



**Draft Recovery Plan**  
**for the**  
**Eastern Massasauga Rattlesnake**  
**(*Sistrurus catenatus*)**

August 21, 2019

## DISCLAIMER

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*), requires the development of recovery plans for listed species, unless such a plan would not promote the conservation of a particular species. Recovery plans delineate such reasonable actions as may be necessary, based upon the best scientific and commercial data available, for the conservation and survival of listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies and others. Recovery plans do not necessarily represent the views, official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director. Recovery plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new information, changes in species status, and the completion of recovery actions. Please check for updates or revisions at the website below before using.

Literature Citation of this document should read as follows:

U.S. Fish and Wildlife Service. 2019. Draft Recovery Plan for the Eastern Massasauga Rattlesnake (*Sistrurus catenatus*). USFWS Midwest Region (Region 3), Bloomington, Minnesota. 17pp.

This recovery plan can be downloaded free of charge from the U.S. Fish and Wildlife Service website: <http://www.fws.gov/endangered/species/recovery-plans.html>

## ACKNOWLEDGEMENTS

We thank the following staff representatives or designated agents of the states for participating in the recovery planning process: Ann Holtrop, Scott Ballard and Joe Kath (Illinois Department of Natural Resources), Nathan Engbrecht (Indiana Department of Natural Resources), Paul Frese and Kelly Poole (Iowa Department of Natural Resources), Dan Kennedy (Michigan Department of Natural Resources) Yu Man Lee (Michigan Natural Features Inventory), Kate Parsons (Ohio Division of Wildlife), Greg Lipps and Lisle Gibbs (The Ohio State University, as designated Agents of Ohio Division of Wildlife), Thomas Bell (New York Department of Environmental Conservation), Kathy Gipe and Chris Urban (Pennsylvania Fish and Boat Commission), Rori Paloski and Richard Staffen (Wisconsin Department of Natural Resources). The following staff of the U.S. Fish and Wildlife Service also participated in the recovery planning process: Louise Clemency and Michael Redmer (Chicago Field Office), Andrew King (Indiana Field Office), Andrew DiAllisandro, Kristen Lundh, and Matthew Mangan (Illinois-Iowa Field Office), Scott Hicks and Carrie Tansy (Michigan Field Office), Trisha Crabill (Missouri Field Office), Sandra Doran and Robyn Niver (Cortland, New York Field Office), Angela Boyer (Ohio Field Office), Robert Anderson, Jennifer Kagel, and Brian Scofield, (Pennsylvania Field Office), Laura Ragan, Alisa Shull, and Jennifer Szymanski (Region 3 Regional Office, Endangered Species Division), and Margaret Rheude (Wisconsin-Minnesota Field Office).

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## I. Introduction

The eastern massasauga rattlesnake (*Sistrurus catenatus*) was listed as a threatened species under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*; Act) on October 31, 2016, following a Species Status Assessment (SSA) conducted by the Service. As stated in the SSA (Szymanski et al. 2016), the eastern massasauga rattlesnake occurred historically at 558 locations in ten states in the upper Midwest and Great Lakes Regions, and in Ontario, Canada. It presently occurs at 263 locations (a 53% decline) in eight states, and is considered extirpated in Missouri and Minnesota within the past 40 years. Of those estimated 263 extant populations, another 15% are of unknown status, and 40% are extant, but quasi-extirpated (a term that indicates the populations are likely to become extirpated in the foreseeable future). The Canadian and Ontario Provincial Governments have noted similar trends in the two populations in Canada, which are listed as Endangered (southern Ontario population) or Threatened (northern Ontario population). Multiple risk factors affect this species, though habitat loss (e.g., through development) and fragmentation (e.g., through development, or vegetative succession from invasive species) are the two that are most widespread (Szymanski et al. 2016, Executive Summary, p. v). Over the species' range, habitat varies, but generally includes components of graminoid (grass and sedge) dominated plant communities, either in or adjacent to shallow wetlands (summarized in Szymanski et al. 2016, p. 15).

