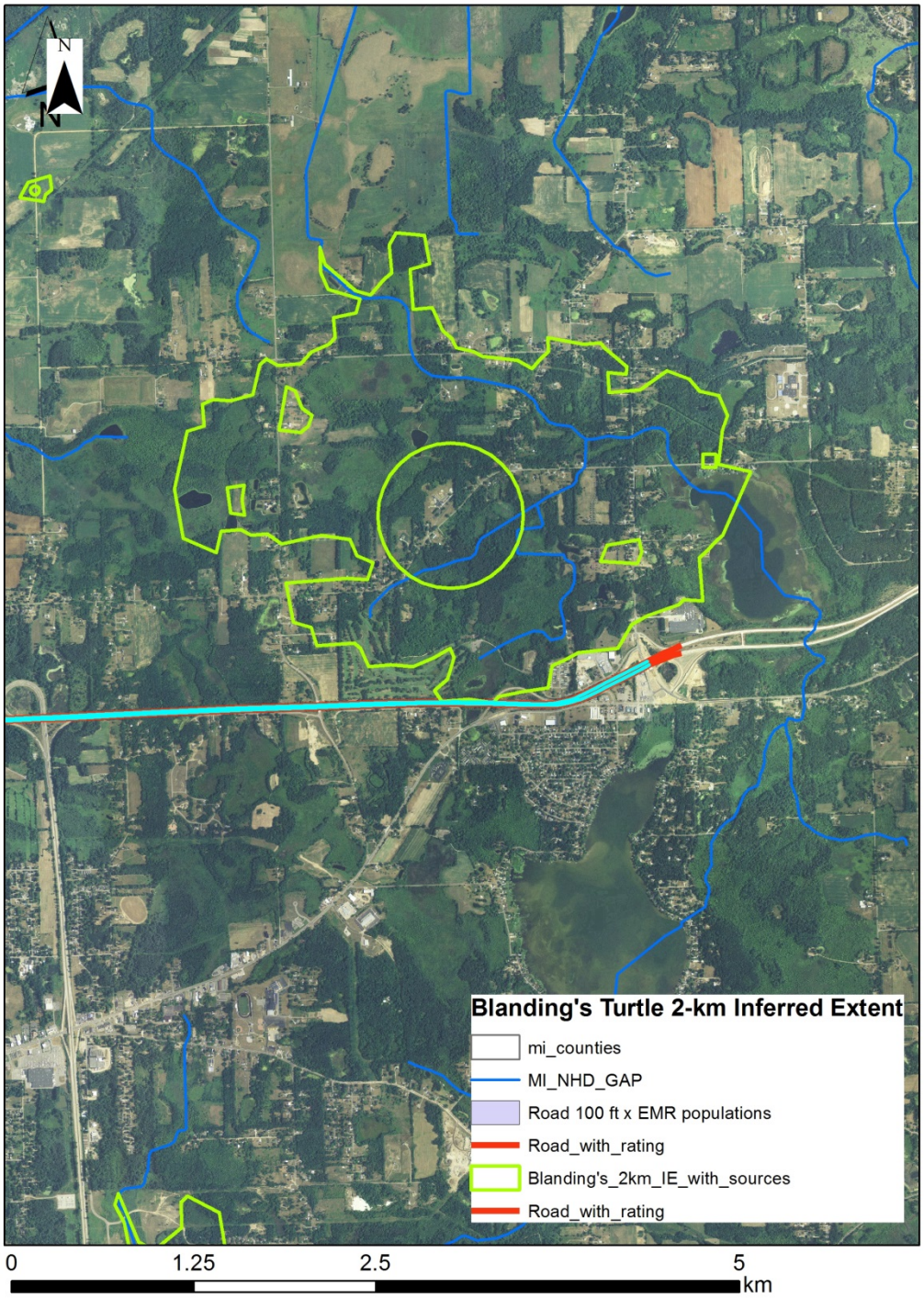

Figure 8. Blanding's turtle element occurrence (EO) (green inner circle) and 2-km inferred extent (green outside boundary). Road segments and future road projects are shown in red. Road segments highlighted in light blue are project sites that were located within 30.5 m (100 ft) or 0.8 km (0.5 mi) of Blanding's turtle inferred extent.

Eastern Massasauga Population Delineations

Eastern massasauga populations in Michigan were delineated for a previous MNFI project based on a population model using known element occurrences of this species in Michigan's NHD and a cost-weighted distance analysis (Lee and Enander 2015). The goal of the population modeling was to help evaluate and delineate eastern massasauga populations by assessing and mapping how far massasaugas might be able to move from known locations based on available information on the species' movement distances and home range sizes in Michigan, potential suitable habitat around known locations, and presence of barriers. The population model and cost-weighted distance analysis also were used to help identify where massasaugas might be able to move between known EOs, and thus potentially function as one population. A brief summary of how the massasauga population delineations were developed is provided in this report. Lee and Enander (2015) provides more detailed information on how the population delineations were generated.

A model was created in ESRI Modelbuilder to process eastern massasauga source features (i.e. source points, lines and polygons) associated with known EOs in Michigan's NHD and convert them to a raster format. Over 1,000 massasauga source features associated with 263 element occurrences were incorporated in the model. Polygons that were mapped with low precision (i.e., "general" precision records) were removed from the source dataset, as their usefulness for modeling current populations is questionable. Historical or older records were included in the analysis as long as the precision was acceptable for the analysis. The remaining features were carefully converted to raster format, ensuring that no features were lost in the rasterization process due to grid size (30 m), or to the possible situation where a larger polygon might overlay a smaller polygon.

To determine the potential extent of massasauga populations and whether source features were close enough to be part of the same population, a cost-weighted surface layer was created that takes into account distance as a cost factor along with other costs assigned to each cell on the landscape based on its suitability for massasauga movement. In this case, we were interested in measuring distance from and between source features taking into account the cost for massasaugas of traveling over different types of land cover, of which some are optimal, sub-optimal, or poor habitats. The NOAA C-CAP 2010 raster layer (30 m) was used for land cover types. Streams and lakes from the GAP NHD streams and the Framework IFR 2004 lakes were inserted or "burned" into the land cover layer to make sure these habitats were included in the analysis since they might be important for massasauga movement.

Each land cover type or class was assigned a weighted cost ranging from 1 (highly suitable habitat) to 10 (highly unsuitable habitat) (Table 3). A weighted cost value of 1 was equal to the Euclidian distance cost alone, and was assigned to all suitable habitat land cover cells. A cell with a weighted cost value of 10 was ten times more costly to move through, and was the value assigned to unsuitable land cover cells. The suitability of different types of land cover as habitat for massasaugas was determined based on available information on massasauga habitat use in the literature and from species experts. Early to mid-successional wetlands and uplands, and forested wetlands and uplands with canopy gaps and/or adjacent to open wetlands and uplands were considered suitable habitats for massasaugas (Wright 1941, Smith, 1961, Reinert and Kodrich 1982, Seigel 1986, Weatherhead and Prior 1992, Johnson and Leopold 1998, Moore 2004,

Table 3. Summary of land cover classes (NOAA C-CAP 2010), assigned weighted costs, and maximum allowable cost distances included in the massasauga population cost distance analysis and model. The weighted costs were assigned based on habitat suitability of the land cover class for massasaugas.

Land Cover Class	Weighted Cost	Maximum Allowable Cost Distance (km)
Palustrine Aquatic Bed	1	5
Palustrine Emergent Wetland	1	5
Palustrine Forested Wetland	1	5
Palustrine Scrub/Shrub Wetland	1	5
Unconsolidated Shore	1	5
Deciduous Forest	2	4
Evergreen Forest	2	4
Mixed Forest	2	4
Scrub/Shrub	2	4
Grassland/Herbaceous	3	3
Bare Land	10	0.5
Cultivated Crops	10	0.5
Developed, Low Intensity	10	0.5
Developed, Medium Intensity	10	0.5
Developed, High Intensity	10	0.5
Developed, Open Space	10	0.5
Open Water	10	0.5
Pasture/Hay	10	0.5

Dreslik 2005, Bissell 2006, DeGregorio 2008, Bailey 2010, Appendix 1). Unsuitable habitats and/or barriers that prevent or reduce movement for massasaugas included late successional, closed-canopy wetlands and uplands; extensive upland habitats with no wetlands nearby (i.e., >1 km wide); active agricultural lands (e.g., croplands, pasture, hay), especially extensive areas (500 m to 1 km in width and length); bare ground; areas with low, medium, and high-intensity development/ densely urbanized and human-altered landscapes; fast-flowing major rivers (500m – 1 km wide); large inland lakes (>500 m in width & length), and the Great Lakes (Wright 1941, Smith, 1961, Reinert and Kodrich 1982, Seigel 1986, Weatherhead and Prior 1992, Johnson and Leopold 1998, Moore 2004, Dreslik 2005, Bissell 2006, DeGregorio 2008, Bailey 2010, Appendix 1). As a result, land cover classes associated with palustrine wetlands were considered suitable habitats for massasaugas for the model, and were assigned a weighted cost value of 1 (Table 1). Land cover classes associated with open and forested upland habitats were considered marginally suitable habitats for massasaugas for the model, and were assigned a weighted cost value of 2 or 3. Remaining land cover classes associated with agricultural use, development, bare land, and open water were considered unsuitable habitats, and were assigned a weighted cost value of 10.

The cost allocation analysis calculated for each cell its nearest source feature (i.e., massasauga raster data) based on the least accumulated cost over the cost-weighted surface layer that was created. The cost allocation zone for each source feature provided an estimate of whether the population was separate or joined to another source population. The maximum total allowable cost distance for each source feature was set at five km (three miles). This was based on eastern massasauga element occurrence specifications developed by Natureserve which state that massasauga sites or source features that are separated by five km (three mi) or more of suitable habitat should constitute separate EOs (Hammerson 2002). We also reviewed and compiled information about maximum distances moved and maximum home range sizes for massasaugas based on radio-telemetry studies in Michigan and other states (Table 1 and Appendix 1).

With the raster file outputs from the cost allocation analysis, we produced a preliminary map and GIS shapefile of potential massasauga population delineations in Michigan based on known massasauga source features and available land cover data and information on massasauga ecology. We visually inspected each mapped population in GIS along with the best available aerial imagery, land cover data, hydrology data, and data on road locations and types to determine if the delineated populations needed to be revised or edited (e.g., if a multiple source features mapped as a single population should be mapped as separate populations, or if separate populations should be mapped as one population). The massasauga population polygons were edited manually as needed based on extent of suitable and unsuitable habitat indicated from aerial imagery and land cover data, and the presence of potential barriers and potential connectivity/dispersal or movement corridors (i.e., streams, rivers, and lakes).

In particular, the mapped populations were reviewed for the presence and type of roads and rivers/streams within and along the outer extent of the populations. Recent studies have found that paved roads represent almost complete barriers to massasauga movement and dispersal due to behavioral avoidance/reluctance to cross roads and/or road mortality (Seigel 1986, Weatherhead and Prior 1992, Hammerson 2002, Shepard et al. 2008a, Shepard et al. 2008b, Dreslik pers. comm., Kingsbury pers. comm.). Snakes have been found to use streams/rivers

though to move between habitat areas (Kingsbury pers. comm., Redmer pers comm.). As a result, busy highways and paved roads, especially high traffic roads, were considered barriers to massasauga movement, and were used to delineate separate massasauga populations unless a stream/river connected suitable habitat on both sides of the road, or if suitable habitat appeared to be present on both sides of the road and road traffic was assumed to be light.

After preliminary population delineations were reviewed and edited, a new GIS shapefile of the final massasauga population delineations was created for distribution and future analysis, planning, and conservation efforts. This new shapefile contains just the outermost boundary or extent of each delineated massasauga population (Appendix 2). Each delineated population was assigned a unique population identification number (i.e., EMRPOPXXX in the POP_ID2 attribute). This shapefile also contains some information about each population including the county in which the population is located, identification numbers for the massasauga EOs that were included in the population, dates when massasaugas were first and last observed, and estimated population viability rank. This shapefile contains massasauga populations that are known to be extant as well as populations that are considered historical but may still be extant and need additional surveys to verify their status.

Eastern Massasauga Habitat Model

We had access to recently completed distribution model for eastern massasaugas in Michigan, developed as part of a PhD dissertation by Eric McCluskey (Figure 9, McCluskey 2016). The model used selected environmental variables and known locations of eastern massasauga in Maxent (a maximum entropy approach) to produce a spatial model of predicted species distribution. The model results in a suitability layer ranging from 0 – 1. If a binary classification of presence/absence is desired, the continuous model output requires a threshold be chosen. A threshold can be selected based on the objectives for generating the distribution model (Wilson et al. 2005). As larger thresholds are selected, commission errors tend to decrease while omission errors increase (Fielding and Bell, 1997). If the modeler decides commission errors are more serious, then the model threshold can be increased at the expense of omission errors. When there is no inclination as to which type of error is more critical, then an optimal threshold can be obtained from the ROC curve by finding the point where sensitivity and specificity are maximized (Manel et al. 2001, Hernandez et al. 2006), which we used with Eric's model to create a binary layer of presence/absence. The threshold that we decided to use to create the habitat presence/absence layer was 41, based on the Maxent results. Using the binary layer as an overlay, we screened the MDOT projects as to whether the model predicted presence or absence.

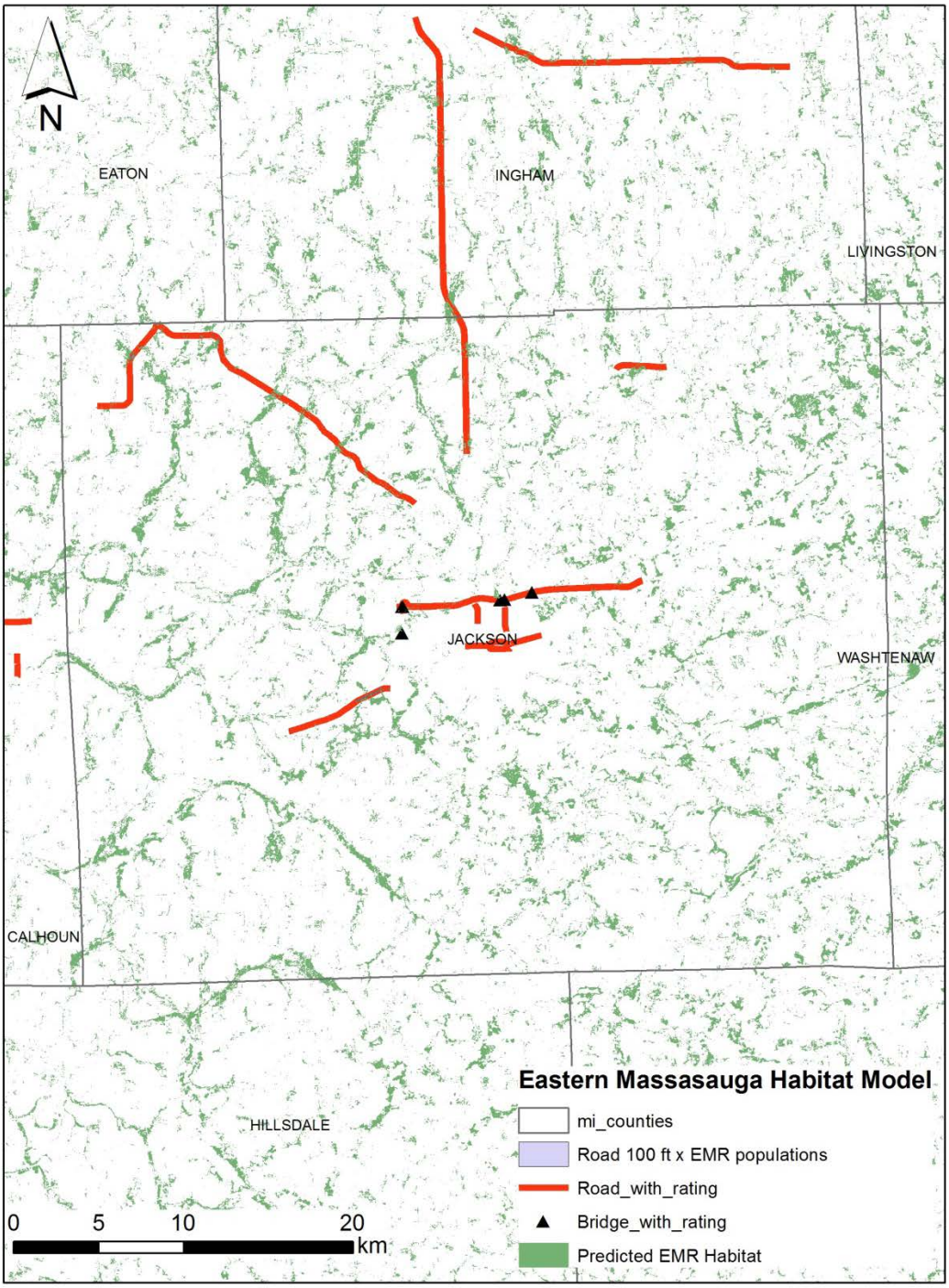

Figure 9. Example of model output predicting areas with suitable habitat for massasaugas (green areas) based on eastern massasauga species distribution or habitat model developed by Eric McCluskey (2016) at Ohio State University. The red lines indicate future road projects and the black triangles indicate future bridge projects in Michigan Department of Transportation's statewide five-year transportation plan.

