

# MINNESOTA'S WILDLIFE ACTION PLAN 2025-2035

## CONSERVING HABITATS AND BIODIVERSITY

### CAVES



## Acknowledgments

We would like to thank more than 300 people who contributed to the development of this State Wildlife Action Plan (SWAP) throughout our revision process over the past two years (see List of Plan Contributors). Everyone's varied perspectives and expertise has improved the plan and will carry on into the next ten years of conservation action for Minnesota's biodiversity and vulnerable wildlife. A specific thank-you to members of the Nongame Wildlife Program core team who facilitated teams, developed content, and pulled together this huge resource: Alison Cariveau (lead), TJ Boettcher, Daren Carlson, Mags Edwards, Julia Geschke, Benjamin Gieseke, Kristin Hall, Chris Jennelle, Tim Mitchell, Elizabeth Nault-Mauer, Jessica Ruthenberg, and Jim Wanstall. Special appreciation also to Lee Pfannmuller, Bridget Henning-Randa, Bob Dunlap, and April Rust who contributed so much to this revision. We thank numerous taxonomic experts and all the volunteers who participated in eleven revision teams; please see the full List of Plan Contributors.

## Funding

The SWAP revision was funded through U.S. Fish and Wildlife Service State Wildlife Grants as well as matching funds from private donations to the Nongame Wildlife Fund and Reinvest in Minnesota funds. We also received funding from the Minnesota Environmental and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).



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Cover Photos: Exploring Mystery Cave, Forestville/Mystery Cave State Park, Dawn Ryan; Old mystery cave, Forestville/Mystery Cave State Park

How to cite this document: Minnesota Department of Natural Resources. (2026). Minnesota's Wildlife Action Plan 2025-2035: Conserving Habitats and Biodiversity. Ecological and Water Resources Division.

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# Caves

## Habitat Description

Karst landscape features are formed by the dissolution of soluble rocks like limestone and dolomite. The resulting porous and soluble rock in the Upper Mississippi Valley has been recognized as one of the most “important karst regions” (Herak & Stringfield 1972, p. 470-471). Key features of karst landscapes include springs, disappearing rivers, sinkholes, cool and stable temperatures, high humidity and caves.

Cave and karst features are concentrated in the southeast corner of Minnesota where thick units of limestone and dolomite rock exist (Alexander & Brick, 2021) and more than 400 caves are found. Fillmore County has the highest concentration of caves in southeast Minnesota, where caves are primarily formed in the Dubuque and Galena formations (Alexander, 1980). Caves exist in other counties of southeastern Minnesota including those formed in the Prairie du Chien Group, St. Peter Sandstone and Platteville limestone.

The largest cave in Minnesota, with over 13 miles of cave passage, is Mystery Cave, located in Forestville/Mystery Cave State Park. Mystery Cave is an important bat hibernaculum and provides habitat for many cave invertebrates. Water from the South Branch Root River sinks underground at Mystery Cave and emerges at Seven Springs Wildlife Management Area, about 1.5 miles east of the cave ([Forestville/Mystery Cave State Park](#)).

In Fillmore County, another significant area of caves is Cherry Grove Blind Valley Scientific and Natural Area (SNA). Cherry Grove SNA protects a large cave system including Goliath Cave, as well as several hydrologically connected smaller caves. Water that sinks into the Cherry Grove Blind Valley travels underground and reemerges approximately 2.7 miles to the northeast at springs on Canfield Creek in Forestville/Mystery Cave State Park ([Cherry Grove Blind Valley SNA](#)).



Photo: Old mystery cave, Forestville/Mystery Cave State Park

Spring Valley Wildlife Management Area, also in Fillmore County, includes a sinkhole that has been hydrologically linked to Spring Valley Caverns and nearby Bly Spring. Other sinkholes on the property are likely hydrologically connected to Spring Valley Caverns as well. Spring Valley Caverns is privately owned with nearly 6 miles of mapped passages. Bat River Cave, also in Fillmore County and privately owned, is ecologically significant because it once supported the largest hibernating colony of bats in Minnesota.