The primary purpose of the Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the Act. Subsection 4(f) of the Act requires the U.S. Fish and Wildlife Service (USFWS) to develop and implement recovery plans for the conservation of endangered and threatened species.

The USFWS recovery planning process entails developing a Recovery Plan and a Recovery Implementation Strategy. This document provides the draft Recovery Plan for the eastern massasauga rattlesnake. The plan describes the recovery vision, strategy, and the required elements per section 4(f)(1)(B) of the Act. These elements include:

- (i) A description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;
- (ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and
- (iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

The Recovery Implementation Strategy (RIS) is a separate document from the Recovery Plan and is developed in close cooperation with partners. It is an operational plan for stepping down the higher-level recovery actions into specific tasks and specifies where, when, and how those tasks will be accomplished. The specifics of the RIS are updated as new information becomes available through recovery implementation. The RIS will be developed following publication of the final Recovery Plan and will be made available on the USFWS website at that time.

To develop the recovery plan for eastern massasauga rattlesnake, we conducted a species status assessment (referred to as an SSA) to evaluate the viability of the species. The assessment

entailed first describing the species' taxonomy, natural history, habitats, ecology, and range. Next, we analyzed the individual, population, and species requirements, the current condition of the species, and the factors that have led to the species' current condition. We then predicted the state of factors and their influence on numbers and distribution into the future. Lastly, given the change in the number and distribution of populations over time, we described eastern massasauga viability by evaluating the ability of the species to maintain a sufficient number and distribution of healthy populations to withstand environmental stochasticity and perturbations, catastrophes, and novel changes in its environment. A summary of the SSA analyses is documented in the Species Status Assessment Report (Szymanski *et al.* 2016) (<https://www.fws.gov/midwest/Endangered/reptiles/eama/pdf/SSAFinalV2July2016EMR.pdf>).

## **A. Recovery Vision.**

As noted above (Introduction, p. 3), the eastern massasauga rattlesnake (*Sistrurus catenatus*) is a small pit viper that occurred historically in ten of the United States (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, and Wisconsin) as well as in Ontario, Canada. It is believed that populations have been extirpated in at least two states (Minnesota and Missouri). Please refer to the SSA Report (Szymanski *et al.* 2016) for a full discussion of the species' biology.

The recovery vision for eastern massasauga rattlesnake is:

- Healthy eastern massasauga rattlesnake populations are conserved in sufficient number and distribution to ensure the species' long-term viability. That is, the species is able to recover from disturbances and fluctuations in the environment (for example, stochastic events such as fire, flooding, and storms, as well as normal variation in rainfall and temperature). Maintaining these healthy populations will require protecting sufficient quantity of high quality habitat and the reduction or management of threats at those sites.
- Eastern massasauga rattlesnake populations occur across longitudinal and latitudinal gradients to maintain evolutionary drivers such as gene flow and natural selection. Maintaining existing genetic diversity and the diversity of selection pressures experienced by eastern massasauga rattlesnake populations will conserve the eastern massasauga rattlesnake's ability to adapt to future changes in its physical (for example, habitat, climate) and biological (for example, predators, competitors, diseases) environment.
- Eastern massasauga rattlesnake populations occur in sufficient number and distribution to guard against catastrophic events (such as widespread drought, flooding, and disease) wiping out portions of the species' adaptive diversity or the species as a whole.

## **B. Recovery Strategy**

The eastern massasauga rattlesnake is threatened by habitat loss due to development, conversion of habitat to agriculture, changes to land cover due to succession by invasive woody species, persecution or poaching, effects of climate change (flooding or drought), and emerging diseases. Maintaining the healthy populations described in the Recovery Vision will require protecting sufficient quantity of high quality habitat and the reduction or management of threats where these populations occur. Given the loss of populations to date and the predicted continued

decline (Szymanski *et al.* 2016), an important part of the recovery strategy includes the following actions to reduce these stressors that are acting on existing populations:

- **Habitat loss:** Although a large proportion (estimated at >60% of populations) of extant eastern massasauga rattlesnake populations occur on protected lands owned by public or non-governmental organization (NGO) conservation partners, some important populations still occur on private lands where formal protection (through purchase or easement) or increased stewardship may be beneficial to improve probability of the snake's persistence.
- **Increase in woody invasive species:** Ensure that adequate management takes place to allow preferred eastern massasauga rattlesnake habitat structure (early successional, gramminoid-dominated plant communities) to remain. Track and measure increased areas suitable for the eastern massasauga rattlesnake after habitat treatments occur and, when possible, determine if population response is positive, thus improving probability of persistence.
- **Catastrophic floods:** Ensure, through land protection or connectivity, that there are refugia available to populations that occur in areas prone to catastrophic flooding. Assess populations after flood events to determine the likelihood that they will continue to contribute to the species' persistence.
- **Drought:** Manage water levels to ensure adequate hydrology (for example, to allow persistence of crayfish populations with which many eastern massasauga rattlesnake populations are associated for hibernation) is available during drought cycles. Assess populations after drought events to determine the likelihood that they will continue to contribute to the species' persistence.
- **Research snake fungal disease and other emerging pathogens:** Improve our understanding of how the causative pathogen is distributed on the landscape and infection pathways. Network and disseminate information if and when new pathogens are detected so that causes and infection or disease pathways may be researched early. Explore novel or existing veterinary disease treatments using either captive or wild-caught eastern massasauga rattlesnakes on an experimental basis to determine whether they may have application to wild populations. To minimize the possibility of disease transmission, evaluate best field hygiene practices for eastern massasauga rattlesnake biologists or habitat managers and, if useful, adopt such practices in the field. Reducing likelihood of disease transmission by humans who are most frequently in contact with eastern massasauga rattlesnakes may help ensure the probability of the snake's persistence.
- **Persecution:** Increase public tolerance and support for eastern massasauga rattlesnake conservation.

Given the likelihood of limited resources, we need to identify, then focus management and protection on, specific populations that will ensure that the breadth of adaptive diversity is maintained. Several remaining populations occupy large complexes of open space in which large areas are in private ownership. Because of the potential for these populations to be viable and

perhaps large, prioritizing habitat protection or incentives to private landowners to help manage habitat in ways beneficial to the eastern massasauga rattlesnake should be a priority where they occur.

We need to increase public tolerance and support for eastern massasauga rattlesnake conservation by working with landowners, partners, and the public. Through working with local outreach partners, we plan to increase outreach that highlights the role and benefits to the ecosystem when eastern massasauga rattlesnakes are present.

Lastly, successful recovery will necessitate an adaptive management approach. We need research to help better understand some fundamental aspects of eastern massasauga rattlesnake ecology. Using an adaptive management framework and monitoring during recovery implementation will allow us to evaluate how to best manage for suitable habitat conditions, protect against disease epidemics, and lessen the effects of climate change to ensure that the recovery actions are effective in recovering the eastern massasauga rattlesnake. In order to adequately assess recovery and guide adaptive management efforts, baseline data will be critical. In most cases, the baseline data does not yet exist and will need to be collected.

## **II. Recovery Criteria**

The recovery criteria provide the objective, measurable targets for achieving the recovery vision. The recovery criteria represent our best assessment of the conditions that would most likely result in a determination that listing under the Act is no longer required. For the eastern massasauga rattlesnake, these conditions will be met when conservation actions have been implemented to ameliorate the primary threats in suitable habitats.

We delineated three conservation units across the range of the eastern massasauga rattlesnake (Fig. 1). The units were originally called “analysis units” in the Eastern Massasauga Rattlesnake Species Status Assessment (SSA; Szymanski *et al.* 2016) and were based on a population genetics study that described three genetic haplotypes (Ray *et al.* 2013). We eliminated some complicated unit boundaries introduced in the original study and the USFWS’s SSA by including entire states within the conservation units rather than recognizing small (just a few counties where genetic haplotypes differed from the remaining counties) areas of genetic variation. In this recovery plan, we call these areas “conservation units” because they generally capture the range of adaptive capacity based on genetics as well as differing selective pressures and threats across the species’ range. As recovery implementation proceeds, the use of various conservation measures (for example, habitat protection, habitat management, research, and outreach) may occur in differing proportions, depending on priorities in each unit.