Assessing Potential Impact of Projects

To assess the potential impact of future projects that occur at or near sites where eastern massasaugas or Blanding's turtle occur or have potential to occur based on documented EOs, inferred extent, population delineations, and/or a habitat model, two factors were considered and evaluated. The first factor was the level of disturbance the proposed road or bridge work type could have on the right-of-way (ROW) and potentially on the species of concern. Each type of road or bridge work was ranked as potentially having low, medium, or high level of impact based on the expected level of disturbance and potential for adversely impacting the species of concern (i.e., by causing direct take and/or habitat loss or degradation) (Appendix 3). MDOT staff evaluated the road and bridge work types and provided impact rankings. Based on these rankings, each proposed road or bridge project in the 5-year plan was ranked for potential impact or disturbance to the ROW and species of concern (if they occur at the project site).

The second factor or criterion that was considered and evaluated was the potential or likelihood for the species of concern (i.e., eastern massasaugas and Blanding's turtle) to occur in the ROW at the project sites. This was ranked as low, moderate, or high potential based on availability of habitat for these species adjacent to the ROW project site and in the surrounding landscape, proximity and connectivity to locations where the species has been documented, and date of last observations. We assessed these factors and the potential for the species of concern to occur along the project site by reviewing recent aerial imagery and information in the NHD. We assessed the potential for eastern massasaugas and Blanding's turtles to occur at or along the project sites that were within 30.5 m (100 ft) of massasauga and Blanding's turtle inferred extent, population delineations, and/or predicted habitat. We only assessed the potential for eastern massasaugas and Blanding's turtles to occur along the project sites that were within 0.8 km (0.5 mi) of massasauga and Blanding's turtle inferred extent and populations and were ranked as having high or medium impact on the ROW and species of concern potentially.

RESULTS

Identifying Potential Impact Areas/Projects

Eastern Massasauga

Only a small number of future road/bridge projects in MDOT's statewide 5-year transportation plan intersected or were within 30.5 m (100 ft) of where eastern massasaugas (EMR) are known to occur or have potential to occur based on the GIS modelling and analysis that were conducted for this project. Of the 1,246 total road maintenance or construction projects in MDOT's 5-year plan, only 24 (2%) road projects intersected or were within 30.5 m (100 ft) of eastern massasauga 1-km inferred extent, 2-km inferred extent, and/or population delineations (Table 4, Figure 10, and Appendix 4) (Note: Different phases of the same road/bridge project/job ID were counted as separate projects.) All of the projects that were within 30.5 m (100 ft) of the EMR 1-km and 2-km inferred extent features were also included in the projects that were within 30.5 m (100 ft) of the EMR population delineations except for two projects (i.e., job ID 127449 phases A and B) which were only listed for the EMR 2-km inferred extent. A total of 115 (9%) road

projects were within 30.5 m (100 ft) of areas predicted to be suitable habitat for massasaugas based on McCluskey's habitat model (Table 4, Figure 11, and Appendix 6). Of the 712 bridge projects in the 5-year plan, only 6 (~1%) projects were within 30.5 m (100 ft) of eastern massasauga 1-km inferred extent, 2-km inferred extent, and/or population delineations, and only 1 project was within 30.5 m (100 ft) of areas predicted to be suitable habitat for eastern massasaugas based on the McCluskey habitat model (Table 4, Figures 11 and 12, and Appendices 5 and 6).

A larger number of future road/bridge projects in MDOT's statewide 5-year transportation plan were within 0.8 km (0.5 mi) of where eastern massasaugas are known to occur based on the GIS modelling and analysis that were conducted for this project. Of the 1,246 total road maintenance or construction projects in the 5-year plan, 47 (4%) of the road projects were within 0.8 km (0.5 mi) of EMR 1-km inferred extent, 2-km inferred extent, and/or population delineations (Table 5, Figure 10, and Appendix 4). However, this total includes seventeen projects that were within 30.5 m (100 ft) of the massasauga 1-km inferred extent, 2-km inferred extent, and/or population delineations. A total of 424 (34%) road projects were within 0.5 mi of areas predicted to be suitable habitat for massasaugas based on McCluskey's habitat model (Table 5 and Figure 13). Of the 712 bridge projects in the 5-year plan, 19 (3%) projects were within 0.8 km (0.5 mi) of EMR 1-km inferred extent, 2-km inferred extent, and/or population delineations (Table 5, Figure 12, and Appendix 5), and 213 (30%) projects were within 0.8 km (0.5 mi) of areas predicted to be suitable habitat for eastern massasaugas based on the McCluskey habitat model (Table 5 and Figure 13).

Table 4. Summary of road and bridge projects in MDOT's 5-year statewide transportation plan that occur within 30.5 m (100 ft) of eastern massasauga (EMR) inferred extent, population delineations, and suitable habitat predicted by McCluskey's habitat model within each project disturbance category (i.e., high, medium, and low).

	Road			Bridge		
Feature	High	Medium	Low	High	Medium	Low
EMR 1 km Inferred Extent	0	0	8	0	0	2
EMR 2 km Inferred Extent	0	0	14	0	0	3
EMR Populations	0	0	22	1	0	5
EMR Predicted Habitat	19	3	93	0	0	1

Table 5. Summary of road and bridge projects in MDOT's 5-year statewide transportation plan that occur within 0.8 km (0.5 mi) of eastern massasauga (EMR) inferred extent, population delineations, and suitable habitat predicted by McCluskey's habitat model within each project disturbance category (i.e., high, medium, and low).

	Road			Bridge		
Feature	High	Medium	Low	High	Medium	Low
EMR 1 km Inferred Extent	1	0	16	0	0	11
EMR 2 km Inferred Extent	1	0	21	0	0	11
EMR Populations	7	0	40	5	0	14
EMR Predicted Habitat	112	13	299	45	5	163

Blanding's Turtle

Only a small number of road/bridge projects in MDOT's statewide 5-year transportation plan intersected or were within 30.5 m (100 ft) of where Blanding's turtles are known to occur or have potential to occur based on the GIS modelling and analysis that were conducted for this project. Of the 1,246 total road maintenance or construction projects in MDOT's 5-year plan, only 29 (2%) of the projects intersected or were within 30.5 m (100 ft) of Blanding's turtle 2-km inferred extent (Table 6, Figure 14, and Appendix 7). Of the 712 bridge projects in the 5-year plan, only 9 (1%) projects were within 30.5 m (100 ft) of Blanding's turtle 2-km inferred extent (Table 6, Figure 14, and Appendix 8).

Table 6. Summary of road and bridge projects in MDOT's 5-year statewide transportation plan that occur within 30.5 m (100 ft) of Blanding's turtle 2-km inferred extent within each project disturbance category (i.e., high, medium, and low).

	Road			Bridge		
Feature	High	Medium	Low	High	Medium	Low
Blanding's turtle 2-km Inferred Extent	5	0	24	2	0	7

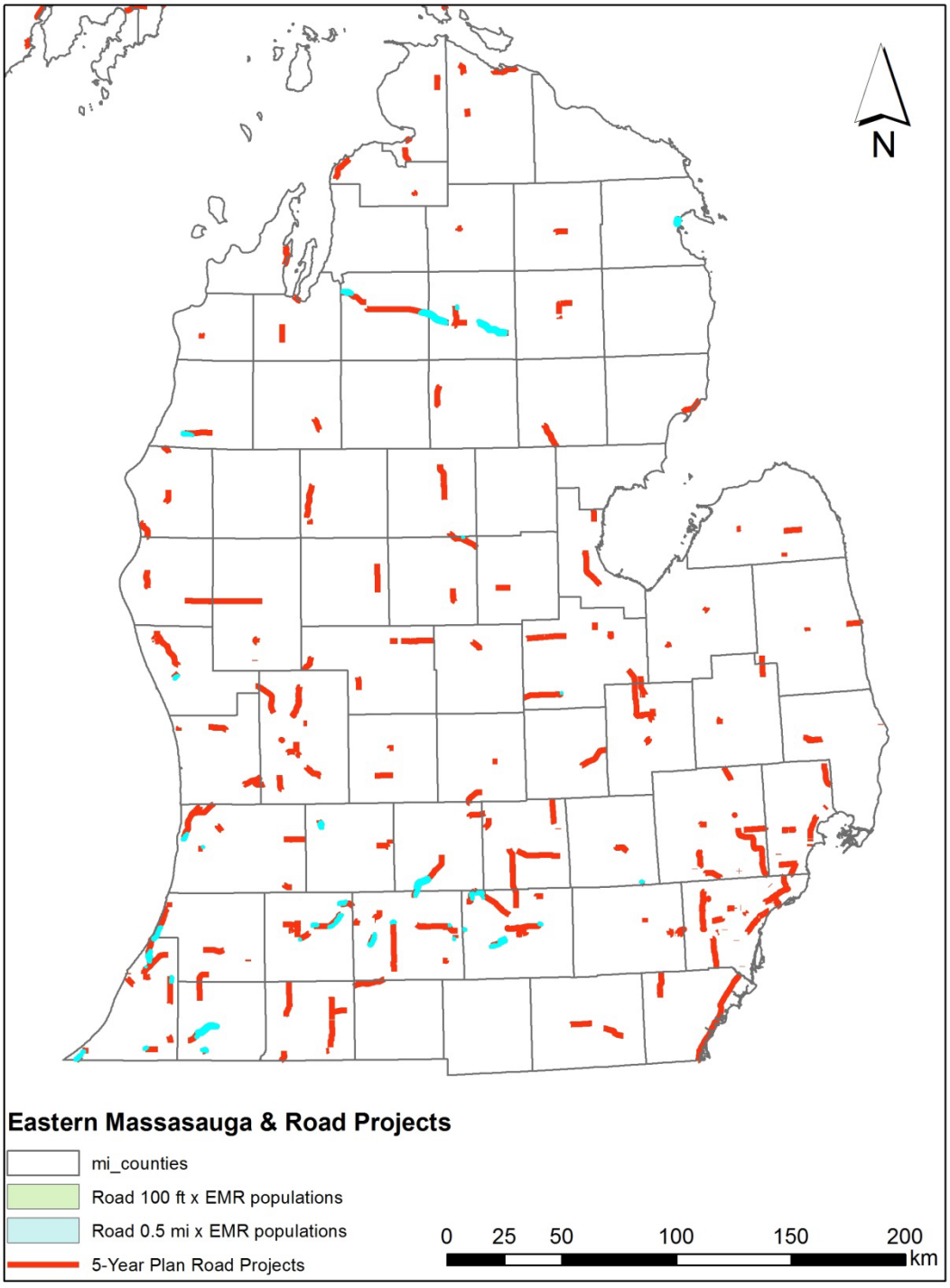

Figure 10. Map showing locations of road projects in the 5-year statewide transportation plan that were within 30.5 m (100 ft) or 0.8 km (0.5 mi) of eastern massasauga 1-km inferred extent, 2-km inferred extent, and/or population delineations in Michigan, shown in light blue.

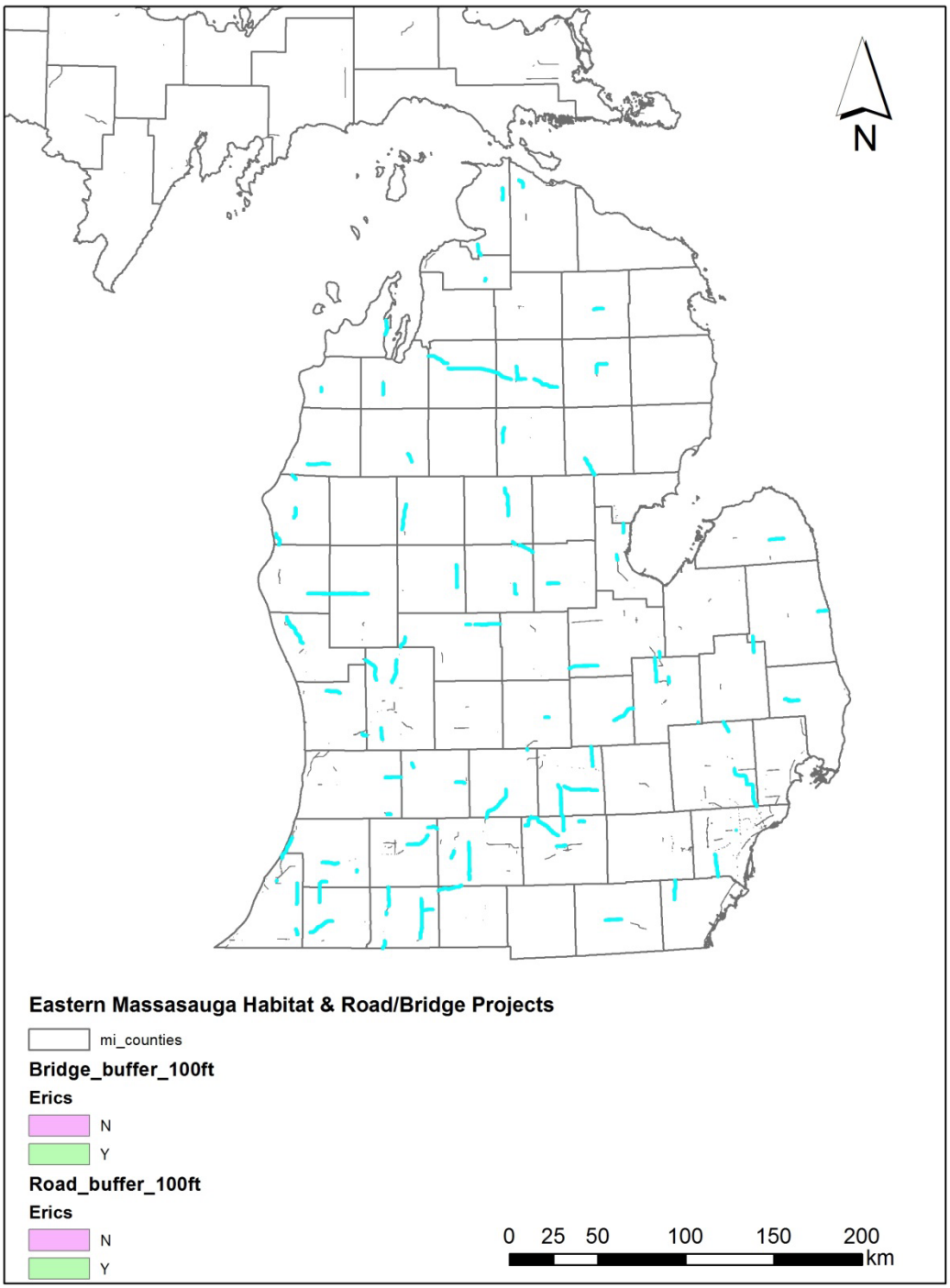

Figure 11. Map showing locations of road and bridge projects in the 5-year transportation plan that were within 30.5 m (100 ft) of areas predicted to be suitable habitat for eastern massasaugas (shown in light blue), based on McCluskey's eastern massasauga species distribution/habitat model (McCluskey 2016).

