

# MINNESOTA'S WILDLIFE ACTION PLAN 2025-2035

## CONSERVING HABITATS AND BIODIVERSITY

### REPTILES



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# Reptiles

## Overview

Despite its cold climate, Minnesota is home to a [diverse assemblage of reptile species](#) – 9 turtles, 16 snakes, and 3 lizards. In 1944 Walter Breckenridge published *Reptiles and Amphibians of Minnesota*, marking the state's beginning of modern herpetology. Breckenridge's publication was considered Minnesota's standard herpetological reference until *Amphibians and Reptiles Native to Minnesota* was published by Oldfield and Moriarty in 1994, followed by an update in 2014 (Moriarty and Hall). In the late 1970s, the Minnesota DNR's Nongame Wildlife Program was established, and has since funded studies on [wood turtles \(\*Glyptemys insculpta\*\)](#), [Blanding's turtles \(\*Emydoidea blandingii\*\)](#), [timber rattlesnakes \(\*Crotalus horridus\*\)](#), [gophersnakes \(\*Pituophis catenifer\*\)](#), [five-lined skinks \(\*Plestiodon fasciatus\*\)](#), and more. The Minnesota Biological Survey, initiated in 1987, surveyed counties across the state targeting rare wildlife and collecting records on common species. Their work has helped establish Minnesota's list of reptile Species in Greatest Conservation Need (SGCN) and has added thousands of records of reptiles to the DNR's Natural Heritage database.

Reptiles play an important role as both predator and prey in their ecosystems. Snakes eat many mammal species that humans consider pests and reduce numbers of disease-carrying ticks attached to those mammals (Kabay et al. 2013). Turtles create and modify habitats as they dig burrows or nests, and function as seed dispersers (Lovich et al. 2018). Conservation and research initiatives targeting reptile species have historically been underfunded and underrepresented despite the ecological importance of these species and particular life history requirements that make them vulnerable to decline, such as low reproductive rate, reliance on rare habitat types, and sensitivity to changes in temperature (Gibbons, 1988; Todd et al., 2010; Christoffel & Lepczyk,

2012; Tingley et al., 2016). In part, this may be due to traits that make them more difficult to study, including the rarity and cryptic nature of many species (Crane et al., 2021) and the fear and disdain that members of the public often feel towards snakes, lizards, and turtles relative to charismatic bird and mammal species (Olson & Pilliod, 2022). SGCN reptiles need focused attention to ensure their long-term conservation. The [Minnesota Herpetological Society](#) is an important venue for public education and promoting the study and conservation of both reptiles and amphibians. [Herpmapper](#), a community science platform designed to gather reptile and amphibian observations worldwide, hosts the [Amphibian & Reptile Survey of Minnesota](#), which provides information on Minnesota's herpetofauna and collects observations of Minnesota's herpetofauna, including turtle road crossing and mortality hotspots through the Minnesota Turtle Crossing Tally and Count Project. On a larger scale, [Midwest Partners in Amphibian and Reptile Conservation](#) (PARC) is an important network dedicated to the conservation of reptiles and amphibians that provides an avenue for collaborative conservation initiatives, outreach and education resources, and more.



Photo: Plains hognose snake, Bob Dunlap

## SGCN and SNI Summary Information

The 2025 SGCN list includes 13 reptiles (46%) of the 28 reptiles in the state and one Species in Need of Information (SNI), the Southern map turtle (*Graptemys ouachitensis*). The SGCN include 8 snakes, three turtles, and two lizards. Four species are state listed as Threatened, and six as Special Concern species. Two species, the Blanding's turtle and wood turtle, are presently under consideration for federal listing. Two species that were on the 2015 list were not included on this update, the Northern ring-necked snake (*Diadophis punctatus*), which is now thought to have a stable population in Minnesota, and [massasauga \(\*Sistrurus catenatus\*\)](#), due to extirpation. A complete list of both SGCN and SNI species can be found in [Appendix B](#).

## Habitat Associations

Reptile SGCN utilize a variety of habitats, but the highest number of species were associated with savanna, prairie and other grasslands, upland deciduous forest and woodland, and cliff, talus, and rock outcrops (see Table 2.9). Cliff, talus, and rock outcrops provide rock surfaces essential for basking and thermoregulation in snakes and lizards, while rock and talus crevices provide important shelter and nesting sites.

Table 2.9 summarizes the association of reptile SGCN with the habitat types identified in the SWAP. Primary habitats are those that species rely on and use most consistently; loss or degradation of these habitats would have the most significant negative effect on their populations. Secondary habitats are used by the species less frequently. Animals with more general habitat requirements are associated with multiple habitat types, while specialists are associated with one or few. Detailed tables associating each SGCN with the 15 habitats identified in the 2025-2035 SWAP can be found in [Appendix D](#).

**Table 2.9. Numbers of Reptile Species in Greatest Conservation Need associated with each of the 15 main habitat types (only showing habitats with reptile SGCN associations).**

Habitats	Primary Habitat	Secondary Habitat	Total
Prairie and Other Grasslands	11	0	11
Savanna	12	0	12
Upland Conifer Forest and Woodland	3	1	4
Upland Deciduous Forest and Woodland	9	1	10
Mesic Hardwood Forest	5	1	6
Deciduous Wet Forest	3	1	4
Riparian and Floodplain Forest	2	1	3
Non-forested Wetlands	1	5	6
Rivers and Streams	3	0	3
Lakes	1	0	1
Vernal Pools	0	1	1
Cliff, Talus, and Rock Outcrops	8	0	8
Urban and Other Developed Lands	0	5	5

Across their entire range, common five-lined skinks are typically found in woodlands. However, in Minnesota they are primarily associated with limestone and granite rock outcrops and bluff prairies. Another lizard SGCN, the six-lined racerunner (*Aspidoscelis sexlineatus*), is also found in prairie, savanna, and rocky habitats, usually in areas with sand or gravel.