If the primary threats have been effectively managed in each conservation unit, the long-term persistence of the eastern massasauga rattlesnake should be ensured. We may initiate an assessment of whether recovery has been achieved and delisting is warranted when the following has been accomplished in each conservation unit:

## **Criterion 1.**

**The probability of continued persistence over 50 years is 95% within each of 3 conservation units described below.**

In the SSA, we relied on a population-specific model developed by Faust *et al.* 2011 to assess the health of populations across the EMR range. Using this baseline model and site-specific information, including population size estimate, risk factors operating at the site, and potential future management changes that might address those factors, the Faust model forecasted the future condition of 57 EMR populations over different time spans (10, 25, and 50 years).

We also evaluated the 50 year time frame during our structured decision making workshop with FWS managers on applying the listing criteria to EMR. The FWS managers identified 50 years as being “foreseeable” based on the life span of EMR and our ability to model population persistence in future years. Forecasting to 50 years, the range of current threats are still foreseeable at the end of that time span based on models and other analyses.

Genetic and ecological diversity represents the eastern massasauga rattlesnake’s ability to adapt to future changes in its physical (for example, habitat and climate) and biological (for example, predators, competitors, diseases) environment. This diversity can be described by identifying diverse geographic units to represent areas of ecological and genetic variation, as well as differing selective pressures (for example, temperature and precipitation). We have identified three geographic conservation units (Fig. 1).

The precise number of healthy populations that will be required to meet this criterion is unknown as it depends on the degree of health of the populations and the distribution of these populations relative to the current and future magnitude, frequency, and spatial extent of broad-geographical environmental stochasticity (for example, successive poor environmental conditions) and catastrophic events (for example, drought, disease). The healthier the populations are, the higher the probability of population persistence within a conservation unit, and thus, the fewer number of populations needed to achieve the probability of persistence criterion. Thus, the number of healthy populations needed to reach the recovery criterion is not static and is geography-dependent and could be achieved by a number of different scenarios with varying combinations of numbers and distribution of populations, and the health of those populations. Identifying these potential scenarios is an activity to be undertaken as part of the Recovery Implementation Strategy and may depend, in part, on available opportunities to work with interested landowners.