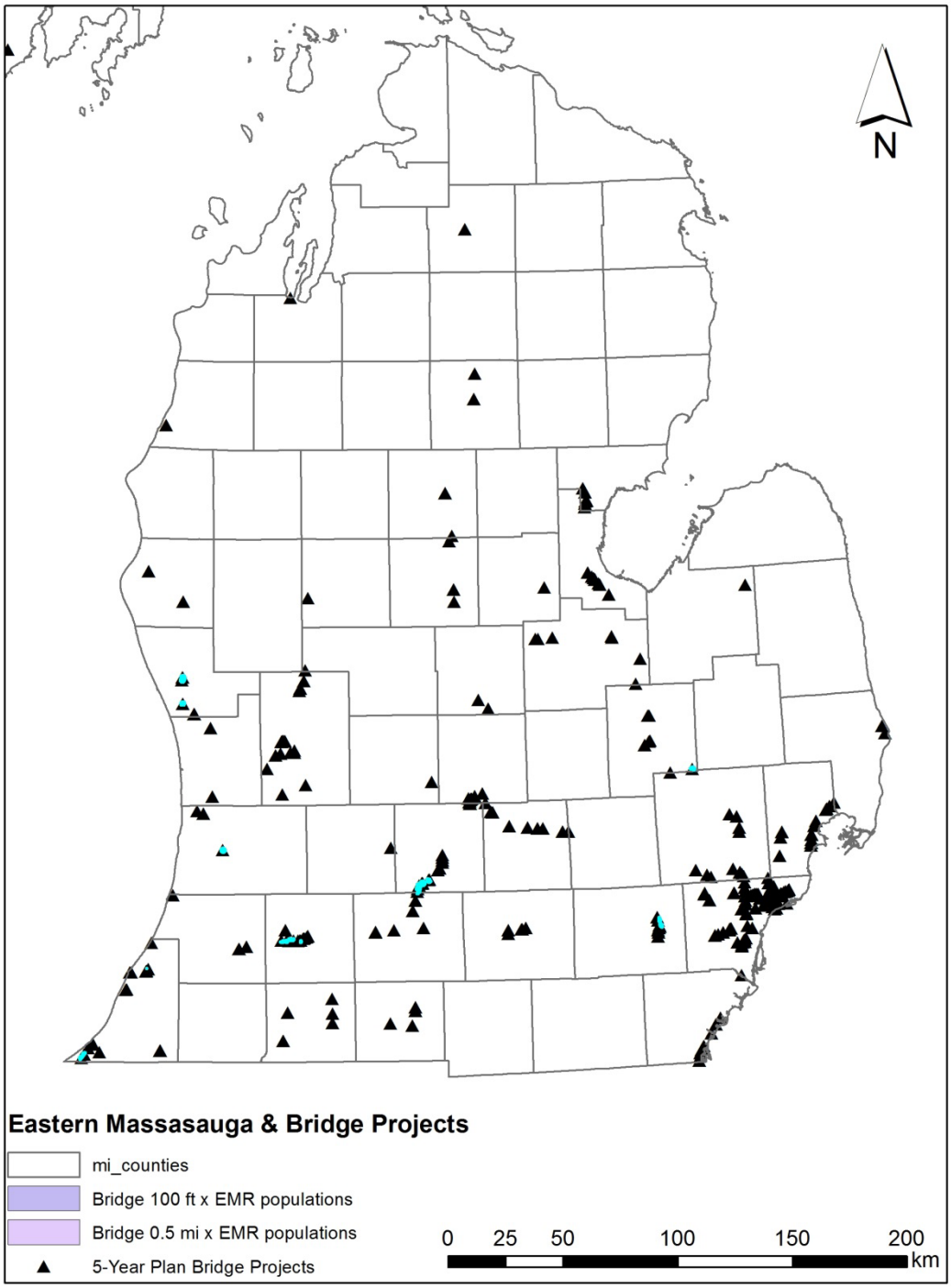

Figure 12. Map showing locations of bridge projects in the 5-year statewide transportation plan that were within 30.5 m (100 ft) or 0.8 km (0.5 mi) of eastern massasauga 1-km inferred extent, 2-km inferred extent, and/or population delineations in Michigan (shown in light blue).

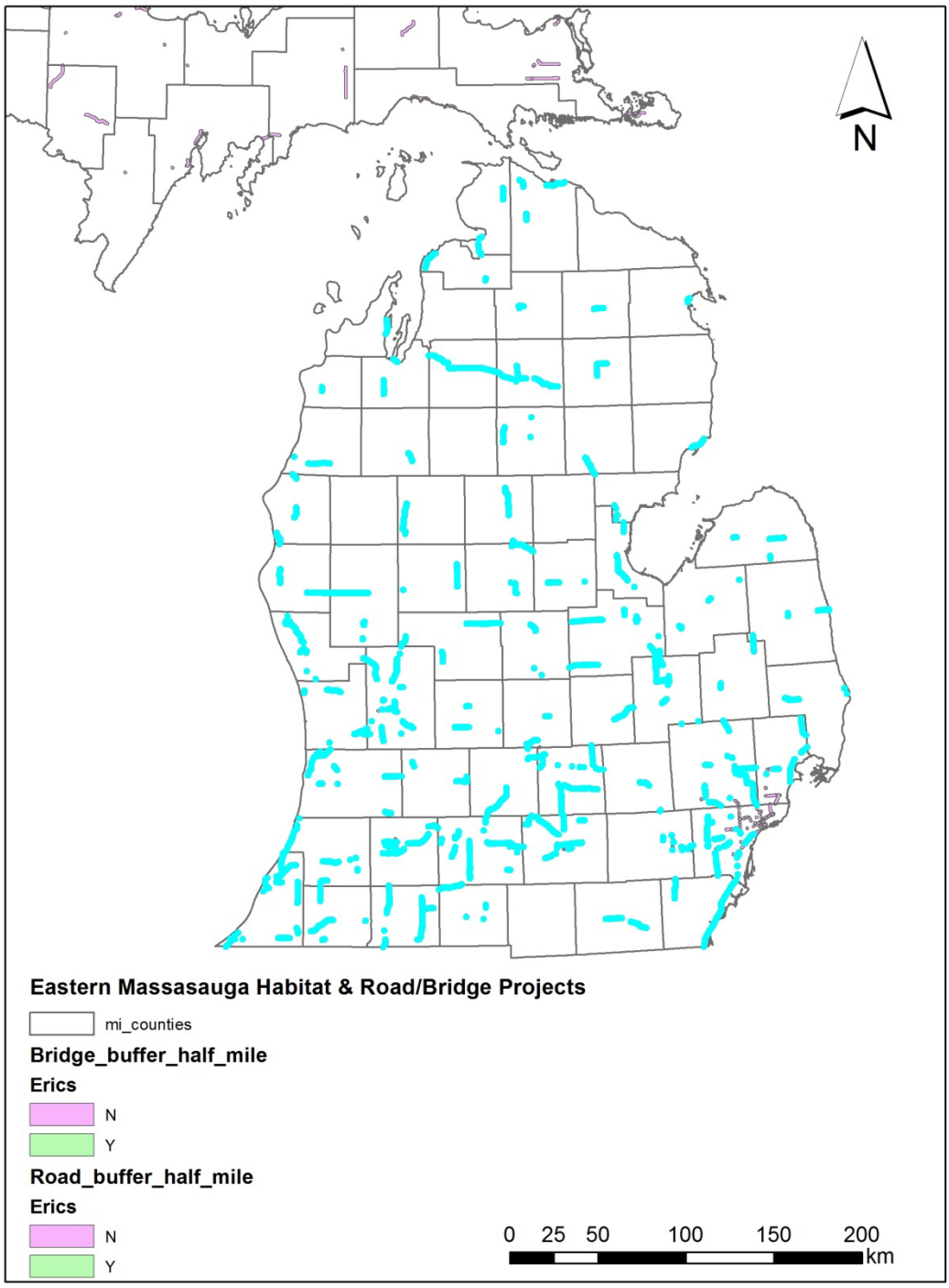

Figure 13. Map showing locations of road and bridge projects in the 5-year transportation plan that were within 0.8 km (0.5 mi) of areas predicted to be suitable habitat for eastern massasaugas (shown in light blue), based on McCluskey's eastern massasauga species distribution/habitat model (McCluskey 2016).

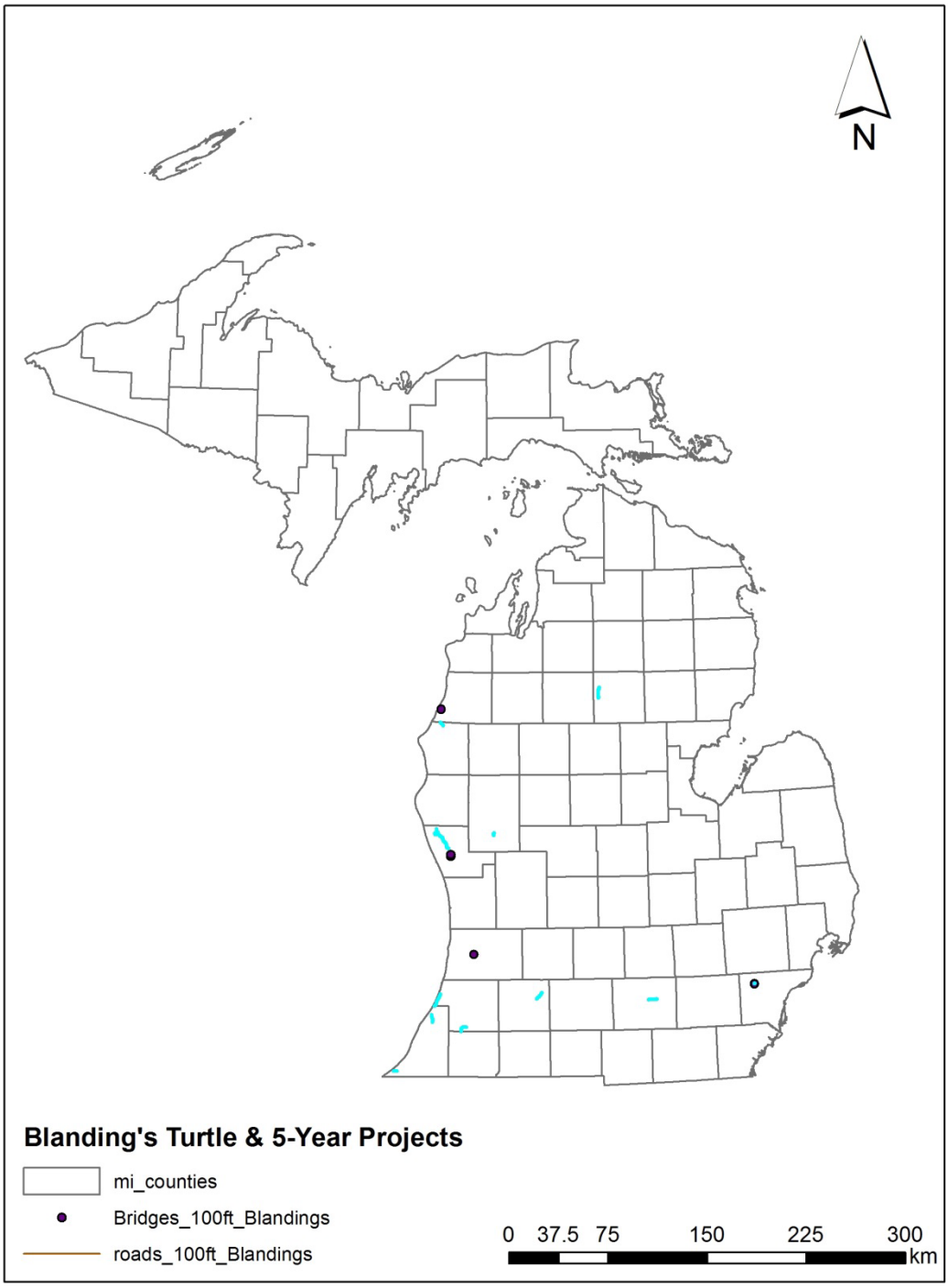

Figure 14. Map showing locations of road and bridge projects in the 5-year transportation plan that were within 30.5 m (100 ft) of Blanding's turtle element occurrences buffered with a 2-km inferred extent in Michigan (shown in light blue and in black).

Assessing Potential Impact of Projects

Eastern Massasauga

Of the 24 road projects in the 5-year plan that were within 30.5 m (100 ft) of eastern massasauga 1-km inferred extent, 2-km inferred extent, and delineated populations, all were ranked as having low impact or disturbance to the ROW and presumably massasaugas if they occur in or along the project sites (Table 4 and Appendix 4). Additionally, of these 24 road projects, five had high-moderate potential or likelihood for massasaugas to occur along the project sites, six had moderate potential, four had moderate to low potential, and nine had low potential for massasaugas to occur along the project sites (Appendix 4). These projects were within 30.5 m of 16 different massasauga populations (Appendix 4). Figure 15 provides an example of one of the road projects that was ranked as having high to moderate potential for massasaugas to occur at or along the project site.

Of the six bridge projects that were within 30.5 m (100 ft) of eastern massasauga 1-km inferred extent, 2-km inferred extent, and delineated populations, only one was ranked as having high impact or disturbance to the ROW and potentially massasaugas if they occur along the project site, and the remaining projects were ranked as having low impact to the ROW and species potentially (Table 4 and Appendix 5). However, the project ranked as having high impact to the ROW was ranked as having low potential or likelihood for massasaugas to occur along the project site (Appendix 5), so the potential for this project to impact massasaugas is likely low unless the species is reconfirmed in the area. Of the remaining 5 bridge projects, only one was ranked as having moderate potential and the remaining four were ranked as having low potential for massasaugas to occur along the project sites (Appendix 5). These bridge projects were associated with five different massasauga populations (Appendix 5).

Of the 115 road projects that were within 30.5 m (100 ft) of areas predicted to have suitable massasauga habitat according to McCluskey's massasauga habitat model, only 19 projects were ranked as having high impact/disturbance and only 3 projects were ranked as having medium impact to the ROW and massasaugas potentially (Table 4 and Appendix 6). Of the 19 projects that were ranked as having high levels of disturbance to the ROW, only one project was ranked as having moderate to low potential for massasaugas to occur along the project site (Figure 16 and Appendix 6). The remaining projects were ranked as having low or no potential for massasaugas to occur along the project site (Figure 16 and Appendix 6). All three projects that were ranked as having medium levels of disturbance to the ROW were ranked as having little to no potential for massasaugas to occur in or along the project site (Appendix 6). Most of the projects ranked as having high or medium levels of disturbance were not near known massasauga EOs or populations, and appeared to have little to no suitable habitat for massasaugas adjacent to or near the project sites based on aerial photo interpretation (Appendix 6).

Only one bridge project in the 5-year plan was within 30.5 m (100 ft) of areas predicted to have suitable massasauga habitat according to McCluskey's habitat model (Table 4 and Appendix 6). This project was ranked as having low impact on the ROW and low potential or likelihood for massasaugas to occur along the project site (Appendix 6). This project site was located in the vicinity of a known massasauga EO/population but no recent observations of massasaugas have been documented, and no suitable habitat appears to occur immediately adjacent to the project site.

Of the 47 road projects in the 5-year plan that were within 0.8 km (0.5 mi) of eastern massasauga 1-km inferred extent, 2-km inferred extent, and delineated populations, only seven were ranked as having high impact or disturbance to the ROW and potentially massasaugas, and the remaining projects were ranked as having low impact to the road ROW and massasaugas (Table 5 and Appendix 4). Of these seven road projects, only one had moderate potential for massasaugas to occur along the project site, and the remaining projects had moderate to low or low potential for massasaugas to occur along the project sites (Appendix 4 and Figure 15). The high impact projects were within 0.8 km (0.5 mi) of four different massasauga populations, and the low impact projects were in the vicinity of 12 additional populations (Appendix 4).

Of the 19 bridge projects in the 5-year plan that were within 0.8 km (0.5 mi) of eastern massasauga 1-km inferred extent, 2-km inferred extent, and delineated populations, only 5 of the projects were ranked as having high impact or high level of disturbance to the ROW and potentially massasaugas (Table 5 and Appendix 5). Of the five high impact projects, four of the projects (actually four phases of the same project/job) were ranked as having moderate to low potential or likelihood for massasaugas to occur along the project sites, and the remaining project was ranked as having low potential for the species to occur along the project site (Appendix 5). The five high impact projects were associated with two different massasauga populations, and the 14 low impact projects were associated with eight additional populations (Appendix 5).

Blanding's Turtle

Of the 29 road projects that occur within 30.5 m (100 ft) of the Blanding's turtle 2-km inferred extent features, only five were ranked as having high impact or disturbance to the project site ROW (Table 6 and Appendix 7). The remaining projects were ranked as having low impact or disturbance to the ROW (Table 6 and Appendix 7). The five projects ranked as having high disturbance to the ROW occur near two different Blanding's populations, and were ranked as having high to moderate potential for the species to occur at or along the project sites (Appendix 7, and see Figure 8 for example of one of these projects/populations). This was based on the projects' proximity to known Blanding's turtle EOs/populations and the presence of suitable or potential Blanding's turtle habitat along or near the project sites.

Of the nine bridge projects that occur within 30.5 m (100 ft) of the Blanding's turtle 2-km inferred extent features, only two were ranked as having high impact or disturbance to the project site ROW (Table 6 and Appendix 8). The remaining projects were ranked as having low impact or disturbance to the ROW (Table 6 and Appendix 8). The two bridge projects ranked as having high disturbance to the ROW occur near one Blanding's turtle EO/population, which is also one of the populations near one of the high impact road projects mentioned above (Table 6 and Appendix 8). These projects were ranked as having high to moderate potential for the species to occur at or along the project sites (Appendix 8). This was based on the projects' proximity to a known and recent Blanding's turtle EO/population and the presence of suitable or potential Blanding's turtle habitat along or near the project site.