The [North American racer \(\*Coluber constrictor\*\)](#) utilizes dry habitats including edges of deciduous woodlands, prairies, rock outcrops, and old crop fields. [Plains hog-nosed snakes \(\*Heterodon nasicus\*\)](#) are a prairie species that prefer sandy or gravelly areas to burrow in. The closely related Eastern hog-nosed snake (*Heterodon platirhinos*) also prefers sandy or loamy soil, but occupies a wider range of habitats including grasslands, open woodlands and forest edges, and river shorelines and floodplains. The smooth greensnake (*Opheodrys vernalis*) is associated with prairies and meadows, edges of mixed forests, and the edges of marshes and bogs. The gophersnake prefers open landscapes like prairies, savannas, pastures, and old cropland, as well as rocky bluff habitats. The [lined snake \(\*Tropidoclonion lineatum\*\)](#) can be found in open prairies with

large amounts of exposed rock. The timber rattlesnake requires hillsides with bluff prairies and rock outcrops, where they breed and overwinter in dens. Nearby forests, forest edges, and open fields are used as feeding grounds in the summer. The [western ratsnake \(\*Pantherophis obsoletus\*\)](#) is a woodland species and prefers forested uplands and valleys with rivers and rock outcrops.

Blanding's turtles prefer open areas with shallow, slow-moving water, like marshes, ponds, bogs, small streams, and ditches. During the winter, they overwinter at the bottom of these bodies of water. Blanding's turtles also utilize upland forested habitat as travel corridors between wetlands, foraging opportunities, and nesting, with some females traveling over a mile to nest (Piepgras & Lang, 2000). Wood turtles utilize rivers and adjacent floodplains and uplands, primarily in forested areas. They nest on sandbars and riverbanks but may also nest in human-altered habitats such as agricultural fields or sand and gravel mines. The smooth softshell is found in large rivers with moderate to fast currents that have sandy or muddy bottoms, which they burrow in during the winter.



Photo: six-lined racerunner, Bob Dunlap

## Case Study: Wood Turtle Nest Success

As part of a USFWS Competitive State Wildlife Grant, the Minnesota DNR Nongame Wildlife Program and collaborators undertook a project in northeastern Minnesota to identify threats to wood turtles and effective conservation actions to address those threats. One area of focus was nest success. Biologists monitored wood turtle nests and found that 5% of nests were successful, with predation the primary cause of nest failure. Badgers were responsible for 85% of predated nests, followed by raccoons, ravens, skunks, and foxes. Different nest protection methods were trialed, including an electric fence around a nest site, nest boxes which completely enclose a nest site with a small opening at the bottom for turtles, and deploying nest cages over individual nests. The different nest protection methods have pros and cons in terms of amount of effort and logistics of working in remote areas. Overall, nest success increased to 50% with nest protection efforts. Nest protection has been a successful conservation action, and these efforts have led to a minimum of 630 wood turtle hatchlings.



*Photo: Wood turtle hatchling, Gaea Crozier*

The real measure of success will be finding out if these conservation actions are having an effect on the overall wood turtle population. To answer that question, biologists have established long-term monitoring sites with a mark-recapture methodology. The goal is to monitor the sites every 5 years to obtain information on abundance, age-class structure, and sex ratio. Some long-term monitoring sites are controls, where no conservation actions are occurring. Other long-term monitoring sites are treatments, with conservation actions like nest protection and enhancing nesting habitat by removing encroaching vegetation and creating nest sites that are more safe from flooding. If these conservation efforts are successful, biologists expect to see an increase in turtles in the younger age classes in the coming years in the treatment monitoring sites. See Brown et al., 2025 for more information.

## Primary Stressors for Reptiles



### Development

Development can cause habitat loss and fragmentation and makes traversing the landscape more difficult and dangerous for reptiles (see also Roads, Trails, and Railroads). Development also can increase the abundance of mesopredators (mid-sized), such as raccoons, badgers, foxes and skunks, which prey on reptiles (Gelvin-Innvaer et al., 2025). Free-roaming cats are non-native predators on snakes and lizards including the common five-lined skink (COSEWIC, 2007). That effect has been often overlooked and warrants further attention as an additive stressor (Lloyd, 2012; Hall, 2019). Erosion control materials including rip rap and mesh, such as those used in construction of roads and to stabilize stream banks, can pose hazards as well, ensnaring snakes, lizards and turtles. (Stuart et al., 2001; Barton & Kinkead, 2005; Walley et al., 2005; Kingsbury & Gibson, 2012).