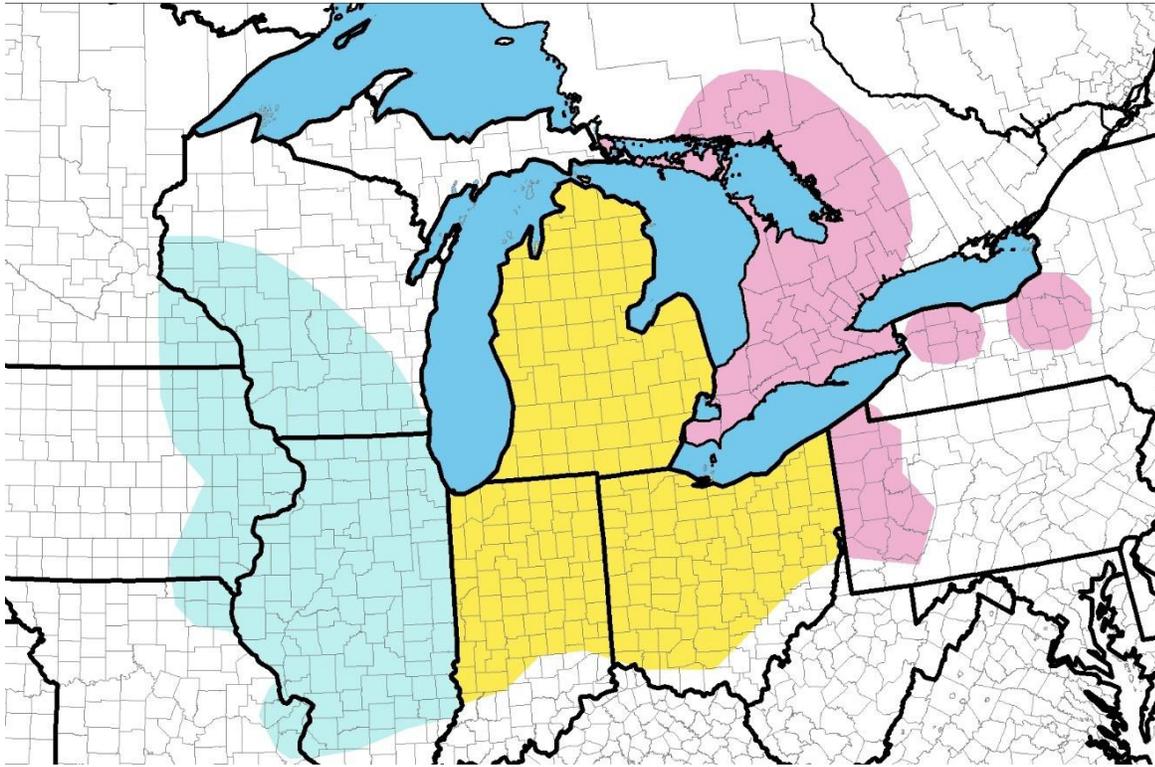


Figure 1. Three conservation units for the eastern massasauga rattlesnake.

**Criterion 2.**

**An adequate quantity and configuration of land is managed and is expected to continue to be managed in a way that will support eastern massasauga rattlesnake populations such that a probability of persistence of 95% over 50 years in each of the 3 conservation units is maintained.**

Populations of the eastern massasauga rattlesnake are well known to be sensitive to habitat modification, including natural succession and some management practices. Because of this, long-term commitments (covering at least 25 years after delisting) for habitat management are necessary to prevent declines in populations after removal from the Endangered and Threatened Species list. This timeframe is based on 3-4 generations for this species, and would help provide key assurances that the species will persist after delisting. Management plans should identify how the landowner or manager will maintain suitable summer and winter habitats, manage threats (including collection and persecution), and monitor the population. Potential funding sources to ensure periodic management needs are met should be identified as well.

**Criterion 3.**

**Threats from climate change and disease are addressed such that a probability of persistence of 95% over 50 years in each of the 3 conservation units is maintained.**

1. Effects of climate change are understood through research and modeling and adequately managed. Previously identified impacts from climate change include increased frequency of catastrophic flooding, or more severe drought cycles. Manage water levels to ensure adequate

hydrology in eastern massasauga rattlesnake habitat during drought cycles, as well as ensuring there are refugia available for populations that occur in areas prone to catastrophic flooding (both identified as potential risks from climate change).

2. The potential effects of current and emerging disease are understood and sufficiently reduced.

### **III. Recovery Actions**

This section provides broad categories of the actions that are necessary to achieve the recovery vision and meet the recovery criteria for the eastern massasauga rattlesnake. These actions apply to each of the three conservation units, but specific implementation may differ geographically (specific tasks will be population-specific). These broad categories of actions will be used to developed step-down recovery implementation strategies. The recovery implementation strategies are adaptable and will be developed in coordination with interested conservation partners.

To address threats to and recover the eastern massasauga rattlesnake, we plan to work with interested conservation partners to implement actions in the following broad categories:

#### **A. Halt and Reverse Declines.**

1. Monitor known eastern massasauga rattlesnake populations and assess viability to help guide and evaluate conservation efforts for the eastern massasauga rattlesnake. Regular monitoring of known eastern massasauga rattlesnake populations is important to help provide information on their presence or absence, population size, and other demographic information to help assess population resiliency or persistence. Monitoring can also help determine if population goals are being reached, and evaluate the effectiveness of conservation efforts. Survey efforts can also help identify declining populations, which can then be targeted for management strategies to help them rebound. Use established (for example, mark-recapture, or other census-based techniques), and/or new (genetics-based techniques) to estimate the effective population size and long-term viability of eastern massasauga rattlesnake populations. We anticipate that this action will require the entire 25 years of implementation. **Est. Cost: \$800,000**
2. Implement habitat management and restoration efforts. Active habitat management is needed to fulfill eastern massasauga rattlesnake habitat requirements in each season and life stage. Furthermore, habitat should be managed in such a way as to allow connectivity among all of the habitat components (basking sites, foraging areas, retreat sites, gestation sites for gravid females, and hibernacula). This action was overwhelmingly identified by state and NGO stakeholders as the greatest single need for eastern massasauga recovery, which reflects it representing approximately 60% of the entire estimated cost. While in many cases this action is already being implemented by most stakeholders as part of normal natural areas operations and management, greater focus directed to sites with viable populations of this species may be a key in implementing recovery. Similarly, ongoing collaboration and cooperation among all stakeholders is essential in adopting and implementing land management practices and providing feedback to each other on the

effectiveness of these practices. We anticipate that this action will require the entire 25 years of implementation. **Est. Cost: \$18,750,000**

3. Habitat Protection. Develop a land protection strategy for the eastern massasauga rattlesnake to focus on protecting sufficient quality and quantity of occupied habitat areas to preserve resiliency, representation, and redundancy of the eastern massasauga rattlesnake. This could be done through various mechanisms including short-term conservation programs (for example, USFWS Partners for Fish and Wildlife agreement or Conservation Reserve Program), as well as longer term agreements or land acquisition (for example, fee title, conservation easements). This action would likely require ten years of implementation. **Est. Cost: \$2,500,000**
4. Develop and refine recommendations on methods to reduce direct mortality of eastern massasauga rattlesnakes from vehicular strikes, persecution, and collection and incorporate these recommendations into land management plans. Because the eastern massasauga rattlesnake is reliant on habitat management, but some management actions may increase the risk of mortality (Baker *et al.* 2016), new approaches and best management practices need to be developed to help managers implement needed actions where eastern massasauga rattlesnakes occur while minimizing regulatory burdens. This action would likely require ten years of implementation. **Est. Cost: \$2,250,000**
5. Develop and implement conservation strategies that help remediate for the effects of climate variability and subsequent hydrological fluctuations in eastern massasauga rattlesnake habitat. A climate change vulnerability (CCVA) assessment indicated that extreme fluctuations in the water table are demographic stressors for the eastern massasauga rattlesnake (Pomara *et al.*, 2014). Therefore, eastern massasauga rattlesnake conservation should include strategies to minimize the effects of hydrological fluctuations during drought and flooding events, such as management or preservation of natural vegetative cover and hydrology within occupied eastern massasauga rattlesnake habitat (Pomara *et al.* 2014, p. 2,097). In particular, remediation strategies for climatic stressors in the western, central, and southeastern portions of the range should be developed since these areas were shown to have high extinction probabilities in the CCVA (Pomara *et al.* 2014, p. 2,097). This action would likely require ten years of implementation. **Est. Cost: \$1,500,000**

## **B. Ensure that the breadth of adaptive diversity is maintained.**

1. Identify key populations to be prioritized for protection within each conservation unit in order to maintain adaptive diversity. Use genetic, geographic, and ecological data to identify populations that represent the range of adaptive capacity for this species. We anticipate that this action will require two years of implementation. **Est. Cost: \$80,000**
2. Develop a conservation strategy to ensure necessary populations are maintained in a healthy state. Actions described above in A should be implemented to protect and manage populations identified as needed to maintain adaptive diversity. We anticipate that this action will require two years of implementation. **Est. Cost: \$80,000**