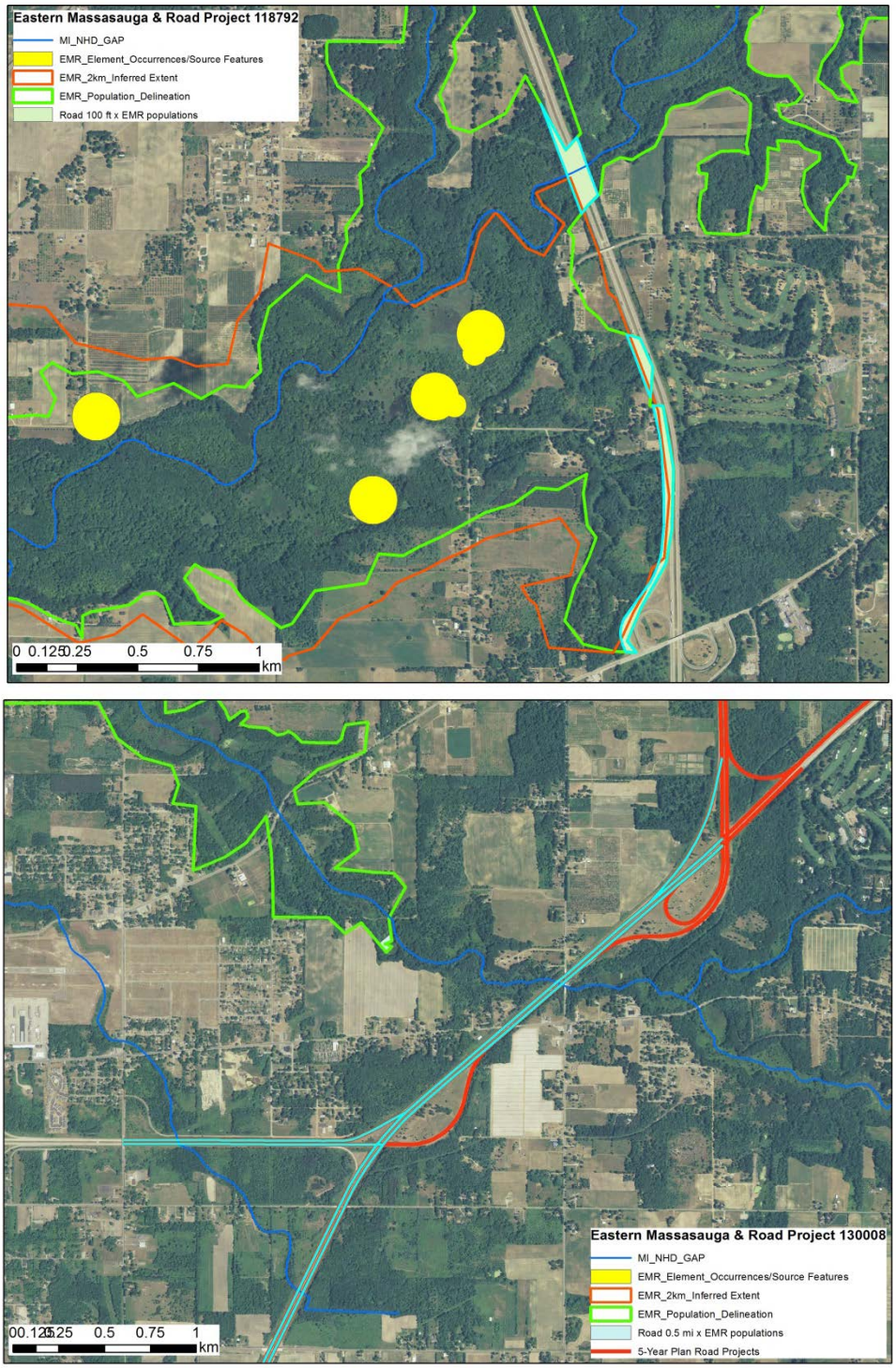

Figure 15. Examples of road projects in the 5-year plan (highlighted in light blue) that were ranked as having high to moderate potential (top air photo) and moderate to low potential (bottom air photo) for eastern massasaugas (EMR) to occur at or along the project site. The project in the top photo was within 30.5 m (100 ft) of EMR source features, 1-km and 2-km inferred extent, and population delineation, and suitable habitat for EMRs occur adjacent to the project site. The project in the bottom photo was within 0.8 km (0.5 mi) of the same EMR population delineation as in the top photo, but was farther away from documented locations of the species, and there is some but not very much suitable habitat along the project site.

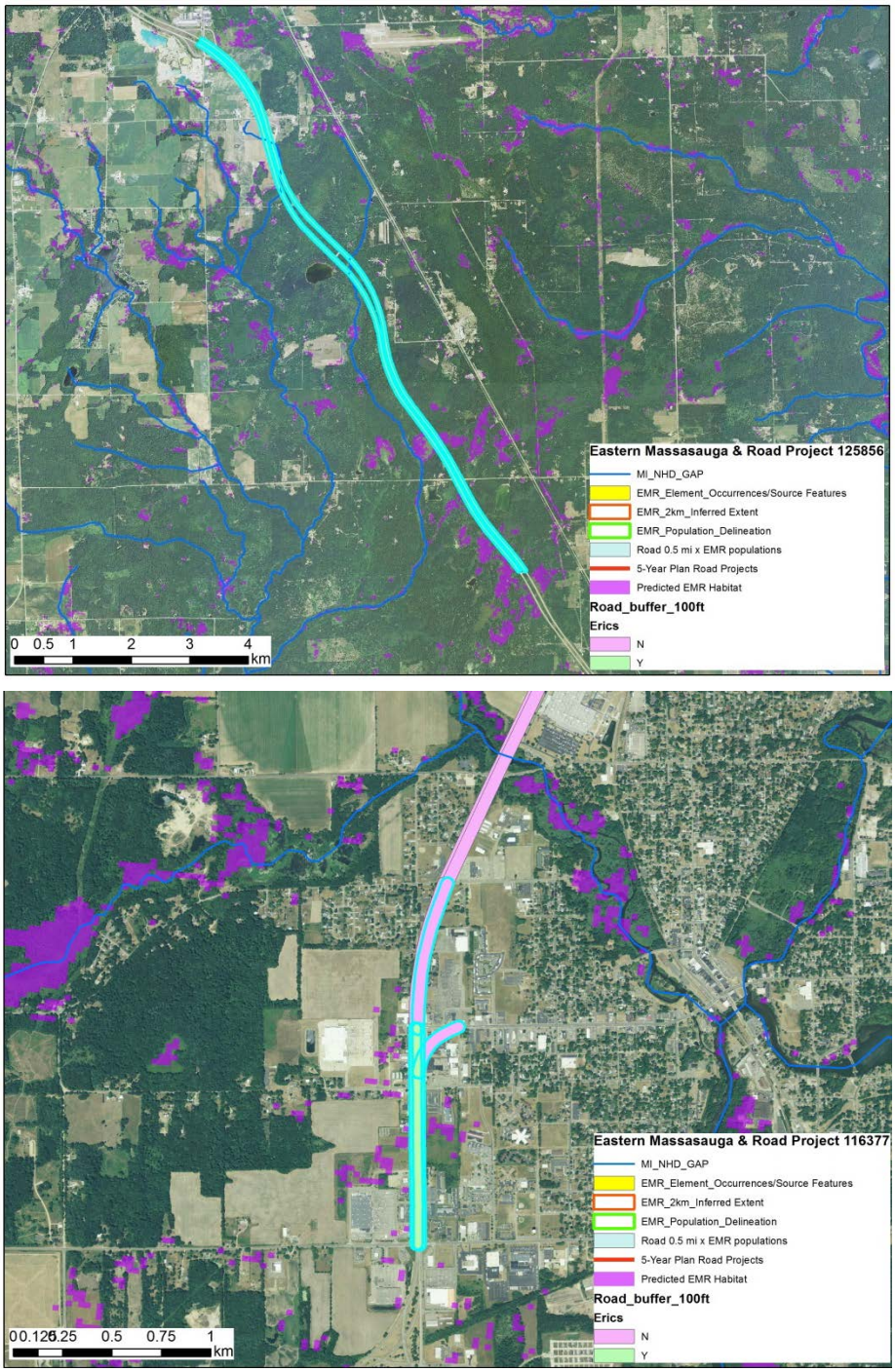

Figure 16. Examples of road projects in the 5-year plan (highlighted in light blue) that occur within 30.5 m (100 ft) of areas predicted to have suitable habitat for eastern massasaugas (EMRs) based on McCluskey's eastern massasauga habitat model (McCluskey 2016) that were ranked as having high impact or level of disturbance to the project right-of-way (ROW). The project in the top photo was ranked as having moderate to low potential for EMRs to occur at or along the project site because of the presence of some suitable or potential EMR habitat along the project site. The project in the bottom photo was ranked as having no potential for EMRs to occur at or along the project site based on lack of suitable habitat observed in the air photo.

DISCUSSION

The GIS modelling and analysis conducted as part of this project provides a useful tool and approach for identifying and assessing future transportation projects that may impact emerging species of concern that may be listed under the federal Endangered Species Act such as the eastern massasauga and Blanding's turtle. This information will help facilitate planning and consultations to identify and incorporate mitigation measures, if needed, early in the planning process which will help keep MDOT projects on schedule. This analysis also helps identify data needs and sites that could benefit from surveys prior to implementation of projects.

Overall, only a small number of the road and bridge projects in the 5-year plan were located in the vicinity (i.e., within 30.5 m/100 ft or 0.8 km/0.5 mi) of sites where massasaugas have been documented in the NHD or have potential to occur based on inferred extent and population models. The total number of road and bridge projects in the 5-year plan that were located within 30.5 m (100 ft) of a massasauga inferred extent and/or population delineation was 30 projects, and 66 projects within 0.8 km (0.5 mi) (Tables 4 and 5) out of approximately 2,000 road and bridge projects total. Most of these projects were ranked as having low impact or level of disturbance on the ROW and presumably species of concern. All but one of the road and bridge projects within 30.5 m (100 ft) and 54 of the 66 projects within 0.8 km (0.5 mi) of massasauga 1-km inferred extent, 2-km inferred extent, and population delineations were ranked as having low impact on the ROW and presumably on massasaugas as well. Furthermore, the projects that were near massasauga EOs, inferred extent, and/or populations and were ranked as having high impact on the ROW only had moderate to low potential for massasaugas to occur along the ROW. As a result, based on information currently available, the likelihood these high disturbance projects would impact massasaugas is probably moderate to low.

Because a systematic, statewide survey for massasaugas and/or habitat for the species has not been conducted in Michigan, there is potential for the species and suitable habitat to occur in new or additional areas that are not in the vicinity of currently known EOs/populations. Incorporating a massasauga species distribution model developed by Eric McCluskey that tried to predict areas with suitable habitat for the species and where the species might occur in the GIS analysis allowed us to assess the potential for projects in the 5-year plan to impact massasaugas in areas where they have not been documented or have not been surveyed yet. Intersecting the project sites in the 5-year plan with predicted massasauga habitat from McCluskey's habitat model identified a much larger number of projects that may impact massasaugas compared to the analysis based on known massasauga EOs/populations. These included a number of projects that were ranked as having high or medium impact on the ROW, with 22 road projects within 30.5 m (100 ft) of predicted suitable massasauga habitat and 125 road projects and 50 bridge projects within 0.8 km (0.5 mi) of predicted suitable habitat (see Tables 4 and 5). However, although the model predicted the presence of suitable habitat near these project sites, visual inspection of recent aerial imagery revealed that this may not be the case. For example, of the 22 road projects that were within 30.5 m (100 ft) of predicted habitat for massasaugas and ranked as having high or medium impact on the ROW, only one project appeared to actually have suitable habitat for massasaugas along the project site based on aerial photo interpretation. The remaining projects were evaluated as having little to no potential for massasaugas to occur along the sites because there did not appear to be any suitable habitat along these sites (Appendix 6). These results suggest that the McCluskey habitat model may be overpredicting habitat for massasaugas at least

in some areas, or that the threshold value we selected for the model may need to be adjusted. Additional review and analysis of the projects that were identified as having potential to impact massasaugas based on predicted habitat in the habitat model are warranted.

The Blanding's turtle results were similar to the massasauga results in that only a small number of road (n=29) and bridge (n=9) projects in the 5-year plan intersect or were located within 30.5 m (100 ft) of a 2-km inferred extent around documented occurrences in the NHD. Only seven (18%) of these projects were ranked as having high impact on the ROW. However, unlike the massasauga results, all seven projects were ranked as having high to moderate potential for Blanding's turtle to occur along the project site, based on proximity to EOs and available habitat according to the IE models and air photo interpretation. Based on the project disturbance rankings and potential for the species to occur along the project sites, these projects have high to moderate potential for impacting Blanding's turtles. Field surveys around these project sites could help clarify habitat conditions and whether the species does occur or have potential to occur along the project sites.

If eastern massasaugas and Blanding's turtles could be impacted during future road and bridge projects, mitigation measures could reduce the potential for adversely impacting these species. Such measures include the following: 1) conducting project activities on land during the species' inactive season (i.e., November through March) or during the active season when individuals move less frequently (e.g., late July through early to mid-October for Blanding's turtles, Beaudry et al. 2010); 2) installing temporary or permanent barriers (e.g., fencing, drift fences) outside the project area that would prevent turtles and snakes from accessing the project area during and/or after project implementation (e.g., Dodd et al. 2004, Aresco 2005a, Glista et al. 2009, Langen 2011); 3) providing safe passage for turtles and snakes to get around the project site and maintain habitat/population connectivity (e.g., installing barriers or drift fences to direct turtle movement to areas that allow safe passage (e.g., streams/rivers, road culverts, underpasses) (Yanes et al. 1995, Dodd et al. 2004, Woltz et al. 2008, Glista et al. 2009); and/or 4) surveying for or keeping an eye out for turtles immediately before conducting project activities and during project implementation and moving any turtles that are found inside the project area to outside the project area. Colley (2015) reported that barrier fencing and ecopassages were effective at minimizing road mortality, facilitating safe passage and habitat connectivity, and promoting population viability of eastern massasaugas at Killbear Provincial Park in Ontario, Canada.

It is important to note that the results of this analysis were partly based on expert opinion, GIS models, and currently available information and data layers which have some limitations and are based on some assumptions. It was already mentioned that information on the locations of massasauga occurrences and suitable habitat in the Michigan NHD is incomplete due to lack of systematic, statewide surveys. The same is true for Blanding's turtles. Potential exists for both species to occur at additional sites which are currently not in the NHD. Additional surveys and efforts to compile information on occurrences of both species should be conducted, particularly along future road and bridge project sites ranked as having high impact on ROWs and on private lands. As new occurrences are likely going to be documented in the NHD and as additional information on these species will become available in the future, this type of assessment of potential impacts of proposed road and bridge projects on these species should be revisited and updated in the future.

Additionally, the inferred extent models for both species and the massasauga population delineations were based on our current knowledge and understanding of these species' ecology (i.e., habitat use and requirements, home range size and maximum movement distances), available land cover data, and expert opinion (e.g., which CCAP land cover classes to include as suitable habitat, and distances the species could move through different land cover classes). The cost-weighted distance model for the eastern massasauga and resulting population delineations also were based on several assumptions. These include treating paved roads as barriers to massasauga movement and using them to delineate separate massasauga populations in some cases. Another assumption was allowing streams to connect occupied areas and areas with suitable habitat including those separated by paved roads and busy highways. Streams may connect areas and provide suitable dispersal or movement corridors at some sites but perhaps not at other or all sites. These assumptions should be revisited and further evaluated in the future. The overall maximum allowable cost distance of five km and maximum cost distances for specific land cover classes also could potentially be reconsidered and refined. Additional information about massasauga and Blanding's turtle distribution and ecology, particularly habitat use and dispersal, as well as information about habitat availability and conditions on the ground could help refine the inferred extent models and population delineations. Additional massasauga observations and surveys in areas with suitable habitat that connect documented sites but currently lack massasauga sightings could help refine population delineations.