Additional important sites for bats in Minnesota include sandstone caves in Pine and Washington counties, including Robinson's Ice Cave and Leslie Cave. In addition, in Lake County, two natural caves, Hole-in-the-Head and Gnomen, provide habitat for hibernating bats (Knowles, 1992). Due to the geology in the northeast region, natural caves are uncommon, and these sites are likely of regional importance to hibernating bat populations. Other geologic features in the north that can offer alternative overwintering habitat for bats include talus slopes and deep vertical rhyolite crevices (Gerda Nordquist, DNR, pers. comm.).

## Habitat Map

We created a map of important caves (Figure 3.20), we compiled spatial data from DNR's Natural Heritage Information System database of caves hosting bat colonies and Open Street Map.

### Natural Heritage Information System

From the Natural Heritage Information System we used data relating to the location of bat colonies.

### Open Street Map

From [Open Street Map](#), we digitized Public/semi-public caves.

## Conservation Overview

Caves provide habitat for rare and unique species of animals, the majority of which in Minnesota are invertebrates specially adapted to living in subterranean environments. Many of these species are troglobites, or organisms that spend their whole life in caves. Many of these species have evolved specialized traits, such as the loss of eyes and pigmentation. Minnesota cave ecology is only partially understood and the animals living there are exposed to extreme conditions with few food sources, no light, yet a stable and consistent temperature of approximately 48° Fahrenheit (F) (8.8° Celsius; C) and nearly 100% humidity. Other surface-dwelling animals such as bats, flies, moths, raccoons, rodents and snakes will use caves to overwinter.

Groundwater within the cave forming karst landscape of southeastern Minnesota is critical to maintaining healthy coldwater stream habitats for trout in southeast Minnesota. Water traveling through bedrock aquifers typically cools as it travels underground. When groundwater emerges at a spring, it provides cool isothermal temperatures critical for coldwater trout species. Native brook trout (*Salvelinus fontinalis*) are found in some of these stream environments. Recreation opportunities provided by trout streams are of great economic importance to communities throughout southeast Minnesota (Anderson, 2016). These fisheries, like the caves themselves, can be affected by [nitrate contamination](#) and pesticide run-off (see also [Water-borne Pollutants](#) below).