### Crop Production

Row crop agriculture has converted native prairie and grasslands that reptiles like Blanding's turtles, gophersnakes, and plains hog-nosed snakes depend on (Congdon et al., 2008; Moriarty & Hall, 2014). Suitable nesting habitat may be a limiting factor for some SGCN reptiles (MWPARC, 2010). Cultivated fields often become the only remaining option for nesting, yet these open, disturbed soils can also be "ecological sinks." For example, female Blanding's turtles have been found to preferentially select bare crop fields for nesting over naturally occurring nest sites (Mui et al., 2016). As crops grow, they shade nests from the sun's warmth which affects egg development, can lead to skewed sex ratios and reduce nest success (Freedberg & Pappas, 2011). Reptiles, such as snakes and turtles, are also injured and killed by farming equipment (Kapfer et al., 2008, Saumure & Bider, 1998; Saumure et al., 2007). Nests and eggs may be subject to destruction from

mid-season tillage, and soil compaction from heavy equipment that could make it difficult for hatchlings to emerge from the nest (Dowling et al., 2010; Henning & Hinz, 2016; Chessman, 2017; King et al., 2025.) Agricultural chemical application also poses threats to turtles and their unhatched eggs. Turtles are long-lived and therefore may also be prone to bioaccumulation of toxins that could have lethal and/or sublethal effects (DNR, 2020). Last, row crop agriculture can negatively affect water quality, hydrology, and plant communities of wetlands, streams, and shallow lakes that SGCN turtles rely on and some SGCN snakes like gophersnakes use in parts of Minnesota for thermoregulation, foraging, and travel (DNR unpubl. data.)

SGCN reptiles use haylands and other managed grassy areas to meet a variety of needs, including for nesting and foraging (Knoot & Best, 2011; Dowling et al., 2010; Wittenberg, 2012; DNR, 2020). Haying for livestock forage and mowing, such as for roadside maintenance, filtration and buffer strips, or firebreaks, pose significant risks of injury and mortality to rare reptiles, especially turtles and snakes (Dalrymple & Reichenbach, 1984; Durbian, 2006; Wiese, 2016). The nesting period is the most vulnerable period for Blanding's turtles (Henning & Hinz, 2016; King et al., 2025). Wood turtles may also be at risk when foraging in uplands (Saumure et al., 2007; DNR, 2020).



### Mining and Quarrying

Hard rock mining operations may remove or degrade rock outcrop habitats and put reptiles at direct risk of harm by equipment during active mining, although these areas can also in the long term provide alternative outcrop habitat. Sand and gravel quarries can attract nesting turtles, increasing the risk of turtles being injured or killed and nests being destroyed by heavy equipment and blasting as part of mining operations (Zagorski et al., 2019; DNR, 2020).



## Wind and Solar Energy Infrastructure

Solar farms shade nesting and basking areas for Blanding's turtles, including agricultural lands which may be the only available nesting areas in the vicinity of the turtle's aquatic habitat. Additionally, unless fence design specifically incorporates periodic openings to accommodate turtles, fencing around solar facilities can block turtle movements and habitat use (MWPARC, 2010).

Easements for wind energy facilities often preclude acquisition and easement protections of adjacent open lands for conservation which in turn affects reptiles dependent on those habitats. (See also Prairies and Other Grasslands chapter).



## Roads, Trails, and Railroads

Roads can fragment reptile habitat and create a hazard for species that need to cross this barrier to reach habitats necessary for their survival and reproduction. Transportation infrastructure and vehicles affect reptiles in many ways (Andrews et al., 2006). Road mortality poses a major threat to snakes and turtles including Blanding's

turtles (King et al., 2025; MWPARC, 2010) and gophersnakes (Kapfer et al., 2008). Railroads have also been documented as a mortality risk (King et al., 2025). Roads can attract cold-blooded reptiles seeking a warm surface to raise their body temperature. Gravel roads and sparsely vegetated road shoulders with disturbed soils may attract nesting turtles which increases risks to breeding females, their nests, and hatchlings from traffic and roadway maintenance (Jones et al., 2024). The turtles' slow movements and habit of withdrawing into their shells when perceiving a threat, such as an oncoming vehicle, further adds to the risks of crossing a road (Gooley, 2010).



## Utility Corridors

Directional boring and trenching for utilities (cable and pipelines) can affect reptiles directly and indirectly. Extensive excavation may destroy reptile nests and hibernation dens. Availability of suitable hibernacula (shelter) can be a limiting factor for snakes in northern latitudes including gophersnakes ("bullsnakes") (Johnson et al., 2022; Kapfer et al 2008; Martino et al., 2012) that overwinter in deep burrows. The DNR has



Photo: Gophersnake, Bob Dunlap

documented Blanding's turtles overwintering in stream banks, including concentrations of many turtles in burrows that extend deep into the banks at least 10 feet (DNR unpubl. data). Such sites could be subject to utility boring (e.g. at stream crossings). Unfortunately, overwintering locations are not universally documented for all Blanding's turtle populations which hinders environmental review.



## Hunting and Collecting Animals

In Minnesota, taking, importing, transporting or selling any state endangered or threatened reptile is prohibited without a state permit (M.S. 84.0895) (e.g. timber rattlesnake, Blanding's turtle, wood turtle, and western ratsnake; MN Rules chapter 6134). Native turtles may not be sold as pets in the state. Although state residents with a fishing license and recreational turtle license may harvest common snapping turtles and western painted turtles for their personal use, commercial harvesting of these species was prohibited beginning in January 2024. The statute has exemptions that provide for the take of painted and snapping turtles by minors to continue the long-standing tradition of summer turtle races in small towns in Minnesota (M.S 97C.605). Once collected, and the races are over, the turtles cannot be released to the wild; their long-term care is the responsibility of the collector.

These rules and regulations provide a strong network of protection for Minnesota's native reptile species although illegal collection still occurs and poses a risk factor especially for imperiled species in Minnesota (DNR, 2020; Christman et al., 2024). Occasionally, a threatened turtle species gets entered illegally in a race (DNR unpubl. data).