When assessing the potential for these species to occur at or along the project sites and potential for these species to be impacted by these projects, it also is important to consider the species' tendency to move across the landscape and use or cross roads. For example, Shepard et al. (2008) found that eastern massasugas in a population in southern Illinois avoided crossing roads, with only three out of 40 adult massasaugas that were transmittered and located daily documented crossing or trying to cross roads and only four times total. Other researchers and studies have also reported similar results (Dreslik pers. comm., Kingsbury pers. comm.). If massasaugas avoid crossing roads, they may be less likely to occur on or along roads and less vulnerable to impacts from road maintenance and construction activities, even if suitable habitat is available along the project site. However, massasauga avoidance of roads or tendency to cross roads may vary depending on the local population, road and traffic conditions, available habitat along the road, proximity to other areas needed for their life history (e.g., overwintering, gestation, and foraging areas), and degree of site fidelity (Shepard et al. 2008, Rouse et al. 2011). Blanding's turtles, on the other hand, utilize complexes comprised of multiple wetlands and surrounding upland habitats, and move frequently overland among wetlands (Compton 2007). They also often move long distances to find suitable nesting sites (Compton 2007). Because Blanding's turtles make frequent and extensive movements overland, they often cross roads (Grgurovic and Sievert 2005, B. Compton, unpublished data and F. Beaudry, unpublished data in Compton 2007). Thus, they may be more vulnerable to impacts from road maintenance and construction activities than massasaugas and other less vagile herp species.

As indicated earlier, the massasauga habitat model developed by McCluskey (2016) may need some additional review and refinement. When we reviewed the aerial imagery around the high impact road and bridge projects that were identified as occurring near suitable massasauga habitat predicted by the McCluskey habitat model, we found that most of the projects did not appear to be adjacent to or near suitable habitat for massasaugas based on aerial imagery. However, we manually reviewed only a subset of the project sites (i.e., high impact projects) that

were identified as occurring near predicted habitat. Review of additional sites is warranted. It may be useful to examine the massasauga habitat model and areas predicted to be suitable habitat with the cost-weighted distance analysis and population delineations to see if the habitat model could help refine the population delineations.

To try to develop a valid and efficient approach for identifying projects that may impact massasaugas, we investigated the use of different buffer distances (i.e., 30.5 m/100 ft and 0.8 km/0.5 mi) and different features such as inferred extent with different buffer distances (1 km and 2 km), massasauga population delineations, and McCluskey's habitat model. As expected, the analysis using 0.8 km (0.5 mi) as the filter for identifying projects that have potential for impacting massasaugas flagged more projects than using the 30.5 m (100 ft) distance filter (e.g., 47 projects compared to 24 for road projects). However, most of the projects that were flagged using the 0.8 km (0.5 mi) distance were ranked as having low to no potential for massasaugas to occur along the project sites because there appeared to be little to no suitable habitat present along the project sites (Appendices 4 and 5). Using a buffer distance of 30.5 m (100 ft) may be sufficient and more efficient since inferred extent and the population delineations already include a buffer around the actual species' locations. In terms of the features that were analyzed, the projects that were identified based on proximity to massasauga 1-km and/or 2 km-inferred extent features also were included when the analysis identified projects near massasauga population delineations (Appendices 4 and 5). Thus, for massasaugas, it may be more efficient and more conservative to focus the analysis on the population delineations because the analysis would likely include all the projects that would get flagged using the 1-km and 2-km inferred extent features but not all the projects that would get flagged using the habitat model. However, using 1-km and/or 2-km inferred extent for this type of assessment is still fairly efficient, and generally identifies projects that are closer to documented EOs/locations than using population delineations and habitat models. Also, based on earlier comments about the habitat model, it may be more reliable to use documented massasauga EOs, inferred extent, and/or population delineations for this type of assessment at this time until the massasauga habitat model is further field tested, reviewed, and/or refined, or use the model in conjunction with these other features.

While the GIS modelling and analysis conducted for this project have provided insight into future transportation projects that may impact eastern massasaugas and Blanding's turtle, other approaches also may be utilized to help identify project sites or areas where these species frequently cross roads and may be particularly vulnerable to road mortality and maintenance and construction projects. For example, Langen et al. (2007) and Langen et al. (2008) found that amphibian and reptile road mortality tends to be spatially clustered along road networks. They were able to develop models that could predict amphibian and reptile road mortality "hot spots," identify valid predictors of these hot spots, and develop a general methodology for creating and validating predictive models of spatial patterns of reptile and amphibian road mortality that can be applied elsewhere by road managers and environmental planners during road design or development of mitigation plans (Langen et al. 2008). Langen et al. (2008) found that presence of wetlands within 100 m (328 ft) of the road, and wetland configuration within 100 m of the road, such as the presence of causeways (raised road with wetlands on both sides of the road), are valid predictors of reptile and amphibian road mortality hot spots in northeastern New York. Factors such as the design and age of the road; traffic patterns; wetland composition, size, and orientation; presence or absence of culverts, bridges, or other potential passageways; and land cover or land use around the road and wetlands may influence which causeways are more prone

to herpetofauna road mortality than others (Langen et al. 2008). Langen et al. (2008) identified 3 steps for locating sites that should be priorities for mitigation or sites to avoid when planning new roads. The first step is to obtain accurate data on spatial patterns of reptile and amphibian road mortality (Langen et al. 2008). The second step is to determine what features of the landscape, road, or local traffic patterns correlate with hot spots of reptile and amphibian mortality, and validate them using different road networks in different landscapes. The final step is to create a simple protocol by which road agency personnel and environmental managers can use the predictors to survey potential hot spots of road mortality and prioritize these sites for mitigation (Langen et al. 2008). This approach could be tailored and applied to eastern massasaugas and Blanding's turtle or coupled with our previous analysis to identify where these and other emerging species of concern may be particularly vulnerable to future road and bridge projects, valid predictors of hot spots, and where mitigation measures may be needed.

CONCLUSIONS

Overall, at this time, it appears that only a small number of future road and bridge projects identified in MDOT's 5-year transportation plan have potential for impacting eastern massasaugas and Blanding's turtles. This approach (using inferred extent and population delineations) seems to be a useful planning tool for helping to identify future projects that may impact these species, which could be applied to other species of conservation concern. This approach not only takes into account where species have been documented but also considers where they have potential to occur. Identifying and assessing projects within 100 ft of inferred extent and/or population delineations seemed to be an adequate and efficient approach. Species distribution or habitat models, such as McCluskey's habitat model for the eastern massasauga, also can be useful but may require more time and manual evaluations due to potential for false positives. Other approaches also may be effective for identifying or predicting project sites that may impact these species, and should be considered and utilized. Finally, it is important to revisit and update this analysis in the future as information on occurrences of these species continues to change and get updated in the Natural Heritage Database, and as new, additional information on the status, distribution, and ecology of these species becomes available over time.

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APPENDICES

Appendix 1. Summary of background information on habitat, movement distances, and home range sizes for eastern massasaugas, based on available information and literature, that was used to help inform development of the massasauga cost-distance analysis/model, population delineations, and viability assessment.

Suitable habitat – habitat capable of supporting reproduction or used regularly for feeding or other essential life history functions; a habitat in which you would expect to find the species (assuming appropriate season and conditions); includes marginally suitable habitat that is contiguous with clearly suitable habitat (from NatureServe 2004).

- Early to mid-successional wetlands and uplands
- Forested uplands and wetlands with canopy gaps and/or adjacent to open uplands or wetlands
- Macrohabitats used by *S. c. catenatus* range-wide include bogs, marshes, peatlands, swamp forests, fens, coniferous forests and lowland hardwood forests (Wright, 1941; Smith, 1961; Reinert and Kodrich, 1982; Seigel, 1986; Weatherhead and Prior, 1992; Johnson and Leopold, 1998).
- The vegetation types that were used by EMRs more than expected based on availability were herbaceous openland, oak association, lowland deciduous forest, floating aquatic, lowland shrub, emergent wetland, and mixed non-forest wetland. Again, the oak association was early to mid-successional. However, the lowland deciduous forest incorporated into the fixed kernel home range for all EMRs at PCCI during both study years was mid to late successional. All other vegetation types mentioned were early to mid-successional. (Bissell 2006)
- Preferred early to mid-successional wetlands and uplands followed by roads and other bare ground features (Bailey 2010)
- Emergent>scrub-shrub> lowland >agric>bare>upland>golf>grass>residential (Moore 2004)
- Barrens (BA): open areas with no canopy and ground cover dominated by lichen and blueberry (*Vaccinium spp*); Closed Canopy Deciduous (CCD): forest with greater than 50% canopy and dominated by either red maple (*Acer rubrum*), oak (*Quercus spp*), or quaking aspen (*Populus tremuloides*); Forest Edge (ED): 15m in either direction of the boundary of a forested habitat and an open habitat; and Scrub Shrub Open (SSO): an area with low canopy cover, <30%, and dominated by low growing shrubs such as blueberry, black cherry (*Prunus serotina*), speckled alder (*Alnus incana*), or willow (*Salix spp*). (DeGregorio 2008)
- IL - grasslands (Dreslik 2005)

Unsuitable habitat - habitat through which the species may successfully disperse but that cannot support reproduction or long-term survival (NatureServe 2004).

- Late successional closed-canopy forest – uplands and wetlands, densely shaded
- EMRs tended to avoid late-successional veg types (wetlands and uplands) with low stem densities and absolute dominance of trees >3 m tall. (Bissell 2006)
- Heavily forested cover/coniferous forests seldom selected unless associated with forest openings (Bailey 2010)

- Snakes avoided human-altered landscapes & adj upland hardwoods; none found on road and never entered golf courses (Moore 2004) – [*But have been found on golf courses at other sites.*]
- Closed Canopy Coniferous (CCC): forest with greater than 50% canopy cover and dominated by either black spruce (*Picea mariana*) or white cedar (*Thuja occidentalis*); Pine (PN): forest dominated by either red pine or jack pine (DeGregorio 2008)
- Densely urbanized area dominated by buildings and pavement / human-altered landscapes

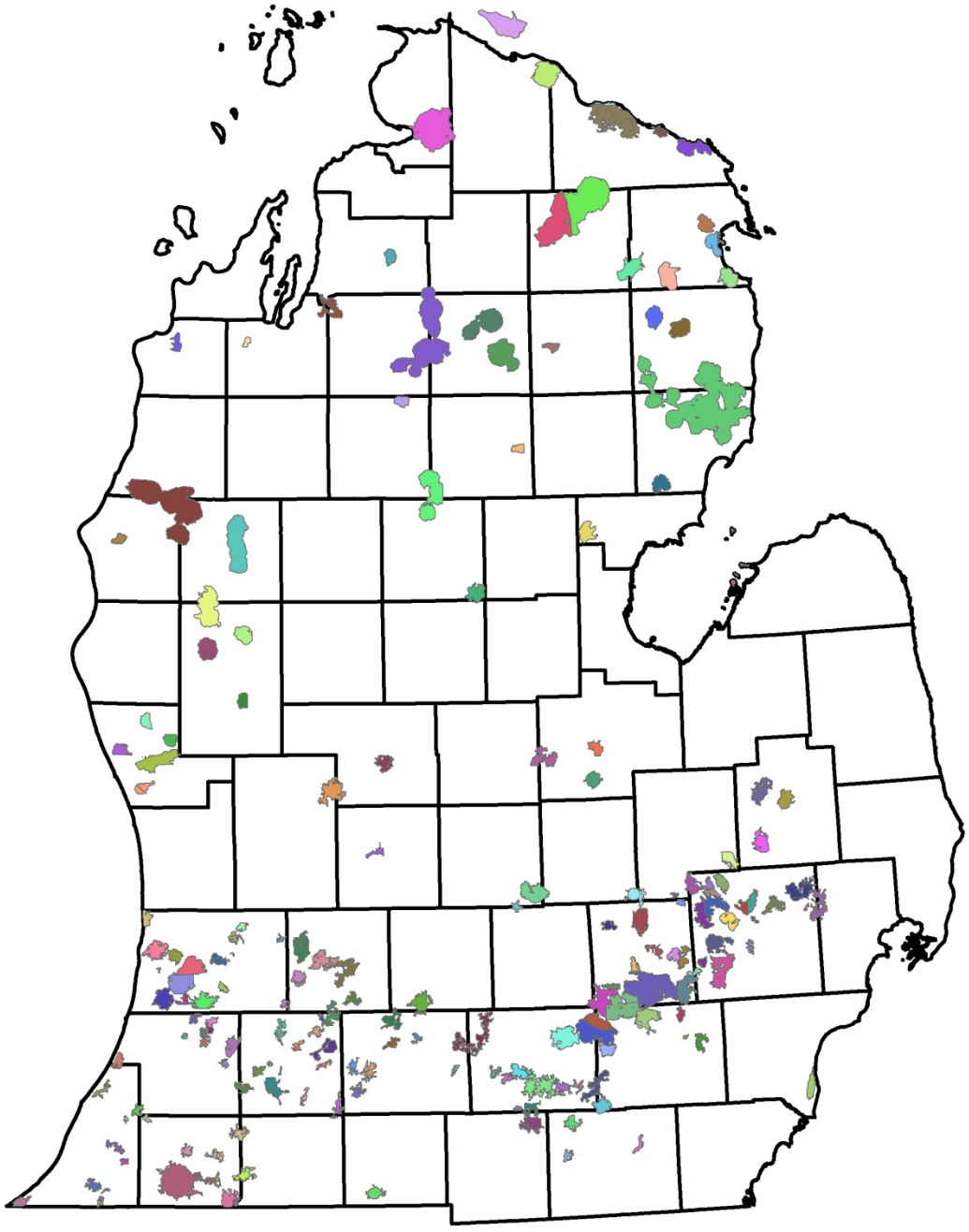
Eastern massasauga movement and home range information based on radio-telemetry studies:

State/ Location	Reference	Mean / Max Distance Moved/Day (m/d)	Mean and Max Range Length (m)	95% fixed kernel home range - mean & max (ha/ac)	MCP home range - mean & max (ha/ac)
SW MI	Bissell 2006	11.6 mean / 315.6 mean daily max	(1,334 mean/ 5,369 max sum/ total distance travelled)	2.8 ha/ 7 ac mean / 17.3 ha / ~40 ac max	2.5 ha mean / 17.9 ha max
SW MI	Bailey 2010	-	-	5.21 ± 4.28 ha / 13 ± 10.6 ac	-
SE MI	Sage 2005	14.6 mean	-	6.2 ha / 15 ac mean	-
SE MI	Moore 2004	6.87 ± 1.14 / 19.27 max	225.73 ± 32.63 mean (1 female moved 465 m)	2.88 ha/ 7 ac mean / 14.19 ha max	1.29 ha / 3 ac mean/ 4.52 ha/11 ac max
N. MI	DeGregorio 2008	-	660 ± 60.1 mean/ 963.3 ±95 max; suitable habitats should be within 500 m	3.8 ± 1.0 ha / 9.4 + 2.5 ac mean (50% core); males – 6.9 ± 1.9 ha (50% core)	16.7 ha ± 2.7 / 41 ac + 6.7 ac mean; 95.07 ha max; males – mean 29.8 ± 4.9 ha
W. PA	Reinert & Kodrich 1982	9.1 mean	89.0 mean	-	1.0 ha / 2.5 ac mean
IL	Phillips et al. 2002	13.1 mean		3.3 ha / 8.2 ac mean	
IL	Dreslik 2005	163 m mean / 600 m max	-	Max – males – 2.57 ± 1.24 ha mean / 4.48 max	Max – males – 5.04 ± 6.68 ha mean/ 32.36 ha max
IN	Kingsbury et al. 2003				1.0 ha / 2.5 ac mean
IN	Marshall et al. 2006	Max – males – 15.13 mean	Max – males – 417.19 ± 69.70 mean; total dist. Moved –1653 ± 239	Max – males – 12.5 ± 2.3 ha	Max – males – 7.32 ± 1.44 ha
WI - MC	Durbian et al. 2008		272 ± 74 mean	5.5 ± 3.1 ha 95%	2.4 ± 1.6 ha

NY	Johnson 2000	19.5 m	797 ± 81 m mean; max mean 1212 ± 110 m (max total dist moved - 3712	7.4 ha / 18 ac; 50% MCP – 5.2 ha mean / 6.3 ha max	26.2 ± 4.49 ha / 65 ac mean/ max – NG females – 41.4 ± 3.36 ha
ONT	Weatherhead & Prior 1992	56 mean / 1,438 max	1030.40 mean		25 ha / 62 ac mean / 76 ha /188 ac max
WI - JC	Durbian et al. 2008		1,378.6 ± 1,102 mean	25.8 ± 24.5 ha 95%	135.8 ± 134.2 ha
MO - SCNWR	Durbian et al. 2008		669.9 ± 83.7 mean	18.8 ± 4.3 ha 95%	17.2 ± 4.3 ha
MO - PSP	Durbian et al. 2008		643.2 ± 147.3 mean	18.8 ± 8 ha 95%	11.9 ± 3.8 ha
MO - SLNWR	Durbian et al. 2008		475.6 + 72.9 mean	6.5 ± 1.0 ha 95%	7.4 ± 1.5 ha

Note: 1 km^2 = 100 ha

Appendix 2. Map of eastern massasauga populations delineated in Michigan based on cost-weighted distance analysis/population model and expert review by MNFI staff in 2014-2015. The different colors indicate separate or distinct populations. It is important to note that not all the populations shown here are extant populations, and that some historical populations are included.