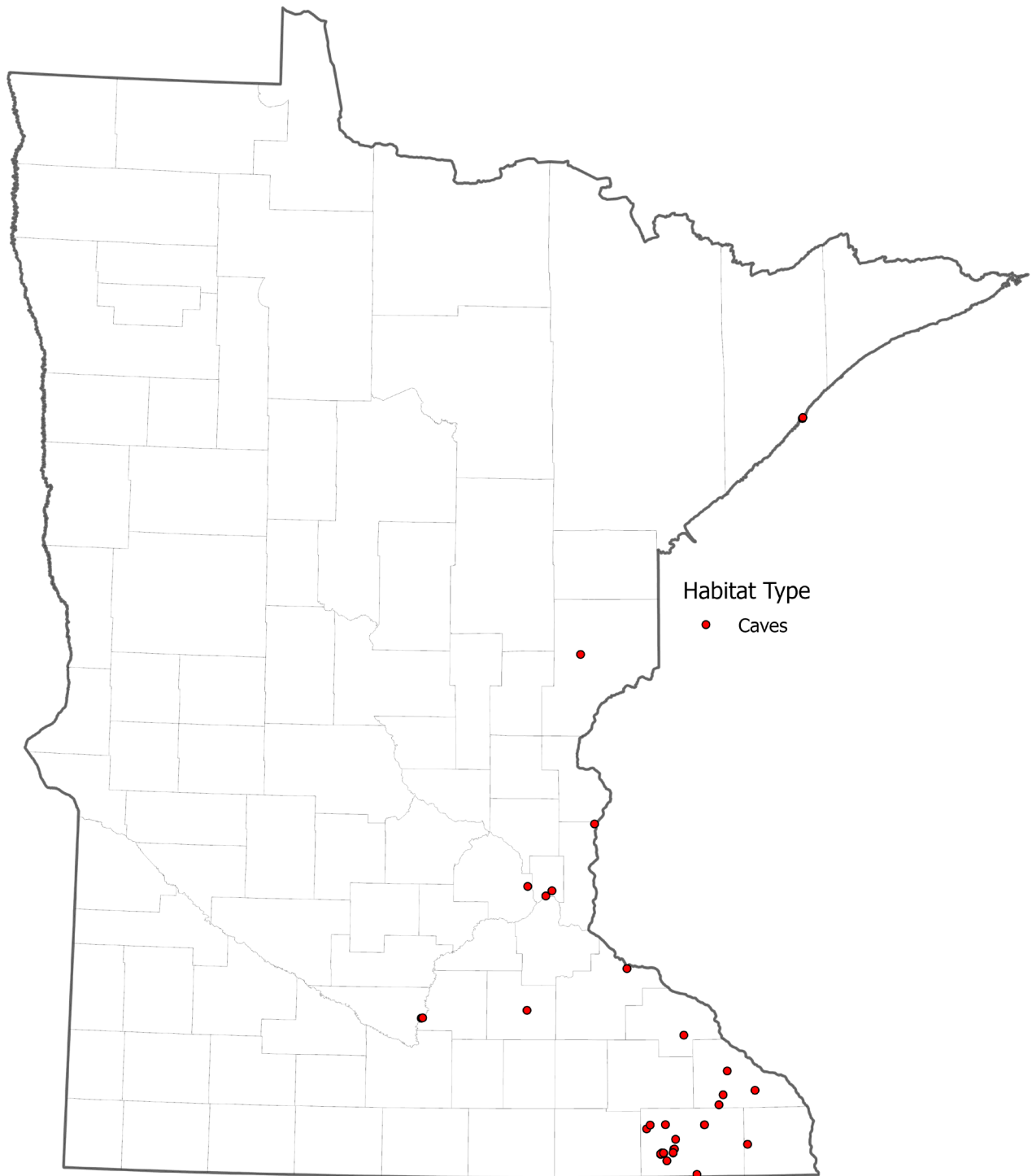


Figure 3.20. A map depicting significant caves in Minnesota including DNR Natural Heritage Information System data of caves used as bat hibernacula and digitized public/semi-public caves from Open Street Map.

## Species

### Bats

Four Species in Greatest Conservation Need species in Minnesota rely on caves and mines for winter survival: [little brown bats \(\*Myotis lucifugus\*\)](#), [big brown bats \(\*Eptesicus fuscus\*\)](#), [tricolored bats \(\*Perimyotis subflavus\*\)](#) and [northern long-eared bats \(\*Myotis septentrionalis\*\)](#).

Caves and mines have been an important habitat for early documentation of bat species in Minnesota. The first account of winter ecology for bats was published in 1934 by Charles A. Evans (Evans, 1934), which was followed by a period of scientific intrigue for bats in the state into the 1950s. Studies over the years added more sites with known hibernacula, more recently well described in the Distribution and Status of Bats in Minnesota report (Nordquist & Birney, 1985).

Caves provide the narrow range of ideal conditions for bats to hibernate for extended periods (Kunz, 1982). To hibernate, bats seek out subterranean environments that do not fluctuate with above-ground weather conditions, where cool temperatures and high humidity remain stable year-round.

This stability provides ideal conditions for bats to enter torpor, a physiological state characterized by a controlled reduction in body temperature, metabolic rate, and overall energy expenditure (Barclay et al., 2001). Torpor is a critical mechanism that allows bats to maintain fat reserves when ambient temperatures are unfavorably cool, and food availability is low (Geiser, 1988). During the long harsh winters in Minnesota, caves provide protective and stable environments where bats can use extended bouts of torpor with sparse active periods to survive without foraging for up to eight months underground.



Photo: two big brown bats hibernating, by Melissa Boman

While there are 490 listed caves described in Minnesota (Alexander & Brick, 2021), not all are suitable for bats. Suitable hibernating conditions within caves are primarily found in large cavities which have small entrances that reduce fluctuation with outside air temperatures. Nordquist and Birney 1985 describes “cud-de-sac or labyrinth passages that protect bats from drafty corridors.” Stable caves in Minnesota generally maintain a constant year-round temperature of 8° C or 47° F, and variation in temperature and humidity levels can be found based on the site entrance exposure, level of water seepage and site size (Nordquist & Birney, 1985). This variation results in differing levels of importance for each cave in supporting bat populations.