Concerns also remain regarding the persecution and killing of species people perceive to be harmful to themselves, their livestock, or their pets. The timber rattlesnake is considered especially vulnerable. Because of the species' low reproductive rate, irregular

reproduction, and high juvenile mortality (DNR, 2009), the loss of even a single adult can significantly affect a local population (Brown, 1993). Another concern is when citizens are fearful of a snake, remove it from their home site and release it elsewhere, it may decrease its long-term survival.



## Timber Harvest

Timber harvest is a forest management tool that can affect wildlife habitat by changing forest structural and compositional diversity. Forest management decisions, including inaction, typically have positive effects for some species and negative effects for others. The wood turtle is a forest-dependent SGCN reptile that is affected by a variety of factors related to forest management including timber harvest, road development, forest type conversion, and herbicide application, which may harm wood turtles directly and degrade their habitats (Tingley & Herman, 2008; DNR, 2020). Blanding's turtles are also vulnerable to these forest management activities as they make upland forest movements in the spring and summer related to breeding, foraging, and nesting (Piepgras & Lang, 2000, Refsnider & Linck, 2012), as well as hatchling movements in fall from nest site to overwintering habitat (Nyhus, 2020). However, canopy openings created by timber harvest may benefit both these turtle species as well as other SGCN reptiles requiring open sites for thermoregulation (Hughes & Litzgus, 2019; Auge et al., 2023). Forest management practices that reduce fuel load can help to prevent catastrophic mid-summer fires which can be lethal to forest-dwelling turtles.



## Fishing

Turtle bycatch and ingestion of fishing tackle can have individual and population level effects (Borkowski, 1997; Barko et al., 2010; Midwood et al., 2015; Steen & Robinson, 2017). Anglers may unintentionally attract and concentrate predators like raccoons by leaving discarded fish cleaning remains and

live bait, which can pose a significant threat to SGCN turtles, particularly hatchlings (see Problematic Native Species; Recreation).



## Recreation

Recreation can have numerous direct and indirect effects on rare, sensitive reptiles and their habitats ([Northeast Blanding's Turtle Working Group, 2022](#)).

Snakes, for example, can be physically harmed by people when they are encountered during outdoor activities, due to widespread fear of snakes. Rare turtle species, like the wood turtle and Blanding's turtle, are vulnerable to a range of recreational activities, including all-terrain vehicle trails and canoe routes located near nesting locations. Off-highway vehicle parks established on sandy areas can pose risks to snakes and turtles that depend on these areas. Recreational sites located on or near sandy shorelines where turtles nest can create a range of disturbances. Garbage left behind at these locations can attract predators to nearby nest sites. Motorized vehicles can cause direct mortality to slow-moving turtles and snakes and inadvertently destroy nests. An increase in human traffic on land also increases the chances turtles are picked up and removed from the local population. A 20-year field study in Connecticut documented a decline in two wilderness wood turtle populations after opened to recreational use (Garber & Burger, 1995).

Larger loose rock is an important habitat component for some SGCN reptiles, such as five-lined skinks (Lang, 1982; Quirt et al., 2006). Rock collecting and recreational cairn building increase disturbance and affect reptile habitat (Schlesinger & Shine, 1994; Hecnar & M'Closkey, 1998; Goldingay & Newell, 2006).

In the water, motorized watercraft can cause direct injury, mortality, disturbance and habitat degradation for turtles (Lester et al., 2013, Selman et al., 2013; Smith et al., 2018).

Summer turtle races are local community events that result in the permanent removal of turtles from their populations, as required

by state law. Despite providing recreational opportunities, turtles collected for the races likely undergo stress and become more prone to disease and injury (Heeb et al., 2024).



## Fire Management

Fire suppression increases the growth and spread of woody vegetation in open upland habitats that are critical for many reptiles. Encroachment of trees and shrubs affects reptile species adapted behaviorally and physiologically to open habitats such as prairies and grasslands, including prairie rock outcrops. For example, woody species reduce suitability for Blanding's turtle nesting and egg development, primarily due to shading (MWPARC, 2010). It may also reduce the ability of hatchling Blanding's turtles to orient towards water after they emerge from the nest (Pappas et al., 2009). For wood turtles, early spring and late fall wild fires can be beneficial by increasing herbaceous (non-woody) vegetation for foraging and openings for nesting. Common five-lined skink populations of the Upper Minnesota River Valley have been affected by woody encroachment on prairie outcrops, a required habitat (Gelvin-Innvaer et al., 2025). Trees like red cedar can shade basking areas for timber rattlesnakes, reducing reproductive success by limiting the number of days with high ground temperatures that females need to incubate young (DNR, 2009). (See also [Prairies and Other Grasslands and Cliff, Talus and Rock Outcrop habitat sub-chapters](#)).

Prescribed fire is a valuable tool to maintain open upland habitats for nesting and basking to benefit SGCN such as five-lined skink, Blanding's turtle, and many SGCN snakes. Prescribed fire also may help create quality foraging habitat (i.e., flush of herbaceous vegetation and berries post-fire). However, many prairies and grasslands now exist as small and isolated patches which make managing both for vegetation and sensitive wildlife a challenge. Fire can cause injury or mortality when it is not applied with the life histories and risk factors of rare, sensitive reptiles in mind.