Appendix 3. Summary of MDOT road and bridge work activities and expert-based impact rankings (high, medium, and low) for general impact or level of disturbance on the right-of-way (ROW). MDOT staff provided this table and the impact/disturbance rankings.

	General ROW Disturbance		
Activity	Low	Medium	High
ROAD WORK			
unbonded concrete overlay	x		
ultra thin asphalt overlay	x		
two course asphalt resurfacing	x		
sound barrier rehabilitation	x		
single course chip seal	x		
resurface, mill, and pulverize	x		
multiple course micro-surfacing	x		
new treatment technology - flexible and composite pavements	x		
mutiple course HMA overlay on composite pavement	x		
multiple course chip seal	x		
paver placed surface seal	x		
overband crack fill	x		
multiple course asphalt overlay	x		
milling and two course asphalt resurfacing	x		
milling and asphalt overlay	x		
joint replacement	x		
hot mixed asphalt resurfacing (one course)	x		
full depth concrete repair	x		
crush and shape and asphalt resurfacing	x		
concrete pavement rubbilize and asphalt resurfacing	x		
concrete pavement inlay	x		
concrete pavement repair	x		
concrete pavement restoration	x		
concrete overlay	x		
concrete joints reseal	x		
cape seal	x		
bit resurfacing and bit shoulders	x		
asphalt overlay	x		
asphalt crack treatement	x		
real estate activities	x		
project management contract	x		
minor rehabilitation		x	
maintaining traffic		x	
multiple rehabilitation		x	
drainage improvement		x	
bit resurface and minor widening		x	

bit resurface and drainage improvement			x	
reconstruction				x
reconstruct and add lane(s) over 0.5 mile long				x
new road, relocating an existing route				x
major reconstruction				x
major rehabilitation				x
left turn lane				x
concrete reconstruction				x
asphalt reconstruction				x
additional lane over 0.5 miles long				x
BRIDGE WORK				
bridge barrier replacement	x			
deck replacement	x			
deck patching	x			
joint replacement	x			
miscellaneous rehab	x			
miscellaneous CPM	x			
overlay deep	x			
overlay shallow	x			
overlay epxoy	x			
painting complete	x			
superstructure repair, steel	x			
substructure repair	x			
substructure patching	x			
superstructure replacement	x			
miscellaneous bridge CPM	x			
scour protection			x	
miscellaneous bridge			x	
widen-maintain lanes			x	
culvert replacement				x
bridge removal				x
bridge replacement				x

Appendix 4. Summary of road projects in MDOT's 5-year statewide transportation plan that were located within 30.5 m (100 ft) and/or within 0.8 km (0.5 mi) of eastern massasauga 1-km and 2-km inferred extent and/or massasauga population delineations (POP) (EMR_FEATURE), and potential for the project to impact massasaugas based on the impact/level of disturbance the project will cause on the project right-of-way (ROW) (IMPACT) and potential for massasaugas to occur at or along the project site (EMR_POT).

PROJECT	BUFFER	EMR_FEATURE	JOB_ID	PHASE	ROUTE	WORK_TYPE	FY	IMPACT	EMR_POT	COMMENTS
Road	100 ft	Pop	37904	A	M-55	Crush & Shape & Asphalt Resurfacing	2020	L	Low	Forested uplands around project site, no wetlands nearby, ~ 3km from river
Road	100 ft	Pop	37904	C	M-55	Crush & Shape & Asphalt Resurfacing	2018	L	Low	Forested uplands around project site, no wetlands nearby, ~ 3km from river
Road	100 ft	Pop	116416	A	M-72	Crush & Shape & Asphalt Resurfacing	2019	L	Mod	Lot of EMR observations and habitat in general area around project site, and some wetland and open upland habitat adajcent to road - so potential for EMRs to occur adj to road and maybe move onto the road
Road	100 ft	1 km	118792	A	I-196	Bit Resurf & Bit Shlders	2018	L	High-Mod	EMR occupied habitat fairly close to project site, and some wetlands/suitable habitat immediately adjacent to project site
Road	100 ft	2 km	118792	A	I-196	Bit Resurf & Bit Shlders	2018	L	High-Mod	EMR occupied habitat fairly close to project site, and some wetlands/suitable habitat immediately adjacent to project site
Road	100 ft	Pop	118792	A	I-196	Bit Resurf & Bit Shlders	2018	L	High-Mod	EMR occupied habitat fairly close to project site, and some wetlands/suitable habitat immediately adjacent to project site
Road	100 ft	1 km	118792	B	I-196	Bit Resurf & Bit Shlders	2018	L	High-Mod	EMR occupied habitat fairly close to project site, and some wetlands/suitable habitat immediately adjacent to project site

Road	100 ft	2 km	118792	B	I-196	Bit Resurf & Bit Shlders	2018	L	High-Mod	EMR occupied habitat fairly close to project site, and some wetlands/suitable habitat immediately adjacent to project site
Road	100 ft	Pop	118792	B	I-196	Bit Resurf & Bit Shlders	2018	L	High-Mod	EMR occupied habitat fairly close to project site, and some wetlands/suitable habitat immediately adjacent to project site
Road	100 ft	1 km	120243	A	M-72	Crush & Shape & Asphalt Resurfacing	2018	L	High-Mod	Project site is along southern boundary of large wetland complex in which EMRs occur throughout, so high-mod pot for EMRs to occur adj to road on north side, lower potential to occur on road
Road	100 ft	2 km	120243	A	M-72	Crush & Shape & Asphalt Resurfacing	2018	L	High-Mod	Project site is along southern boundary of large wetland complex in which EMRs occur throughout, so high-mod pot for EMRs to occur adj to road on north side, lower potential to occur on road
Road	100 ft	Pop	120243	A	M-72	Crush & Shape & Asphalt Resurfacing	2018	L	High-Mod	Project site is along southern boundary of large wetland complex in which EMRs occur throughout, so high-mod pot for EMRs to occur adj to road on north side, lower potential to occur on road
Road	100 ft	2 km	120275	A	M-60	Milling and Two Course Asphalt Resurfacing	2022	L	High-Mod	Wetland habitat adjacent to and on both sides of the road, good potential for EMRs to occur along the road
Road	100 ft	Pop	120275	A	M-60	Milling and Two Course Asphalt Resurfacing	2022	L	High-Mod	Wetland habitat adjacent to and on both sides of the road, good potential for EMRs to occur along the road
Road	100 ft	2 km	120275	B	M-60	Milling and Two Course Asphalt Resurfacing	2017	L	High-Mod	Wetland habitat adjacent to and on both sides of the road, good potential for EMRs to occur along the road

Road	100 ft	Pop	120275	B	M-60	Milling and Two Course Asphalt Resurfacing	2017	L	High-Mod	Wetland habitat adjacent to and on both sides of the road, good potential for EMRs to occur along the road
Road	100 ft	2 km	120277	A	M-60	Milling and Two Course Asphalt Resurfacing	2017	L	Low	Wetland habitat nearby but mostly houses along road, and no recent observations
Road	100 ft	Pop	120277	A	M-60	Milling and Two Course Asphalt Resurfacing	2017	L	Low	Wetland habitat nearby but mostly houses along road, and no recent observations
Road	100 ft	Pop	127019	A	I-94	Two Course Asphalt Resurfacing	2018	L	Low	No/little open/suitable wetland habitat along road/project site or nearby
Road	100 ft	2 km	127449	A	US-12	Milling and Two Course Asphalt Resurfacing	2018	L	Mod-Low	Some wetland habitat along road/project site and both sides of road and a stream crosses road, so some potential but no recent EMR observations
Road	100 ft	2 km	127449	B	US-12	Milling and Two Course Asphalt Resurfacing	2017	L	Mod-Low	Some wetland habitat along road/project site and both sides of road and a stream crosses road, so some potential but no recent EMR observations
Road	100 ft	Pop	128151	A	M-37	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Mod	Wetland habitat adj to road/project site and along stream that connects to site of EO but no EMRs have been documented in the immediate vicinity of the project site.
Road	100 ft	Pop	128572	A	M-72	Single Course Chip Seal	2017	L	Mod	Lot of EMR observations and habitat in general area around project site, and forested wetlands and uplands adajcent to road/project site - so potential for EMRs to occur adj to road and maybe move onto the road

Road	100 ft	1 km	128577	A	M-72	Multiple Course Micro-Surfacing	2017	L	Mod-Low	Some wetland habitat near part of the road/project site and one obs near the road, so some potential but few recent EMR observations.
Road	100 ft	2 km	128577	A	M-72	Multiple Course Micro-Surfacing	2017	L	Mod-Low	Some wetland habitat near part of the road/project site and one obs near the road, so some potential but few recent EMR observations.
Road	100 ft	Pop	128577	A	M-72	Multiple Course Micro-Surfacing	2017	L	Mod-Low	Some wetland habitat near part of the road/project site and one obs near the road, so some potential but few recent EMR observations.
Road	100 ft	1 km	128588	A	US-23	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Low	Recent EMR obs nearby to the south, and wetland habitat nearby but houses all along this stretch of the road, and no recent observations along project site.
Road	100 ft	2 km	128588	A	US-23	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Low	Recent EMR obs nearby to the south, and wetland habitat nearby but houses all along this stretch of the road, and no recent observations along project site.
Road	100 ft	Pop	128588	A	US-23	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Low	Recent EMR obs nearby to the south, and wetland habitat nearby but houses all along this stretch of the road, and no recent observations along project site.
Road	100 ft	Pop	128723	A	US-12	Bit Resurf & Bit Shlders	2018	L	Low	Some wetland habitats nearby but no suitable habitat immediately adjacent to project site, and no recent EMR observations nearby and highly fragmented habitat.
Road	100 ft	1 km	128736	A	VARIOUS	Overband Crack Fill	2017	L	Low	Some wetland habitats nearby but no suitable habitat immediately adjacent to project site, and no recent EMR observations nearby and highly fragmented habitat.

Road	100 ft	2 km	128736	A	VARIOUS	Overband Crack Fill	2017	L	Low	Some wetland habitats nearby but no suitable habitat immediately adjacent to project site, and no recent EMR observations nearby and highly fragmented habitat.
Road	100 ft	Pop	128736	A	VARIOUS	Overband Crack Fill	2017	L	Low	Some wetland habitats nearby but no suitable habitat immediately adjacent to project site, and no recent EMR observations nearby and highly fragmented habitat.
Road	100 ft	Pop	128741	A	M-96	Single Course Chip Seal	2017	L	Mod-Low	Some open wetland habitat with potential for EMR along/adjacent to project site/road, but EMR documented a little distance away not immediately near project site.
Road	100 ft	2 km	129142	A	M-66	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Mod	Quite a bit of wetland habitat and EO near project site and open wetland habitat adj to part of project site but no recent EMR observations
Road	100 ft	Pop	129142	A	M-66	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Mod	Quite a bit of wetland habitat and EO near project site and open wetland habitat adj to part of project site but no recent EMR observations
Road	100 ft	Pop	129213	A	M-99	New Treatment Technology-Flexible & Comp Pavements	2017	L	Mod	Extensive wetland habitat in the vicinity of project site connected to sites where EMRs were observed, and wetland habitat immediately adjacent to the road/project site, but known EMR sites not in immediate vicinity of project site.
Road	100 ft	Pop	129991	A	M-50	Multiple Course Micro-Surfacing	2017	L	Mod	Extensive wetland habitat in the vicinity of project site connected to sites where EMRs were observed, and wetland habitat adjacent to the road/project site, but EMR sites not in immediate vicinity of project site.

Road	100 ft	1 km	130049	A	I-69	Multiple Course Asphalt Overlay	2020	L	Low	Some wetlands near project site but wetlands and suitable habitat adjacent to only a small part of the project site, and no recent observations, so low potential.
Road	100 ft	2 km	130049	A	I-69	Multiple Course Asphalt Overlay	2020	L	Low	Some wetlands near project site but wetlands and suitable habitat adjacent to only a small part of the project site, and no recent observations, so low potential.
Road	100 ft	Pop	130049	A	I-69	Multiple Course Asphalt Overlay	2020	L	Low	Some wetlands near project site but wetlands and suitable habitat adjacent to only a small part of the project site, and no recent observations, so low potential.
Road	100 ft	1 km	130049	C	I-69	Multiple Course Asphalt Overlay	2017	L	Low	Some wetlands near project site but wetlands and suitable habitat adjacent to only a small part of the project site, and no recent observations, so low potential.
Road	100 ft	2 km	130049	C	I-69	Multiple Course Asphalt Overlay	2017	L	Low	Some wetlands near project site but wetlands and suitable habitat adjacent to only a small part of the project site, and no recent observations, so low potential.
Road	100 ft	Pop	130049	C	I-69	Multiple Course Asphalt Overlay	2017	L	Low	Some wetlands near project site but wetlands and suitable habitat adjacent to only a small part of the project site, and no recent observations, so low potential.
Road	0.5 mi	Pop	105885	A	I-94	Reconstruct and Add Lane(s) Over 0.5 Mile Long	2020	H	Mod - Low	EMR obs/pop near project site, and open wetland habitat near site, but mostly forested along project site, no recent observations, and landscape highly fragmented & lot of development.

Road	0.5 mi	1 km	106587	A	I-196 (SB)	Reconstruction	2021	H	Low	EMR obs/pop near project site and some open wetland habitat, but may be too wet; little suitable EMR habitat immediately adjacent to project site, and no recent observations
Road	0.5 mi	2 km	106587	A	I-196 (SB)	Reconstruction	2021	H	Low	EMR obs/pop near project site and some open wetland habitat, but may be too wet; little suitable EMR habitat immediately adjacent to project site, and no recent observations
Road	0.5 mi	Pop	106587	A	I-196 (SB)	Reconstruction	2021	H	Low	EMR obs/pop near project site and some open wetland habitat, but may be too wet; little suitable EMR habitat immediately adjacent to project site, and no recent observations
Road	0.5 mi	Pop	120273	A	I-94	Reconstruction	2018	H	Mod	EMR obs not too far from project site, extensive wetland habitat in the vicinity of project site connected with area with EMR obs, and suitable wetland habitat along project site in a few fairly small areas on east end of the project site, but no recent observations, so moderate potential (to high?)
Road	0.5 mi	Pop	130008	A	I-94	Reconstruction	2021	H	Mod-Low	Couple areas along project site with potential/suitable wetland habitat for EMRs mainly along streams that cross the project site, and EO obs/pop not too far away but not in immediate vicinity of project site and habitat tapers off and basically narrow band along streams that cross the road.

Road	0.5 mi	Pop	130008	B	I-94	Reconstruction	2019	H	Mod-Low	Couple areas along project site with potential/suitable wetland habitat for EMRs mainly along streams that cross the project site, and EO obs/pop not too far away but not in immediate vicinity of project site and habitat tapers off and basically narrow band along streams that cross the road.
Road	0.5 mi	Pop	130008	C	I-94	Reconstruction	2018	H	Mod-Low	Couple areas along project site with potential/suitable wetland habitat for EMRs mainly along streams that cross the project site, and EO obs/pop not too far away but not in immediate vicinity of project site and habitat tapers off and basically narrow band along streams that cross the road.
Road	0.5 mi	Pop	130008	D	I-94	Reconstruction	2018	H	Mod-Low	Couple areas along project site with potential/suitable wetland habitat for EMRs mainly along streams that cross the project site, and EO obs/pop not too far away but not in immediate vicinity of project site and habitat tapers off and basically narrow band along streams that cross the road.
Road	0.5 mi	1 km	115095	A	I-69	Overlay - Epoxy	2020	L	Low	Project site near EOs and some wetland habitat close to project site. Low potential because forested habitat, open uplands/old fields adj to project site and other highway and lack of recent EMR observations.