The majority of the important bat hibernaculum in Minnesota are localized to southeastern Minnesota where the karst region is found (Nordquist & Birney, 1985). Located in Fillmore County, Mystery Cave is the largest limestone cave system in Minnesota. Thus, this site supports generally constant temperature and humidity levels beneficial to bat populations, particularly species like little brown bats. Bat counts and banding efforts were conducted by the Minnesota Speleological Survey beginning in the late 1970s. Other important sites were mentioned above.

Considering the limited number of suitable hibernacula across Minnesota, combined with concentrations of vulnerable bat populations, and the narrow range of conditions that make caves irreplaceable habitat for bats, caves are extremely important environments to protect for the health and persistence of bat populations in Minnesota. White-nose syndrome threatens cave-wintering bats in Minnesota (see Diseases and Pathogens section below).

## Invertebrates

Three species of springtails (arthropods in the class Collembola) were designated as Species in Need of Information (SNI). These were highlighted for inclusion due to having global conservation status ranks of vulnerable or imperiled (*Arrhopalites dubius* and *Tullbergia hades*, G2, imperiled; *Onychiurus obesus*, G3, vulnerable). These organisms are completely confined to cave systems and adapted to subterranean life. As detritivores, these springtails feed on microbial films, fungi, and decomposing organic matter lining cave pools, playing a vital role in nutrient cycling and supporting food webs in the nutrient-poor conditions of cave ecosystems. Their troglotic (i.e., obligated to underground living) lifestyle makes them excellent bioindicators of cave habitat integrity as they depend completely on stable subterranean conditions (Christiansen, 1964). They are also likely to be very sensitive to water quality, particularly pollutants from agricultural runoff, which also makes them bioindicators for assessing cave ecosystem health. These species are found in Mystery Cave and associated caves, as well as Goliath cave and associated caves at Cherry Grove Blind Valley Scientific and Natural Area. Due to a lack of information about these species, they were designated SNI rather than SGCN.



Photo: Elongate springtail, Goliath's Cave Cherry Grove Blind Valley Scientific and Natural Area

Caves provide a unique environment for the evolution of specially adapted species, and due to the disparate distribution of caves across the landscape, many fauna from caves are likely to be significantly rare. However, the taxonomy for many invertebrate groups remains poorly understood, and there is a shortage of active taxonomists. As a result, even though some collections exist, such as a 2022 survey of Forestville/Mystery Cave State Park (by Zara Environmental LLC; Krejca & McDermid, 2022), our understanding of representative invertebrate communities remains limited and there is not enough information to determine if any cave-dwelling species should be designated SGCN.

Several species of mites in the family Rhagidiidae (Acari), including some troglotic forms, have been reported from caves across the United States (Elliott & Strandtmann, 1971; Zacharda, 1985). These tiny arachnids, which are relatives of spiders and ticks, are a common but often overlooked component of cave ecosystems. In the 2022 invertebrate inventory

of Mystery Cave, a member of the Rhagidiidae was recorded for the first time, marking a new addition to the known fauna of the cave and contributing to the broader understanding of subterranean biodiversity in the region (Krejca & McDermid, 2022). Like springtails, these animals play vital roles in cave ecosystems as predators, nutrient recyclers, and indicators of environmental health. Their presence likely helps maintain ecological balance in sensitive cave environments, and their loss could disrupt entire subterranean food webs. Additionally, many Rhagidiid mites remain poorly studied, so their conservation protects not only biodiversity but also future opportunities for scientific discovery.

Small, shrimp-like crustaceans known as amphipods (Order Amphipoda) were recorded for the first time in Mystery Cave during a 2021 biological survey (Krejca & McDermid, 2022). This finding is noteworthy, as a previous study by Montz (1993) specifically highlighted the absence of amphipods in this cave. The newly collected specimens may represent a range extension of known Driftless Area species or possibly a previously undescribed species. Either scenario highlights the ecological significance of the discovery and underscores the need for continued biological exploration and conservation of subterranean habitats like Mystery Cave.

Spiders (Araneae: Nesticidae) are often among the most diverse and ecologically important invertebrates found in cave ecosystems, including species that are either fully adapted to life underground (trogllobites) or partially so (troglophiles). While it is not yet clear how specialized the spiders found in Mystery Cave are, or whether they represent unique endemic species, the individuals collected during recent surveys are notable and merit further investigation (Krejca & McDermid, 2022).