For example, adult female Blanding's turtles have been injured and killed by prescribed burning conducted during their nesting periods in May and June when they were trapped away from aquatic refuge. Spring burning in native prairies and wet meadows has resulted in injury and mortality of Blanding's turtles (Lang, 2004). Fire can also cause direct mortality of prairie snakes and lizards (Setser & Cavitt, 2003, Schultz & Caven, 2021). During early spring emergence, snakes typically remain near their hibernation dens, and when temperatures are cool, they are less able to escape quickly if threatened by fire.



### Dams and Water Management

Turtles can be affected by a wide variety of water management when that occurs without considering turtle requirements and vulnerabilities. Examples include dams, water drainage and drawdowns, stream channelization, excavation/dredging culvert installation and even construction activities associated with stream restoration. The creation of physical barriers and changes to water flow that result in loss of feeding and nesting habitat, and changes to water quality are among the documented effects (Barcenas-Garcia et al., 2022). Water appropriations and drawdowns that reduce water levels during critical low water periods pose another threat especially when there are no accessible alternative habitats or when turtles are inactive during overwintering (Hall & Cuthbert, 2000; MWPARC, 2010; DNR 2020; NatureServe, 2025).

Turtles face direct risk of injury and mortality from heavy equipment operation in waterbodies. Currently, there is no corroborated evidence that proposed actions to mitigate the effects of dredging and other excavation to turtles effectively results in avoidance of turtle injury or mortality (Barcenas-Garcia et al., 2022). Dredging during the turtles' active season and posting spotters during dredging are not proven to be reliably effective measures due to the turtles'

cryptic coloring, insufficient water clarity that obscures vegetation, and the tendency of many freshwater turtles to "hide" in place within their shells rather than to evade direct threats.



Photo: smooth softshell (left) and spiny softshell (right), Jeff LeClerc



### Invasive Species (Problematic Non-native Species)

Invasive, non-native species can alter open habitats that are critical for reptiles, including rare species (Gibbons et al., 2000). Prairies and grasslands dominated by dense stands and thick thatch layers of smooth brome (*Bromus inermis*) are unsuitable for nesting and successful hatching by Blanding's turtles (L. Gelvin-Innvaer, pers. comm.). Bluff prairies overgrown with buckthorn (*Rhamnus cathartica* and *Frangula alnus*) negatively affect timber rattlesnakes in southeastern Minnesota (DNR, 2009) and five-lined skinks on rock outcrops along the Upper Minnesota River Valley (Gelvin-Innvaer et al., 2025). (See sub-chapter on Cliff, Talus and Rock Outcrops).



## Problematic Native Species

Reptiles are affected by nest predation from mesopredators like raccoons, badgers, foxes, and skunks. Mesopredators also injure and kill juveniles and adults. Although an important component of native ecosystems, the populations of these native predators can be artificially elevated and concentrated through factors such as habitat fragmentation, constructed trails, and attractants such as garbage and discarded bait. Human-subsidized nest predators have been identified as major factor in Blanding's and wood turtle declines (DNR, 2020). Dense stands of native and non-native reed canary grasses (*Phalaris spp.*) in floodplains reduce the availability of sandy nesting areas used by wood turtles (DNR, 2020).



## Diseases and Pathogens

North American reptiles face a variety of risks from diseases, pathogens, and parasites (Gibbons et al., 2000). For example, snake fungal disease has been found in several species that are known to occur in Minnesota, including milk snakes, black rat snakes, and timber rattlesnakes. Caused by a fungus (*Ophidiomyces ophidiicola*) it can spread internally, causing eye infections and pneumonia, and externally, causing lumps or ulcerations. Mortality can occur (Cornell College of Veterinary Medicine, 2021). Turtles are also carriers of various pathogens and can be affected by a variety of diseases, including metabolic bone syndrome. Emerging diseases such as *Emydomyces testavorans* and *Emydoidea herpesvirus 2* are of particular concern for turtles, including Blanding's turtles (Woodburn et al., 2019, Andersson et al., 2021). Turtles also are well-known carriers of *Salmonella* bacteria which is easily transmitted to people who handle them. Overall, there is a lack of focus on and awareness of releasing and transporting captively held species without rigorous precautions and criteria.



## Water-borne Pollution

Freshwater turtles are bioindicators of environmental pollution due to their longevity, ecological diversity, and trophic positioning (higher in food web). Mercury contamination has been studied the most extensively (Dias et al., 2025) although other environmental pollutants can also have direct and indirect effects on reptiles (Gibbons et al., 2000). In general, insufficient research on the direct, indirect, and synergistic effects of pesticides and herbicides on reptiles hampers informed proposal review and technical guidance.



## Air-borne Pollution

Airborne mercury enters aquatic ecosystems primarily through atmospheric deposition, where it settles onto land and water bodies via rain, snow, or dry particles, and then can be washed into water bodies. Otherwise, chemical application on uplands often is via aerial spraying. As noted above, several life traits of freshwater turtles make them suitable bioindicators of environmental pollution (Thompson et al., 2018; Dias et al., 2025) and effects on reptiles are vastly under researched.



## Light and Noise Pollution

Apart from sea turtles, where light pollution has shown to negatively affect hatchling movements, reptiles have rarely been the subject of field research addressing the effects of light or noise pollution. However, some studies suggest that freshwater turtles like the Blanding's turtle orient toward dark horizons upon hatching to help them disperse from nests into wetlands (Pappas et al., 2009).