3. Survey for previously unknown eastern massasauga rattlesnake populations and in areas that are important to preserving adaptive capacity and meeting recovery criteria and where the status of populations are unknown. It is important to survey in an effort to find previously undiscovered eastern massasauga rattlesnake populations. These “new” populations can be monitored for population demographics and targeted for conservation efforts, particularly if they are genetically distinct or adapted to a specific set of environmental conditions. Such populations may prove to be important to the species’ adaptive capacity and the preservation of its representation across the range. Survey efforts in areas where populations previously occurred, but have since become unknown in status can also be useful for eastern massasauga rattlesnake recovery efforts. In some cases, populations have gone without monitoring for a long time. In others, the eastern massasauga rattlesnake has simply gone undetected in spite of survey efforts. The eastern massasauga rattlesnake’s secretive behavior and cryptic coloration make it a difficult species to detect in the wild, especially when populations are either small or dispersed in low densities over large areas. Many times low population densities can contribute to this difficulty. The absence of eastern massasauga rattlesnake detection at a site where this species has previously been recorded does not necessarily prove it has been extirpated. Long-term survey efforts should be conducted before extirpation is assumed, particularly if such populations are believed to be important to the preservation of this species’ adaptive capacity. We anticipate that this action will require five years of implementation. **Est. Cost: \$200,000**

### **C. Increase public tolerance and support for eastern massasauga rattlesnake conservation.**

1. Engage and provide cooperative support for land-owning organizations and private land owners when they can assist in eastern massasauga rattlesnake conservation. We anticipate that this action will require the entire 25 years of implementation. **Est. Cost: \$400,000**
2. Incentivize actions that benefit the eastern massasauga rattlesnake and its habitat, while also recognizing that the needs of land owners vary. For example some land owners may wish to continue using land in ways that are compatible with eastern massasauga rattlesnakes (such as upland bird hunting), but don’t have the resources to improve habitat in a way that benefits both targets. We anticipate that this action will require ten years of implementation. **Est. Cost: \$200,000**
3. Work with local outreach partners to increase outreach that highlights the role and benefits to the ecosystem when eastern massasauga rattlesnakes are present. We anticipate that this action will require ten years of implementation. **Est. Cost: \$300,000**
4. Increase our knowledge and understanding to ensure effective recovery of the eastern massasauga rattlesnake.
  - a. Evaluate the effects of habitat management activities (including species and habitat responses to management treatments). Additional research, monitoring, and analysis are needed to determine appropriate management options for maintaining, enhancing, and restoring eastern massasauga rattlesnake habitat in an adaptive management approach. As additional research is conducted on the effects of

management practices on the eastern massasauga rattlesnake, these best management practices should be re-examined and refined so they effectively reduce mortality to the eastern massasauga rattlesnake, while also achieving habitat management objectives. **Est. Cost: \$100,000**

- b. Collaboratively use genetic data as an additional source of assessing population viability and guiding captive management. Recent advances in population genetics techniques allow adaptive variation, demography, and effective population size to be estimated without long-term monitoring in the field, for example by mark-recapture methods. In addition, the eastern massasauga rattlesnake has been the subject of several range-wide and population level genetics studies, and these should be used to inform management of the captive population to ensure appropriate diversity is available if future reintroductions are attempted. As this is an evolving field of study, collaboration among the USFWS, stakeholders, and researchers will be crucial to standardize data collection and analysis. We anticipate that this action will require five years of implementation. **Est. Cost: \$250,000**
- c. Investigate the risks of disease to populations of the eastern massasauga rattlesnake, and potential management options. For example, epidemiological surveys and research are needed to determine the extent of snake fungal disease and other disease-causing pathogens that could potentially be a stressor to populations of the eastern massasauga rattlesnake.. Research should be conducted to determine the factors that influence the prevalence of snake fungal disease among eastern massasauga rattlesnake populations (Allender *et al.* 2016), and populations should be assessed for their potential vulnerability to the risk of a disease outbreak. Strategies to minimize the impacts of disease at the population and species level as well as to enhance the health of individual eastern massasauga rattlesnakes should be developed. This action would likely take ten years of implementation. **Est. Cost: \$1,500,000**
- d. Address effects of climate change, which has been projected to impact eastern massasauga rattlesnake populations through increased catastrophic flooding, localized droughts, and increasing invasion by woody species. Identifying key/specific sites (adjacent to water-control reservoirs where flooding is likely) that are at high risk from climate-driven factors affecting key populations needed for recovery, and finding ways to remediate for impacts could be crucial for maintaining adaptive capacity, especially near the edges of the range of the eastern massasauga rattlesnake. Identify new management approaches for established invasive species, and identify new invaders that may be a potential threat to the preferred habitat of the eastern massasauga rattlesnake. We anticipate that this action will require the entire 25 years of implementation. **Est. Costs: \$1,500,000**
- e. Explore the need, cost/benefits, and feasibility of eastern massasauga rattlesnake population restoration efforts through captive propagation and augmentation. Populations that are believed to be at high risk for extirpation may benefit from targeted captive propagation or attempts at population augmentation, especially if, and after, the threats to those populations are addressed. While this may increase resiliency of some populations, and adaptive capacity of the species, attempts to augment or introduce the eastern massasauga rattlesnake to the wild should be considered investigational and the USFWS would consider use of