Continued research could reveal important insights into the cave's biodiversity, the evolutionary adaptations of subterranean spiders, and the role that spiders play in subterranean food webs.



Photo: Cave cobweb spider, Forestville/Mystery Cave State Park

Bathynellacea are an order of minute, groundwater-dwelling crustaceans typically found in caves, wells, and sometimes within the interstitial spaces of other aquatic environments (Schminke & Noodt, 1988). Despite their global distribution, occurring on every continent except Antarctica, they are notably absent from the fossil record. Their presence is also generally limited in regions previously covered by glacial ice, with only sparse recolonization documented in such areas (Grzimek, 2004). A 2021 collection in Mystery Cave marked the first recorded occurrence of Bathynellacea within the park, representing a species adapted specifically to groundwater environments (Krejca & McDermid, 2022). As such, it is restricted to subterranean habitats like caves and aquifers, highlighting the unique and specialized biodiversity found in Minnesota's karst systems.

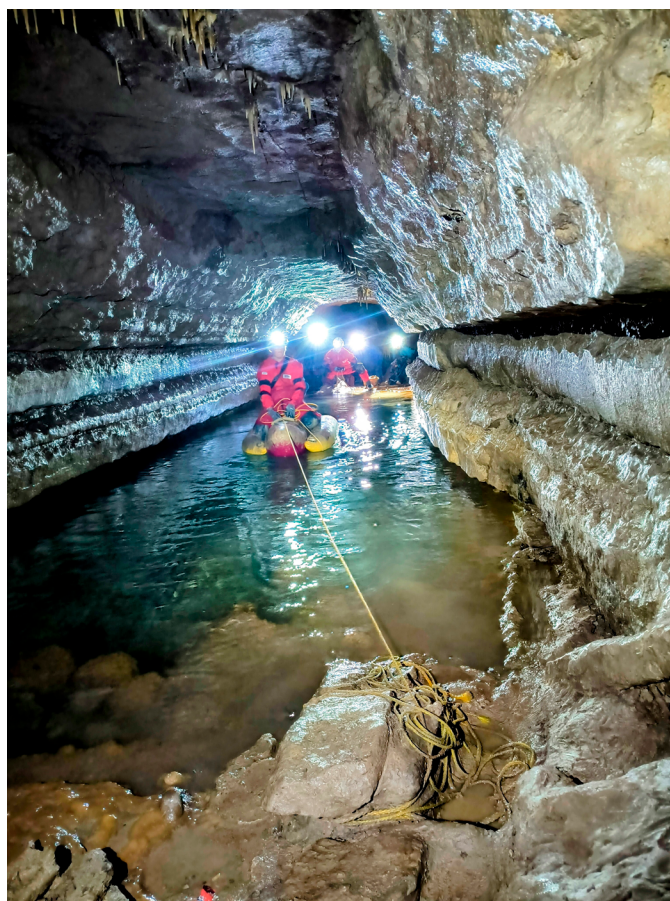
Between 1989 and 1993, Montz (1993) documented the presence of several copepod and cladoceran species in the Mystery Cave system. Three copepod species representing two orders were identified from the Disappearing River: *Acanthocyclops vernalis* (tentatively identified) and *Eucyclops speratus* from the order Cyclopoida, and *Phyllognathopus viguieri* from the order Harpacticoida. More recently, in 2021, copepods were collected from several locations within the cave system, including Coon (Goliath's) Cave, Old Mystery

Cave, Woodchuck Cave, the Big Spring complex and Seven Springs (Krejca & McDermid, 2022).

Water fleas (order Cladocera) were also found in the system. Montz (1993) reported six cladoceran species from the Disappearing River and one additional species from Blue Lake within Mystery Cave.

In a 2021 survey, specimens resembling cladocerans were collected from Coon (Goliath's) Cave, Old Mystery Cave, Big Spring and Seven Springs (Krejca & McDermid, 2022). However, these were not identified to species level. These findings suggest that both copepods and cladocerans are relatively widespread in the Mystery Cave hydrological network and may play an important role in the cave's aquatic food web.