## Changes in Temperature related to Climate

Minnesota has experienced a clear warming trend over the past century. Between 1895 and 2020, average statewide temperatures increased by 3.0 degrees Fahrenheit (°F; [Climate Trends](#)). This warming has become more pronounced in recent decades and during the winter months. Since 1985, average winter temperatures in Minnesota have risen by 5.4°F, with average winter low temperatures increasing even more significantly by 6.8°F ([Climate Change in Minnesota](#)). These changes have led to a shortened season of snow cover and a reduction in lake ice duration by 10-14 days over the past 50 years (MPCA & DOC, 2025). Furthermore, these shifts in thermal regimes are ecologically significant. Many species are adapted to narrow temperature ranges, and such rapid changes can result in increased thermal stress, the spread of invasive species, and heightened disease and pathogen risks (Ratcliffe et al. 2025).

This warming trend is expected to continue. By mid-century (2040-2059), Minnesota's average annual temperature is projected to rise by an additional 3.8 - 4.5 °F, depending on future greenhouse gas emissions scenarios (Liess et al., 2022; [Climate Change in Minnesota](#)). Climate change does not act in isolation, interacting with invasive species dynamics, land-use change, and shifts in water quality and quantity, compounding ecological effects (He et al., 2019; Finch et al., 2021). For additional context and resources, refer to the Climate Adaptation section in Chapter 6: Implementation.

Reptiles depend on external conditions to regulate their body temperatures, which influences their activity and metabolism. Substantially warmer winters have implications for Minnesota's reptiles which have evolved long dormancy periods for winter survival. Although reptiles must have overwintering sites below the frostline to avoid freezing, those sites must also be sufficiently cool for

them to maintain a reduced metabolic state during dormancy. Later freezes and earlier winter thaws affect reptile activity periods and have implications for technical guidance to help ensure their conservation. Warmer temperatures during their nesting season may cause skewed sex ratios for Blanding's turtles and Southern map turtles due to temperature dependent sex determination (Gutzke & Packard, 1987; Vogt, 2018) which will affect population structure and reproductive output.



## Changes in Precipitation and Hydrology related to Climate

From 1895 to 2020, Minnesota's average annual precipitation increased by 3.4 inches ([Climate Trends](#)). The state has also seen a notable rise in the frequency and intensity of heavy precipitation events. Since 2000, very heavy rains (6 inches or more in a single day) have occurred two to three times more frequently than during the 20th century (Williams-Sether & Sanocki, 2025; [NOAA National Centers for Environmental Information State Climate Summaries 2022: Minnesota](#)). These extreme events have led to a corresponding increase in flooding, which can disrupt ecosystems, human infrastructure, and water quality (Williams-Sether & Sanocki, 2025).

Future projections indicate continued increases in annual precipitation, especially during the winter and spring months, which are likely to exacerbate flooding risks. Flooding can be detrimental to species like turtles, which may be killed, washed downstream, buried under sand, or experience nest failure ([Climate trends affecting lakes and rivers](#)). Flooding also can cause erosion and incising of stream banks that degrade a stream's natural connections to floodplains and cause the loss of meanders and other natural features favored by Blanding's and wood turtles. Steep, high stream banks also hamper turtle access to terrestrial habitats. Increased flooding often results in more proposals for riprap, other hardened infrastructure, and drainage systems which can pose risks to turtles and otherwise alter their native habitats.

The same climate models also forecast an increase in late summer drought events, underscoring the variability and unpredictability of hydrologic patterns under a changing climate ([Climate Change in Minnesota](#)). By mid-century (2040-2059), average annual precipitation is projected to increase by up to 1.2 inches, depending on emissions scenario (Liess et al., 2022; [Climate Change in Minnesota](#)). This seemingly counterintuitive pattern — wetter winters and springs, punctuated by hotter, drier late summers — has profound implications for water availability, wetland health, soil stability, and species

dependent on seasonal hydrologic cycles (Runkle et al., 2022). Droughts may especially affect reptile species associated with water, like Blanding's (Anthonysamy et al., 2013) and wood turtles. Longer term, drought can also alter terrestrial habitats and food chains for all reptiles. For more information and resources for climate-adapted management strategies, see the Climate Adaptation Section in Chapter 6: Implementation.



Photo: Timber rattlesnake, Amod Zambre

## Priority Species Conservation Strategies

To implement the SGCN Goal of this Plan, to conserve rare, declining, and vulnerable wildlife and plant SGCN through targeted actions, three strategies were identified:



**Strategy 1.** Survey, monitor and research to document the distribution and trends of SGCN, assess the threats they experience, and evaluate conservation actions that support resilient populations.



**Strategy 2.** Collaborate to deliver conservation actions that support resilient populations of SGCN and their habitats in partnerships with agencies, Tribes, non-governmental organizations, private landowners, and others.







**Strategy 3.** Develop and share informational material to guide conservation actions for SGCN wildlife, such as species accounts, threat assessments, recovery plans, relevant regulations, avoidance measures, and beneficial habitat management practices.

Examples of conservation actions are grouped below under these three strategies and tagged with icons for the stressor(s) that they address. Some of these actions are widely in place as best practices while others may be more novel. Some actions combine multiple strategies, in which case we present it under the one it fits best. Actions such as those focused on monitoring might not always be tied to a specific stressor; these are labeled with not applicable (NA) in the stressor column.

## Potential Conservation Actions for Reptiles



**Strategy 1.** Survey, monitor and research to document the distribution and trends of SGCN, assess the threats they experience, and evaluate conservation actions that support resilient populations.