experimental populations per section 10(j) of the ESA. This action would likely take ten years of implementation. **Est. Costs: \$750,000**

- f. Achieve a better understanding of genetic diversity in the eastern massasauga rattlesnake. The eastern massasauga rattlesnake is a wide-ranging species that can have detectable genetic structure between neighboring populations in small portions of its range. Adaptive significance of this is not fully understood and may help inform recovery implementation. This action would likely take five years to investigate priority questions. **Est. Costs: \$250,000**

**IX. Time and Costs** – The time(s) needed to implement recovery is a guide for meeting the recovery goals, objectives, and criteria discussed in this plan. The initiation and completion of recovery actions is subject to the availability of funds, as well as other constraints affecting the parties involved. The total cost of recovery is only an estimate and may change substantially as efforts to recover the species continue. Thus, detailed cost breakdowns for each conservation unit, with expected annual costs are not known at this time, and estimates above are for all three conservation units. While we have the statutory responsibility for developing and implementing this recovery plan, recovery of the eastern massasauga rattlesnake across the coterminous United States will necessitate the involvement of Federal, Tribal, State, private, and local interests. The continued expertise and contributions of these, and additional agencies and interested parties, is needed to implement the recovery actions identified in this plan. While this recovery plan contains an overall framework of broad actions for attaining recovery, to enhance the effectiveness of this recovery plan, we intend to develop and adopt a Recovery Implementation Strategy (RIS) as a flexible way to step down these actions to specific activities that can be updated or modified as needed, independently of revising the recovery plan. The RIS should be updated as needed to reflect lessons learned from recovery implementation and next highest priorities for recovery implementation.

Estimated costs provided for the actions above are based on those actions being completed within the anticipated timeframes identified for each action. In some cases (for example habitat management actions such as prescribed fire and brush removal) actions will be ongoing, but their costs calculated here are for twenty five years. We do not anticipate that recovery of the EMR will be achieved sooner than 25 years, due to the widespread threats, uncertainty about cost/benefit trade-offs to the species from management techniques, likely availability of funds, as well as due to biological characteristics of the species. If all actions are fully funded and implemented as outlined, including full cooperation of all partners needed to achieve recovery, we expect recovery criteria for delisting could be met by 2043. **Total Estimated Cost of the Recovery Actions identified above: \$31,410,000**

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## **Appendix: Future EMR Status Review or Delisting Process**

If recovery criteria are met or the USFWS otherwise determines that the threats to EMR have been effectively managed and sufficiently reduced in a conservation unit, we may initiate an assessment of whether recovery has been achieved. In the case of EMR, each of the conservation units may later be determined to meet the definition of a distinct population segment (DPS) under our Policy Regarding Recognition of Distinct Population Segments (61 FR 4722, Feb. 7, 1996). Consequently we may consider, consistent with applicable law, whether it is possible to delist at the conservation unit (DPS) scale. Any proposal to delist the EMR or any potential DPSs would be published in the Federal Register. After analyzing the comments received on the proposed rulemaking, we would decide whether to complete the proposed delisting action or leave the protections of the Act in place. Our final decision would be announced in the Federal Register. The comments received and our responses to them would be addressed in the final rule.