In summary, cave-dwelling invertebrates are highly specialized organisms that play essential roles in nutrient cycling and food web dynamics within subterranean ecosystems. Despite their ecological importance, little is known about their population status, distribution or specific ecological functions. Many species are adapted to stable, low-light environments and are highly sensitive to environmental changes, making them valuable indicators of groundwater and habitat health. Improved surveillance and monitoring of these invertebrates are critical for understanding and conserving the unique biodiversity of cave ecosystems in Minnesota.



*Photo: Exploring Mystery Cave, Forestville/Mystery Cave State Park, Dawn Ryan*

## Primary Stressors for Caves

Throughout Minnesota, habitats have been lost and degraded due to pressures associated with human settlement, subsistence, livelihoods and recreation. Indeed, habitat loss or alteration remains the primary threat to most, if not all, SGCN. In this section, we identify key “stressors” that may continue to contribute to habitat degradation and loss. The list is adapted from a globally recognized threats lexicon developed by the International Union for the Conservation of Nature (Salafsky et al., 2024). For additional details, see the “Stressors” section in Chapter 1: Species in Greatest Conservation Need.

It is important to note that some of the factors listed as “stressors” can also be used to advance conservation goals. Broad terms such as “fire management” reflect the dual nature of these factors as they may function as stressors in some contexts while serving as valuable conservation tools in others. For example, an intense wildfire following prolonged fire suppression may cause significant stress for the habitat and species affected, while prescribed fire, when planned appropriately, can enhance ecosystem health and resilience.

Information about a subset of primary stressors specifically affecting this habitat is included below, followed by a set of conservation actions addressing those stressors.



### Crop Production

Commercial agriculture dominates southeast Minnesota where Minnesota has its highest concentration of caves. The use of nitrogen-based fertilizers, herbicides, pesticides and other chemicals can degrade water quality in cave environments. In karst areas of southeast Minnesota, human influences on groundwater and surface water quality have been documented for decades (Mohring, 1983; Jameson & Alexander, 1994 Kuehner et al., 2025).

The main Goliath Cave sinkhole entrance has been completely filled with sediment from run-off. The Scientific and Natural Area

is surrounded by farm fields that are tilled. When sediments, including agricultural plant material (like corn stalks), and manure run off farm fields, it can significantly alter the cave's hydrology and introduce pollutants that threaten the unique underground ecosystem. A recent inventory noted approximately 20 different species of invertebrates found in Goliath Cave (Krejca & McDermid, 2022). These highly specialized species, such as blind isopods, cave beetles or springtails, have evolved in stable, low-nutrient, low-light environments with little tolerance for change and are therefore threatened by a sudden influx of sediments and pollutants.



### Livestock Management

Livestock operations, particularly concentrated feed lots, can threaten caves through pollution. Manure and agricultural runoff can contaminate water sources, which can enter caves through sinkholes, sinking streams, and fractures in bedrock. Caves act as conduits for groundwater and can transport pollutants very quickly downstream. For instance, Mystery Cave has an underground stream that is a meander cut-off of the South Branch Root River. Agriculture and grazing operations are active on the surface above Mystery Cave. The caves' river flows underground two miles and resurfaces at Seven Spring Wildlife Management Area, which is an important trout habitat. Goliath's Cave in Cherry Grove Blind Valley has its own underground river which flows five miles and resurfaces in Canfield Creek in Forestville/ Mystery Cave State Park another important trout habitat. Goliath Cave is surrounded by agriculture and livestock operations.



### Mining and Quarrying

Mining, including limestone extraction, can directly impact caves, eliminating habitat for cave adapted species. Mining operations can also affect cave and karst systems in other ways such as thermal effects on springs and surface-water streams, changes to water turbidity and lowering of groundwater and surface-water levels from mine dewatering (Green et al., 2005).



## Recreation

During the fall and winter months (September 1 – May 1) when bats are likely to be present in caves, human presence can disturb and wake bats similar to white-nose syndrome symptoms that result in mortality. In addition, recreators can inadvertently spread the causative fungus of white-nose syndrome if shoes and gear taken underground are not sufficiently decontaminated. For these reasons, major bat hibernacula in Minnesota are protected with gated entrances and restricted access for safety of bats and people.

The presence of visitors in caves can also elevate air temperatures. In Mystery Cave, tours cause an elevation in temperature of about 1.5 degrees F every time a group of visitors passes by a set of data loggers over the past five years (Dawn Ryan, DNR, pers. comm.).