Stressor	Action
	Research responses of reptiles to solar facilities and measures to make solar facilities more reptile-friendly (Hernandez et al., 2014).
	To address road mortality, develop or collaborate with existing citizen science programs to identify stretches of road that are mortality hotspots (e.g. the <a href="#">Minnesota Turtle Crossing Tally and Count</a> ). Once identified, use these data to work with MnDOT to develop and apply effective mitigation strategies such as safe under-road passages to help reduce collisions, which benefits wildlife and motorists.
	Conduct rigorous monitoring to assess responses of SGCN to management activities such as prescribed fire, conservation grazing, timber harvest and water management. Apply findings to develop improved evidence-based management recommendations to avoid or reduce the risk of effects on SGCN (Binley et al., 2025). Graduate research projects could help address needs for intensive research.
	Research and apply reptile-friendly solutions for controlling invasive vegetation like smooth brome, reed canary grass, and buckthorn.












Stressor	Action
	Prioritize research and monitoring on snake fungal disease as well as diseases putting Blanding's turtles and other turtle species at risk such as adenoviruses and <i>Emydomyces testavorans</i> (Fredrickson et al., 2024).
NA	Resurvey/monitor reptile SGCN populations whose last observations in the <a href="#">Natural Heritage Information System</a> (NHIS) database are over 10 years old to confirm continued presence of the species, assess population status, and identify specific conservation needs.
NA	To help address data gaps which hinder conservation, support continued research on efficacy of tools like environmental DNA (eDNA) and camera traps to augment (not replace) standard survey and monitoring techniques for rare SGCN reptiles in various environments, such as Blanding's and wood turtles (Kranz, 2023; Davis et al., 2025).
NA	Support more in-depth research of Blanding's turtle populations to help answer key conservation questions such as: <ul style="list-style-type: none"> <li>• Habitat use and movements of hatchlings</li> <li>• Response to nesting habitat creation and management</li> <li>• Response to stream restoration (including construction phase)</li> <li>• Response to different grassland and forest management regimes</li> </ul>










Photo: North American racer, Jeff LeClere



**Strategy 2. Collaborate to deliver conservation actions that support resilient populations of SGCN and their habitats in partnership with agencies, Tribes, non-governmental organizations, private landowners, and others.**

Stressor	Action
	To address habitat fragmentation from development, protect key areas through land acquisition, conservation easements, and other protected designations. Conserve, reconstruct and manage suitable nesting habitats for SGCN reptiles.
	Reducing landscape fragmentation by increasing buffering, connectivity, and conditions similar to native remnant habitats can help reduce effects of native and non-native predators on rare sensitive prey species (Schneider, 2001).
	To help avoid entanglement by reptiles and other wildlife and effects on their habitats, consider these practices (DNR, 2004): A) Use biodegradable netting, preferably natural materials with short degradation periods. Erosion control blankets should be limited to bio-netting or natural netting types due to the risk of entanglement and death of small animals. Avoid photodegradable materials (break down in sunlight), as they do not degrade properly when covered/shaded, and products containing plastic mesh netting or other plastic components. B) Avoid mulch products that contain synthetic (plastic) fiber additives near waterbodies. Identify acceptable materials in Category 3N or 4N mulches. See <a href="#">Standard Specifications for Construction - MnDOT</a> .
	When possible, restore agricultural lands to high quality reconstructed prairie.
	When haying and mowing, promote and apply measures such as found in the <a href="#">Habitat Management Guidelines for Amphibians and Reptiles of the Midwestern United States</a> (Kingsbury & Gibson, 2012) and <a href="#">Mowing Guidelines in Rare Turtle Habitat</a> (MANHESP, 2009) which can be adapted to accommodate larger turtles like the Blanding's turtle. These include mowing when reptiles are less active (November to February) and mowing at high blade settings.
	Apply current guidelines for solar facility fencing to allow access for SGCN turtles (DNR, 2023).
	Work with wind energy companies and conservation partners to reduce restrictions of wind easements on land acquisition and conservation of adjacent lands that reptiles and other wildlife depend upon.
	Using the best available information, establish safe under-road passages and surmountable curbs to aid safe wildlife crossings for the benefit of wildlife and motorists (Markle & Stapleton, 2022, Markle et al., 2025). Avoid creating new roads in important areas for reptiles such as adjacent to water bodies as well as identified crossing hotspots for turtles (Congdon & Keinath, 2006) and snakes.
	Encourage collaboration among all stakeholders and across ownerships to promote effective management for the health and resilience of forests and their ability to provide ecological, wildlife habitat, and other values.
	Consider temporarily closing off key nesting areas for reptile SGCN during critical periods (e.g. nesting, emergence). Consult the Northeast Blanding's Turtle Working Group Guidelines for Recreational Area Development and Maintenance (2022).