Road	0.5 mi	2 km	115095	A	I-69	Overlay - Epoxy	2020	L	Low	Project site near EOs and some wetland habitat close to project site. Low potential because forested habitat, open uplands/old fields adj to project site and other highway and lack of recent EMR observations.
Road	0.5 mi	Pop	115095	A	I-69	Overlay - Epoxy	2020	L	Low	Project site near EOs and some wetland habitat close to project site. Low potential because forested habitat, open uplands/old fields adj to project site and other highway and lack of recent EMR observations.
Road	0.5 mi	Pop	116204	A	M-57	Crush & Shape & Asphalt Resurfacing	2020	L	No	No suitable EMR habitat along project site and no recent EMR osbervations near this site/may be extirpated.
Road	0.5 mi	Pop	118164	A	M-120	Concrete Pavement Rubblize & Asphalt Resurfacing	2017	L	Low/No	Area adjacent to project site is mostly developed, but is fairly close to the river and some wetland habitat so may be some potential for EMR to occur along project site.
Road	0.5 mi	Pop	118165	A	M-120	Concrete Pavement Rubblize & Asphalt Resurfacing	2019	L	No	Area adjacent to project site is mostly developed/ no suitable EMR habitat adjacent to project site.
Road	0.5 mi	Pop	118165	C	M-120	Concrete Pavement Rubblize & Asphalt Resurfacing	2017	L	No	Area adjacent to project site is mostly developed/ no suitable EMR habitat adjacent to project site.
Road	0.5 mi	Pop	118947	A	US-10	Unbonded Concrete Overlay	2019	L	Low/No	Little bit of wetland habitat along project and near EO but low potential for EMR based on surrounding habitat/landscape and lack of recent EMR observations.

Road	0.5 mi	1 km	123301	A	M-311	Milling and Two Course Asphalt Resurfacing	2019	L	No	No/little suitable or potential EMR habitat along project site and surrounding landscape/mostly ag.
Road	0.5 mi	2 km	123301	A	M-311	Milling and Two Course Asphalt Resurfacing	2019	L	No	No/little suitable or potential EMR habitat along project site and surrounding landscape/mostly ag.
Road	0.5 mi	Pop	123301	A	M-311	Milling and Two Course Asphalt Resurfacing	2019	L	No	No/little suitable or potential EMR habitat along project site and surrounding landscape/mostly ag.
Road	0.5 mi	Pop	128067	C	M-89	Two Course Asphalt Resurfacing	2019	L	No	No suitable or potential EMR habitat along project site/mostly developed.
Road	0.5 mi	Pop	128739	A	M-140	Multiple Course Micro-Surfacing	2017	L	No	No suitable or potential EMR habitat along project site/mostly ag fields.
Road	0.5 mi	2 km	129139	A	VARIOUS	Asphalt Crack Treatment	2017	L	No	No suitable EMR habitat along/adjacent to project sites.
Road	0.5 mi	Pop	129139	A	VARIOUS	Asphalt Crack Treatment	2017	L	No	No suitable EMR habitat along/adjacent to project sites.
Road	0.5 mi	Pop	129146	A	VARIOUS	Asphalt Crack Treatment	2017	L	No	No suitable EMR habitat along project site, and project site is very small.
Road	0.5 mi	Pop	129146	C	VARIOUS	Asphalt Crack Treatment	2017	L	No	No suitable EMR habitat along project site, and project site is very small.
Road	0.5 mi	Pop	129974	A	I-75 SB	Multiple Course Micro-Surfacing	2017	L	Low	Some wetland habitat along portions of the project site, esp. N half, so some potential but no recent observations.

Road	0.5 mi	Pop	129974	C	I-75 SB	Multiple Course Micro-Surfacing	2017	L	Low	Some wetland habitat along portions of the project site, esp. N half, so some potential but no recent observations.
Road	0.5 mi	Pop	130028	A	NB US-23	Sound Barrier Rehabilitation	2020	L	No	No suitable or potential EMR habitat along project site/mostly developed.
Road	0.5 mi	Pop	130028	C	NB US-23	Sound Barrier Rehabilitation	2018	L	No	No suitable or potential EMR habitat along project site/mostly developed.

Appendix 5. Summary of bridge projects in MDOT's 5-year statewide transportation plan that were located within 30.5 m (100 ft) and/or within 0.8 km (0.5 mi) of eastern massasauga 1-km and 2-km inferred extent and/or massasauga population delineations (EMR_FEATURE), and potential for the project to impact massasaugas based on the impact/level of disturbance the project will cause on the project right-of-way (ROW) (IMPACT) and potential for massasaugas to occur at or along the project site (EMR_POT).

PROJECT	BUFFER	EMR_FEATURE	JOB_ID	PHASE	ROUTE	WORK_TYPE	FY	IMPACT	EMR_POT	COMMENTS
Bridge	100 ft	1 km	115095	A	I-69	Overlay - Epoxy	2020	L	Low	A lot of wetland habitat around/near project site but not immediately adjacent to project site and habitat very fragmented although stream connects, and no recent observations
Bridge	100 ft	2 km	115095	A	I-69	Overlay - Epoxy	2020	L	Low	A lot of wetland habitat around/near project site but not immediately adjacent to project site and habitat very fragmented although stream connects, and no recent observations
Bridge	100 ft	Pop	115095	A	I-69	Overlay - Epoxy	2020	L	Low	A lot of wetland habitat around/near project site but not immediately adjacent to project site and habitat very fragmented although stream connects, and no recent observations
Bridge	100 ft	2 km	115218	A	I-69	Overlay - Deep	2020	L	Low	A lot of wetland habitat around/near project site but not immediately adjacent to project site and habitat very fragmented although stream connects, and no recent observations
Bridge	100 ft	Pop	115218	A	I-69	Overlay - Deep	2020	L	Low	A lot of wetland habitat around/near project site but not immediately adjacent to project site and habitat very fragmented although stream connects, and no recent observations
Bridge	100 ft	Pop	115752	A	M-89	Superstructure Replacement	2018	L	Low	Wetland habitat adj to road and project site but no recent observations, and looks pretty wet to south of the road/bridge (EO ID 711 last obs 1938)

Bridge	100 ft	Pop	115908	A	M-15	Culvert Replacement	2019	H	Low	Not much wetland habitat around/within known EO but some wetland habitat to the S near project site, but unsuitable habitat immediately adjacent to project site and no recent observations, so low potential for EMRs to occur at project site
Bridge	100 ft	Pop	122746	A	I-94	Healer Sealer	2017	L	Low	High-mod potential for EMR to occur in wetland habitat to SW and fairly close, but unsuitable habitat immed adjacent to road/bridge, low pot snake will go onto bridge here
Bridge	100 ft	1 km	126927	A	US-31	Substructure Replacement	2017	L	Mod	Very wet, emergent wetlands/marsh along this section of the road, better habitat and more recent observations farther to the east, but EMRs will use emergent marsh.
Bridge	100 ft	2 km	126927	A	US-31	Substructure Replacement	2017	L	Mod	Very wet, emergent wetlands/marsh along this section of the road, better habitat and more recent observations farther to the east, but EMRs will use emergent marsh.
Bridge	100 ft	Pop	126927	A	US-31	Substructure Replacement	2017	L	Mod	Very wet, emergent wetlands/marsh along this section of the road, better habitat and more recent observations farther to the east, but EMRs will use emergent marsh.
Bridge	0.5 mi	Pop	115095	A	I-69	Overlay - Epoxy	2020	L	Low	A lot of wetland habitat around/near project site but not immediately adjacent to project site and habitat very fragmented although stream connects, and no recent observations
Bridge	0.5 mi	Pop	115218	A	I-69	Overlay - Deep	2020	L	Low	A lot of wetland habitat around/near project site but not immediately adjacent to project site and habitat very fragmented although stream connects, and no recent observations

Bridge	0.5 mi	Pop	115752	A	M-89	Superstructure Replacement	2018	L	Low	Wetland habitat adj to road and project site but no recent observations, and looks pretty wet to south of the road/bridge (EO ID 711 last obs 1938)
Bridge	0.5 mi	Pop	115908	A	M-15	Culvert Replacement	2019	H	Low	Not much wetland habitat around/within known EO but some wetland habitat to the S near project site, but unsuitable habitat immediately adjacent to project site and no recent observations, so low potential for EMRs to occur at project site
Bridge	0.5 mi	Pop	122746	A	I-94	Healer Sealer	2017	L	Low	High-mod potential for EMR to occur in wetland habitat to SW and fairly close, but unsuitable habitat immed adjacent to road/bridge, low pot snake will go onto bridge here
Bridge	0.5 mi	Pop	123135	A	I-94	Overlay - Deep	2018	L	Low	No/little open/suitable wetland habitat along road/project site or nearby
Bridge	0.5 mi	Pop	123168	A	I-94	Painting Complete	2018	L	Low	No/little open/suitable wetland habitat along road/project site or nearby
Bridge	0.5 mi	Pop	126927	A	US-31	Substructure Replacement	2017	L	Mod	Very wet, emergent wetlands/marsh along this section of the road, better habitat and more recent observations farther to the east, but EMRs will use emergent marsh.
Bridge	0.5 mi	Pop	127443	A	I-94	Bridge Barrier Railing Replace	2018	L	Low	High-mod potential for EMR to occur in wetland habitat to SW and fairly close, but unsuitable habitat immed adjacent to road/bridge, low pot snake will go onto bridge here
Bridge	0.5 mi	Pop	129961	A	I-96	Overlay - Deep	2020	L	No	Project site near known EMR EO, but no suitable habitat for EMR at/along project site/developed.

Bridge	0.5 mi	Pop	129961	C	I-96	Overlay - Deep	2018	L	No	Project site near known EMR EO, but no suitable habitat for EMR at/along project site/developed.
Bridge	0.5 mi	Pop	129961	D	I-96	Overlay - Deep	2018	L	No	Project site near known EMR EO, but no suitable habitat for EMR at/along project site/developed.
Bridge	0.5 mi	Pop	129977	A	US-23	Overlay - Epoxy	2019	L	No	Project site near known EMR EO, but no suitable habitat for EMR at/along project site and project site separated from EO by development and several roads/mostly developed.
Bridge	0.5 mi	Pop	129977	C	US-23	Overlay - Epoxy	2017	L	No	Project site near known EMR EO, but no suitable habitat for EMR at/along project site and project site separated from EO by development and several roads/mostly developed.
Bridge	0.5 mi	Pop	129977	D	US-23	Overlay - Epoxy	2017	L	No	Project site near known EMR EO, but no suitable habitat for EMR at/along project site and project site separated from EO by development and several roads/mostly developed; project site elevated above another road.
Bridge	0.5 mi	Pop	130008	A	I-94	Reconstruction	2021	H	Mod-Low	Couple areas along project site with potential/suitable wetland habitat for EMRs mainly along streams that cross the project site, and EO obs/pop not too far away but not in immediate vicinity of project site and habitat tapers off and basically narrow band along streams that cross the road.

Bridge	0.5 mi	Pop	130008	B	I-94	Reconstruction	2019	H	Mod-Low	Couple areas along project site with potential/suitable wetland habitat for EMRs mainly along streams that cross the project site, and EO obs/pop not too far away but not in immediate vicinity of project site and habitat tapers off and basically narrow band along streams that cross the road.
Bridge	0.5 mi	Pop	130008	C	I-94	Reconstruction	2018	H	Mod-Low	Couple areas along project site with potential/suitable wetland habitat for EMRs mainly along streams that cross the project site, and EO obs/pop not too far away but not in immediate vicinity of project site and habitat tapers off and basically narrow band along streams that cross the road.
Bridge	0.5 mi	Pop	130008	D	I-94	Reconstruction	2018	H	Mod-Low	Couple areas along project site with potential/suitable wetland habitat for EMRs mainly along streams that cross the project site, and EO obs/pop not too far away but not in immediate vicinity of project site and habitat tapers off and basically narrow band along streams that cross the road.

Appendix 6. Summary of bridge and road projects in MDOT's 5-year statewide transportation plan that were located within 30.5 m (100 ft) of areas predicted to have suitable habitat for eastern massasaugas based on McCluskey's eastern massasauga species distribution or habitat model (McCluskey 2016) (HABITAT = Yes), and potential for the project to impact massasaugas based on the impact/level of disturbance the project will cause on the project right-of-way (ROW) (IMPACT) and potential for massasaugas to occur at or along the project site (EMR_POT). (Note: Only high and medium impact projects were evaluated for EMR_POT.)

PROJECT	BUFFER	EMR_ FEATURE	JOB_ID	PHASE	ROUTE	WORK_TYPE	FY	IMPACT	HABITAT	EMR_POT	COMMENTS
Bridge	100 ft	Habitat	115908	A	M-15	Culvert Replacement	2019	H	Y	Low	Not much wetland habitat around/within known EO but some wetland habitat to the S near project site, but unsuitable habitat immediately adjacent to project site and no recent observations, so low potential for EMRs to occur at project site
Road	100 ft	Habitat	110627	A	M-34	Major Rehabilitation	2022	H	Y	NO	No EMR obs/pop near (closest ~7-8 mi away) and no habitat for EMRs along project site, all ag fields
Road	100 ft	Habitat	116377	A	US-131	Reconstruction	2017	H	Y	NO	No EMR obs/pop near (closest ~5 mi away) and no habitat for EMRs along project site, ag fields & development
Road	100 ft	Habitat	116377	A	US-131	Reconstruction	2017	H	Y	NO	No EMR obs/pop near (closest ~5 mi away) and no habitat for EMRs along project site, ag fields & development

Road	100 ft	Habitat	117992	A	US-131	Reconstruction	2018	H	Y	Low/NO	No EMR obs nearby, and a small portion of the project site bordered by forested floodplain/wetland but no/little open wetlands along or near project site, so low/no potential for EMRs.
Road	100 ft	Habitat	117992	A	US-131	Reconstruction	2018	H	Y	Low/NO	No EMR obs nearby, and a small portion of the project site bordered by forested floodplain/wetland but no/little open wetlands along or near project site, so low/no potential for EMRs.
Road	100 ft	Habitat	119012	A	US-131	Reconstruction	2017	H	Y	Low/NO	Little wetland habitat along road/part of project site, but no EMR obs nearby, little suitable/wetland habitat in vicinity of project site, and landscape very fragmented.
Road	100 ft	Habitat	120273	A	I-94	Reconstruction	2018	H	Y	Low/NO	Closest EMR obs/pop ~6-8 mi away, some open wetlands adjacent to project site but landscape and habitat very fragmented, low pot. for EMRs to occur along project site.

Road	100 ft	Habitat	123643	A	US-10	Major Rehabilitation	2018	H	Y	NO	No EMR obs nearby, and doesn't look like suitable/wetland habitat near/along project site
Road	100 ft	Habitat	125856	A	I-75	Major Rehabilitation	2017	H	Y	Mod-Low	No EMR obs nearby, but quite a bit of open wetland habitat along and near project site, so potential for EMRs along project site.
Road	100 ft	Habitat	125856	A	I-75	Major Rehabilitation	2017	H	Y	Mod-Low	No EMR obs nearby, but quite a bit of open wetland habitat along/ near project site, so potential for EMRs along project site.
Road	100 ft	Habitat	125869	A	I-69	Reconstruction	2021	H	Y	NO	No EMR obs/pop. nearby, and no open wetland/potential EMR habitat along or near project site, mostly forested and river/stream.
Road	100 ft	Habitat	126968	A	US-31	Reconstruction	2020	H	Y	Low/NO	EMR obs/pop ~5 mi away, and some open wetland habitat along river/stream in vicinity of project site, but little/no suitable/ potential habitat for EMRs adjacent to project site.
Road	100 ft	Habitat	130008	D	I-94	Reconstruction	2018	H	Y	NO	EMR obs/pop ~7 mi to N, but no real habitat along project site

Road	100 ft	Habitat	130013	C	US-131	Asphalt Reconstruction	2019	H	Y	Low/NO	No EMR obs nearby, small portion of project site with some open wetlands adjacent/nearby but most of project site bordered by houses.
Road	100 ft	Habitat	130024	A	I-69	Major Rehabilitation	2021	H	Y	NO	No EMR obs nearby, and doesn't look like suitable/wetland habitat near/along project site
Road	100 ft	Habitat	130024	A	I-69	Major Rehabilitation	2021	H	Y	NO	No EMR obs nearby, and doesn't look like suitable/wetland habitat near/along project site
Road	100 ft	Habitat	130024	A	I-69	Major Rehabilitation	2021	H	Y	NO	No EMR obs nearby, and doesn't look like suitable/wetland habitat near/along project site
Road	100 ft	Habitat	130024	C	I-69	Major Rehabilitation	2017	H	Y	NO	No EMR obs nearby, and doesn't look like suitable/wetland habitat near/along project site
Road	100 ft	Habitat	130024	C	I-69	Major Rehabilitation	2017	H	Y	NO	No EMR obs nearby, and doesn't look like suitable/wetland habitat near/along project site

Road	100 ft	Habitat	123914	A	M-54	Bit Resurf & Drainage Imprv	2019	M	Y	Low/NO	No EMR obs nearby, small area of open/shrubby wetlands along part of project site and rest bordered by houses, and landscape mostly ag and highly developed, so don't think any or very little potential for EMRs to occur along project site
Road	100 ft	Habitat	127121	A	I-94	Bit Resurf & Drainage Imprv	2017	M	Y	Low/NO	No EMR obs/pop nearby, couple small areas with open wetland habitat along/adjacent to project site and along stream which may provide habitat for EMRs but landscape highly fragmented.
Road	100 ft	Habitat	130105	C	US-127	Minor Rehabilitation	2017	M	Y	NO	No EMR obs nearby, small area of open wetlands along part of project site and rest bordered by ag fields and development, and landscape mostly ag and developed, so don't think any potential for EMRs to occur along project site
Road	100 ft	Habitat	37904	A	M-55	Crush & Shape & Asphalt Resurfacing	2020	L	Y		

Road	100 ft	Habitat	111375	B	M-24	Resurf, Mill & Pulver	2022	L	Y		
Road	100 ft	Habitat	113455	A	US-127	Crush & Shape & Asphalt Resurfacing	2020	L	Y		
Road	100 ft	Habitat	113455	A	US-127	Crush & Shape & Asphalt Resurfacing	2020	L	Y		
Road	100 ft	Habitat	115073	A	M-66	Asphalt Overlay (=1 1/2 inches)	2019	L	Y		
Road	100 ft	Habitat	116087	A	I-75	Concrete Overlay (>4")	2017	L	Y		
Road	100 ft	Habitat	116204	A	M-57	Crush & Shape & Asphalt Resurfacing	2020	L	Y		
Road	100 ft	Habitat	116416	A	M-72	Crush & Shape & Asphalt Resurfacing	2019	L	Y		
Road	100 ft	Habitat	117997	A	M-46	Multiple Course Asphalt Overlay with ASCRL	2018	L	Y		
Road	100 ft	Habitat	118792	B	I-196	Bit Resurf & Bit Shlders	2018	L	Y		
Road	100 ft	Habitat	118947	A	US-10	Unbonded Concrete Overlay	2019	L	Y		
Road	100 ft	Habitat	119043	A	M-32	Crush & Shape & Asphalt Resurfacing	2020	L	Y		
Road	100 ft	Habitat	119065	A	M-142	Crush & Shape & Asphalt Resurfacing	2017	L	Y		

Road	100 ft	Habitat	120169	A	US-31	Crush & Shape & Asphalt Resurfacing	2017	L	Y		
Road	100 ft	Habitat	120243	A	M-72	Crush & Shape & Asphalt Resurfacing	2018	L	Y		
Road	100 ft	Habitat	120269	A	M-60	Two Course Asphalt Resurfacing	2017	L	Y		
Road	100 ft	Habitat	120269	A	M-60	Two Course Asphalt Resurfacing	2017	L	Y		
Road	100 ft	Habitat	122109	B	I-75	Real Estate Activities	2017	L	Y		
Road	100 ft	Habitat	122635	A	US-31	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	122635	A	US-31	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	122658	A	M-37	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	123206	C	US-31	Two Course Asphalt Resurfacing	2017	L	Y		
Road	100 ft	Habitat	123278	B	M-33	Crush & Shape & Asphalt Resurfacing	2017	L	Y		
Road	100 ft	Habitat	123278	C	M-33	Crush & Shape & Asphalt Resurfacing	2017	L	Y		

Road	100 ft	Habitat	123301	A	M-311	Milling and Two Course Asphalt Resurfacing	2019	L	Y		
Road	100 ft	Habitat	123301	A	M-311	Milling and Two Course Asphalt Resurfacing	2019	L	Y		
Road	100 ft	Habitat	124147	A	M-13	Bit Resurf & Bit Shlders	2019	L	Y		
Road	100 ft	Habitat	126114	A	US-131	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	126122	A	M-46	Single Course Chip Seal	2017	L	Y		
Road	100 ft	Habitat	126474	A	M-20	Single Course Chip Seal	2017	L	Y		
Road	100 ft	Habitat	126474	A	M-20	Single Course Chip Seal	2017	L	Y		
Road	100 ft	Habitat	127023	A	US-127	Cape Seal	2017	L	Y		
Road	100 ft	Habitat	127023	A	US-127	Cape Seal	2017	L	Y		
Road	100 ft	Habitat	127029	C	M-79	Two Course Asphalt Resurfacing	2018	L	Y		
Road	100 ft	Habitat	127032	C	US-31	Two Course Asphalt Resurfacing	2018	L	Y		
Road	100 ft	Habitat	127525	C	I-275	Concrete Pavement Restoration	2018	L	Y		

Road	100 ft	Habitat	127563	A	M-139	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	127582	A	M-36	Cape Seal	2017	L	Y		
Road	100 ft	Habitat	127665	C	M-153	Overlay - Shallow	2017	L	Y		
Road	100 ft	Habitat	127994	A	M-179	Milling & Asphalt Overlay (1 1/2 inches)	2018	L	Y		
Road	100 ft	Habitat	128123	A	M-6	Concrete Pavement Inlay	2018	L	Y		
Road	100 ft	Habitat	128127	A	US-31	Two Course Asphalt Resurfacing	2021	L	Y		
Road	100 ft	Habitat	128151	A	M-37	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	128465	A	US-131	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	128572	A	M-72	Single Course Chip Seal	2017	L	Y		
Road	100 ft	Habitat	128577	A	M-72	Multiple Course Micro-Surfacing	2017	L	Y		
Road	100 ft	Habitat	128577	A	M-72	Multiple Course Micro-Surfacing	2017	L	Y		
Road	100 ft	Habitat	128584	C	M-115	Single Course Chip Seal	2017	L	Y		

Road	100 ft	Habitat	128672	A	CADILLAC TSC WIDE	Asphalt Crack Treatment	2017	L	Y		
Road	100 ft	Habitat	128722	A	US-131	Hot Mixed Asphalt Resurfacing (One Course)	2022	L	Y		
Road	100 ft	Habitat	128722	A	US-131	Hot Mixed Asphalt Resurfacing (One Course)	2022	L	Y		
Road	100 ft	Habitat	128722	A	US-131	Hot Mixed Asphalt Resurfacing (One Course)	2022	L	Y		
Road	100 ft	Habitat	128736	A	VARIOUS	Overband Crack Fill	2017	L	Y		
Road	100 ft	Habitat	128736	A	VARIOUS	Overband Crack Fill	2017	L	Y		
Road	100 ft	Habitat	128736	A	VARIOUS	Overband Crack Fill	2017	L	Y		
Road	100 ft	Habitat	128736	A	VARIOUS	Overband Crack Fill	2017	L	Y		
Road	100 ft	Habitat	128736	A	VARIOUS	Overband Crack Fill	2017	L	Y		
Road	100 ft	Habitat	128739	A	M-140	Multiple Course Micro-Surfacing	2017	L	Y		
Road	100 ft	Habitat	128741	A	M-96	Single Course Chip Seal	2017	L	Y		
Road	100 ft	Habitat	128741	A	M-96	Single Course Chip Seal	2017	L	Y		
Road	100 ft	Habitat	128909	A	NB I-75	Concrete Joints Reseal	2017	L	Y		

Road	100 ft	Habitat	129088	A	M-20	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	129139	A	VARIOUS	Asphalt Crack Treatment	2017	L	Y		
Road	100 ft	Habitat	129139	A	VARIOUS	Asphalt Crack Treatment	2017	L	Y		
Road	100 ft	Habitat	129139	A	VARIOUS	Asphalt Crack Treatment	2017	L	Y		
Road	100 ft	Habitat	129142	A	M-66	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	129151	A	M-50	Multiple Course Micro-Surfacing	2017	L	Y		
Road	100 ft	Habitat	129162	A	M-106	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	129166	A	US-127	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	129166	A	US-127	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	129166	C	US-127	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	129175	A	M-52	Single Course Chip Seal	2017	L	Y		

Road	100 ft	Habitat	129213	A	M-99	New Treatment Technology-Flexible & Comp Pavements	2017	L	Y		
Road	100 ft	Habitat	129877	A	US-131	Concrete Joints Reseal	2017	L	Y		
Road	100 ft	Habitat	129878	A	I-96	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	129878	A	I-96	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	129932	B	M-37	Crush & Shape & Asphalt Resurfacing	2019	L	Y		
Road	100 ft	Habitat	129963	A	M-22	Full Depth Concrete Pavement Repair	2017	L	Y		
Road	100 ft	Habitat	129974	C	I-75 SB	Multiple Course Micro-Surfacing	2017	L	Y		
Road	100 ft	Habitat	129991	A	M-50	Multiple Course Micro-Surfacing	2017	L	Y		
Road	100 ft	Habitat	129997	A	US-23	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	130011	A	M-66	Multiple Course Chip Seal	2017	L	Y		

Road	100 ft	Habitat	130014	C	NB AND SB I-75	Unbonded Concrete Overlay	2019	L	Y		
Road	100 ft	Habitat	130021	A	M-53	Bit Resurf & Bit Shlders	2021	L	Y		
Road	100 ft	Habitat	130021	A	M-53	Bit Resurf & Bit Shlders	2021	L	Y		
Road	100 ft	Habitat	130034	A	US-BR-127	Multiple Course Chip Seal	2017	L	Y		
Road	100 ft	Habitat	130049	A	I-69	Multiple Course Asphalt Overlay	2020	L	Y		
Road	100 ft	Habitat	130816	A	M-54	Hot Mixed Asphalt Resurfacing (One Course)	2017	L	Y		
Road	100 ft	Habitat	131083	A	VARIOUS	Asphalt Crack Treatment	2017	L	Y		
Road	100 ft	Habitat	131083	A	VARIOUS	Asphalt Crack Treatment	2017	L	Y		
Road	100 ft	Habitat	131083	A	VARIOUS	Asphalt Crack Treatment	2017	L	Y		
Road	100 ft	Habitat	131568	A	M-51	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		
Road	100 ft	Habitat	131568	A	M-51	Milling & Asphalt Overlay (1 1/2 inches)	2017	L	Y		

Appendix 7. Summary of road projects in MDOT's 5-year statewide transportation plan that were located within 30.5 m (100 ft) of Blanding's turtle 2-km inferred extent (BLAND_FEATURE), and potential for the project to impact Blanding's turtles based on the impact/level of disturbance the project will cause on the project right-of-way (ROW) (IMPACT) and potential for Blanding's turtles to occur at or along the project site (BLAND_POT). (Note: Only high impact projects were evaluated for BLAND_POT.)

PROJECT	BUFFER	BLAND_ FEATURE	PR_Key	JOB_ID	PHASE	WORK_TYPE	FY	IMPACT	BLAND_POT	COMMENTS
Road	100 ft	2 km IE	110611A47183260	110611	A	Reconstruction	2017	H	High-Mod	Turtle was on Hine's Drive. Project site near EO and a lake, and some forest and open upland habitat adjacent to project site so potential for species to occur on or along/ adjacent to the project site. Landscape developed though.
Road	100 ft	2 km IE	110611A16804082.585	110611	A	Reconstruction	2017	H	High-Mod	Turtle was on Hine's Drive. Project site near EO and a lake, and some forest and open upland habitat adjacent to project site so potential for species to occur on or along/ adjacent to the project site. Landscape developed though.

Road	100 ft	2 km IE	110611A16041027.259	110611	A	Reconstruction	2017	H	High-Mod	Turtle was on Hine's Drive. Project site near EO and a lake, and some forest and open upland habitat adjacent to project site so potential for species to occur on or along/ adjacent to the project site. Landscape developed though.
Road	100 ft	2 km IE	120273A89780917.1	120273	A	Reconstruction	2018	H	High-Mod	Fairly extensive wetland habitat incl small ponds for Blanding's nearby, some wetlands along/adjacent to project site, project site is close to EO, although no recent observations.
Road	100 ft	2 km IE	120273A89710717.104	120273	A	Reconstruction	2018	H	High-Mod	Fairly extensive wetland habitat incl small ponds for Blanding's nearby, some wetlands along/adjacent to project site, project site is close to EO, although no recent observations.
Road	100 ft	2 km IE	51471A8579100.936	51471	A	Two Course Asphalt Resurfacing	2017	L		
Road	100 ft	2 km IE	51471A8593010	51471	A	Two Course Asphalt Resurfacing	2017	L		

Road	100 ft	2 km IE	90084A8607020.078	90084	A	Milling & Asphalt Overlay (1 1/2 inches)	2019	L		
Road	100 ft	2 km IE	122635A85750914.121	122635	A	Milling & Asphalt Overlay (1 1/2 inches)	2017	L		
Road	100 ft	2 km IE	122635A85930214.111	122635	A	Milling & Asphalt Overlay (1 1/2 inches)	2017	L		
Road	100 ft	2 km IE	113455A105210112.182	113455	A	Crush & Shape & Asphalt Resurfacing	2020	L		
Road	100 ft	2 km IE	113455A105220512.177	113455	A	Crush & Shape & Asphalt Resurfacing	2020	L		
Road	100 ft	2 km IE	115084A7117017.906	115084	A	Milling and Two Course Asphalt Resurfacing	2021	L		
Road	100 ft	2 km IE	118792A13644030	118792	A	Bit Resurf & Bit Shlders	2018	L		
Road	100 ft	2 km IE	118792A13620050	118792	A	Bit Resurf & Bit Shlders	2018	L		
Road	100 ft	2 km IE	118792A13643010	118792	A	Bit Resurf & Bit Shlders	2018	L		
Road	100 ft	2 km IE	118792A13642100	118792	A	Bit Resurf & Bit Shlders	2018	L		
Road	100 ft	2 km IE	118792A13620060	118792	A	Bit Resurf & Bit Shlders	2018	L		
Road	100 ft	2 km IE	118792B13620050	118792	B	Bit Resurf & Bit Shlders	2018	L		
Road	100 ft	2 km IE	118792B13643010	118792	B	Bit Resurf & Bit Shlders	2018	L		
Road	100 ft	2 km IE	118792B13642100	118792	B	Bit Resurf & Bit Shlders	2018	L		

Road	100 ft	2 km IE	118792B13620060	118792	B	Bit Resurf & Bit Shlders	2018	L		
Road	100 ft	2 km IE	118792B13644030	118792	B	Bit Resurf & Bit Shlders	2018	L		
Road	100 ft	2 km IE	128127A21750713.838	128127	A	Two Course Asphalt Resurfacing	2021	L		
Road	100 ft	2 km IE	128127C21750713.838	128127	C	Two Course Asphalt Resurfacing	2019	L		
Road	100 ft	2 km IE	128736A13598070	128736	A	Overband Crack Fill	2017	L		
Road	100 ft	2 km IE	128736A5808020	128736	A	Overband Crack Fill	2017	L		
Road	100 ft	2 km IE	128741A14100.975	128741	A	Single Course Chip Seal	2017	L		
Road	100 ft	2 km IE	131568A5794070	131568	A	Milling & Asphalt Overlay (1 1/2 inches)	2017	L		

Appendix 8. Summary of bridge projects in MDOT's 5-year statewide transportation plan that were located within 30.5 m (100 ft) of Blanding's turtle 2-km inferred extent (IE) (BLAND_FEATURE), and potential for the project to impact Blanding's turtles based on the impact/level of disturbance the project will cause on the project right-of-way (ROW) (IMPACT) and potential for Blanding's turtles to occur at or along the project site (BLAND_POT). (Note: Only high impact projects were evaluated for BLAND_POT.)

PROJECT	BUFFER	BLAND_ FEATURE	PR_Key	JOB_ID	PHASE	ROUTE	WORK_TYPE	FY	IMPACT	BLAND_POT	COMMENTS
Bridge	100 ft	2-km IE	106613A16041027.419	106613	A	M-14 OLD	Bridge Replacement	2017	H	High-Mod	Turtle was on Hine's Drive. Project site near EO and a lake, and some forest and open upland habitat adjacent to project site so some potential for Blanding's turtle to occur on or along/adjacent to the project site. Landscape very developed though.
Bridge	100 ft	2-km IE	106621A16041027.47	106621	A	M-14 OLD	Bridge Replacement	2017	H	High-Mod	Turtle was on Hine's Drive. Project site near EO and a lake, and some forest and open upland habitat adjacent to project site so some potential for Blanding's turtle to occur on or along/adjacent to the project site. Landscape very developed though.
Bridge	100 ft	2-km IE	115752A303010312.013	115752	A	M-89	Superstructure Replacement	2018	L		

Bridge	100 ft	2-km IE	126927A85930210.094	126927	A	US-31	Substructure Replacement	2017	L		
Bridge	100 ft	2-km IE	126927A85930210.759	126927	A	US-31	Substructure Replacement	2017	L		
Bridge	100 ft	2-km IE	126927A85750910.74	126927	A	US-31	Substructure Replacement	2017	L		
Bridge	100 ft	2-km IE	128712A11542070.294	128712	A	M-55	Substructure Patching	2019	L		
Bridge	100 ft	2-km IE	128712C11542070.294	128712	C	M-55	Substructure Patching	2017	L		
Bridge	100 ft	2-km IE	128712D11542070.294	128712	D	M-55	Substructure Patching	2017	L		