Stressor	Action
	<p>When planning prescribed burns, research whether any SGCN reptiles are known or potentially occur on the parcel. Burns should be conducted at times and under conditions when specific rare reptiles are less likely to be on land and access to water refuges remain available (Congdon &amp; Keinath, 2006). Consult guidelines regarding prescribed fire and reptiles (MWPARC, 2008b) with appropriate modifications for target species of concern. Also consider how annual weather variation and climate change affect reptile activity, phenology, and access to safe refuge. Develop more comprehensive prescribed burn guidance based on scientific literature and expertise that considers factors such as fire frequency, intensity, timing, acreage, configuration of treated area, buffers around hibernacula, and access to fire refuge and escape routes in a landscape context (Kapfer et al., 2008). Where prescribed fire poses a significant risk, consider other forms of beneficial habitat disturbance such as conservation grazing. Managing for a mosaic of grassland structure and leaving unburned refuges may also benefit SGCN turtles and snakes in those habitats (Setser &amp; Cavitt, 2003).</p>
	<p>Replace dams and restore streams in a way that minimizes negative effects and increases benefits to turtles during demolition and construction as well as final restoration design. Consider turtle phenology (seasonal behaviors) for the given area and life history characteristics. Time water drawdowns and ditch cleaning at a time of year less likely to affect turtles. Employ measures such as temporary barriers to keep turtles out or temporary drainage prior to excavation to encourage turtles to move to safety or to be more visible for active rescue. Avoid dredging where endangered or threatened turtles occur unless or until rigorous empirical research clearly identifies measures that will result in effective avoidance of injury or mortality.</p>
	<p>Manage water levels and conduct riverine management and restorations with SGCN turtles to address their requirements and include measures to avoid take (Congdon &amp; Keinath, 2006).</p>
	<p>Protect nests of rare reptile species from native and non-native predators. Manage human-subsidized predators, like raccoons, especially near nesting areas (MWPARC, 2008a; Golba, 2024).</p>
	<p>Disinfect shoes and gear before traveling to a new outdoor site, whether you are a field biologist, land manager, or outdoor enthusiast. Use scrub brushes and immerse items in disinfectant such as 1% solution of Virkon Aquatic, 3% solution of bleach, or 70% solution of ethanol (Olson et al., 2021; Rzadkowska et al., 2016; Bletz et al., 2023.)</p>
	<p>Create buffer zones around bodies of water to reduce water-borne pollutants. Increase native plantings and add filtration ponds.</p>
	<p>Create buffer zones along rivers and streams to reduce the effect of flooding on shoreline habitat. Increase the availability of flood-safe nesting habitat.</p>
<p>NA</p>	<p>Headstarting of Blanding's turtles and wood turtles in suitable habitats with compatible management of habitat and mesopredators to boost recruitment in populations with age ratios heavily skewed to older individuals (Golba, 2024).</p>
<p>NA</p>	<p>Implement the <a href="#">Minnesota Wood Turtle Conservation Plan</a>.</p>



**Strategy 3. Develop and share informational material to guide conservation actions for SGCN wildlife, such as species accounts, threat assessments, recovery plans, relevant regulations, avoidance measures, and beneficial habitat management strategies.**

Stressor	Action
	Increase public education and outreach about how releases of captive reptiles (including wild-caught individuals) can spread disease and introduce non-native species.
NA	Public outreach about turtle by-catch and <a href="#">what to do if you accidentally hook a turtle</a> .
NA	Increase enforcement of nongame illegal take issues; educate conservation officers on the issue and monitor key areas for poaching. Develop effective solutions for masking rare reptile locations on websites like iNaturalist. Collaborate with initiatives like <a href="#">Collaborative to Combat the Illegal Trade in Turtles (CCITT)</a> for effective approaches (Christman et al., 2024).
NA	Increase public awareness of state rules and regulations around take, possession, purchasing, and selling of native reptile species and the reasons for these laws. Promote alternative ways to appreciate Minnesota's reptiles in their native habitats.
NA	Outreach/education to reduce persecution of venomous and non-venomous snakes via interpretive programs, handouts, social media posts, and other communications. Increase public understanding and appreciation of snakes and how to co-exist with them.
NA	Educate land managers, including private landowners, about habitat needs of rare forest species.
NA	Develop and implement a state conservation plan for Blanding's turtles.
NA	Revise and develop comprehensive best management practices (BMPs), including but not limited to required avoidance measures, for listed reptiles. Prioritize Endangered and Threatened species that are often flagged in internal or external project reviews. These BMPs should be based on the best available updated scientific/technical information, vetted by species experts; be date versioned and in digital format; address the range of practices/actions that affect the species and that commonly arise in reviews; address relevant variation in habitat use and phenology across that species' Minnesota range as it relates to technical guidance for the species (e.g. critical periods, avoidance periods, activity); and be linked from the species' Rare Species Guide account on the DNR website.

## Case Study: Listed Turtle Environmental DNA Project

Rare reptiles can be particularly difficult to detect, which can hinder conservation and environmental review. Although conventional survey methods like visual encounter surveys or trapping are the “gold standard”, they can be costly and time-consuming. Therefore, scientists from the DNR Nongame Wildlife Program and MnDOT Office of Environmental Stewardship identified a need for additional tools to augment (not replace) standard monitoring methods. Environmental DNA (eDNA) is an emerging technology that holds promise as a rapid, coarse survey tool to help detect rare wildlife. Water samples can be analyzed for DNA shed by animals into their environment to detect their presence, without needing to directly observe or capture them. These scientists championed a proposal to assess the efficacy of eDNA for detecting Blanding’s turtles and wood turtles across their ranges in Minnesota. MnDOT accepted and funded the proposal which led to contracting an expert research team from the University of Illinois. A Minnesota Technical Advisory Panel comprised of representatives from several DNR divisions, MnDOT, the Mille Lacs Band of Ojibwe, and the Minnesota Zoo provided additional guidance and input. This project, which is wrapping up in 2025, has demonstrated that environmental DNA is a rapid, sensitive, and cost-effective tool for monitoring these species under certain conditions. Their final report provides guidance on methodology and recommendations for next steps to further refine its use (Kranz 2023; Davis et al. 2025).



*Photo: Blanding's turtle, Bob Dunlap*

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