## Diseases and Pathogens

As critical habitat for overwintering bats, caves have also been at the heart of white-nose syndrome (WNS), an epidemic that has devastated hibernating bat populations across North America. This disease affects hibernating bats by disturbing the delicate hibernation cycle, resulting in bats waking from torpor more frequently and burning the fat reserves needed to survive the winter with no insects (Frick et al., 2010). The causative fungus, *Psuedogymnoascus destructans*, is a non-native, subterranean, cold-loving fungus that thrives in the same areas of caves where bats hibernate. The fungus infects tissues of hibernating bats, vulnerable with no immune response while in torpor, and becomes visible white patches on the forearms, ears or nose of the bat, giving the disease the WNS namesake. The confirmation of WNS in Minnesota during the winter of 2015-2016 has been followed by declines averaging greater than 90% for hibernating bats across the state, particularly for the little brown bat, Northern long-eared bat, and tricolored bat.



## Water-borne Pollution

One of the most frequently detected contaminants in groundwater and surface waters of southeastern Minnesota is nitrate-nitrogen (commonly referred to as nitrate). Nitrate concentration is commonly elevated in the root zone underlying row-crop agriculture in Minnesota, where concentrations collected from lysimeters average greater than 20 ppm (Kuehner et al., 2020). Nitrate is leached in cultivated row-crop settings following precipitation and snowmelt and moves to shallow groundwater where it migrates to underlying aquifers and streams. Depending on the timing of recharge, nitrate concentrations in shallow karst may rapidly increase or decrease (Barry et al., 2020). In southeastern Minnesota, trout-stream baseflow nitrate concentration positively correlates to the percentage of row crop agriculture in the watershed (Watkins et al., 2013).

Elevated levels of nitrate may indicate that other surface contaminants have the potential to reach an aquifer. Pesticides frequently co-occur with nitrate, with the likelihood of detecting at least one pesticide compound increasing as the concentration of nitrate increases (MDA, 2019; Goedjen et al., 2024). Trout fisheries are also affected by [nitrate contamination](#) directly as well as fed by underwater sources from caves as noted above.

Southeastern Minnesota has several karst aquifers with different properties. In general, the shallow Galena karst aquifer (which is present across Fillmore County) has high nitrate levels and short groundwater residence time (Kuehner et al., 2025). Groundwater residence time is the time it takes water to travel from the surface to the point it was sampled; residence time is related to the amount of nutrient removal it provides. The Prairie du Chien aquifer, more common across counties east of Fillmore, has longer residence times and lower nitrate levels.



## 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. Increased flooding events carry pollutants from agricultural run-off, faulty septic systems, and pesticide, which can affect springtails and other animals who live in caves. While many cave-dwelling

animals are aquatic, they are adapted to near constant temperatures. In addition, flooding events cause increases in cave temperatures. In Mystery Cave, increases in temperature of close to 10 °F have been detected during floods, and the cave takes months to return to normal temperatures (Dawn Ryan, DNR, pers. comm.).

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). For more information and resources for climate-adapted management strategies, see the Climate Adaptation Section in Chapter 6: Implementation.

### Case Study: Goliath Cave and Cherry Grove Blind Valley SNA






Cherry Grove Blind Valley Scientific and Natural Area (SNA) was established in March 2000 after the landowner applied for a quarry permit to mine limestone on the property. Goliath Cave and several other small caves in the SNA would have been mined away and lost, had the state not purchased the property. Goliath Cave includes ancient rock formations dating back to the Ordovician Period (443.7-488.3 million years before present), when what is now Minnesota was located south of the equator and covered in shallow seas. The cave system also provides cold water to trout streams in the area. See [Cherry Grove Blind Valley Scientific and Natural Area](#) for more information.



Photo: Dawn Ryan, cave manager, by cave opening, Cherry Grove Blind Valley Scientific and Natural Area

## Priority Habitat Conservation Strategies



To implement the Habitat Goal of this Plan, to protect and enhance the resilience, function, and ability of habitats to support biodiversity, especially for SGCN, five strategies were identified:

- 
**Strategy 1. Protect, buffer, and connect high quality habitats to optimize biodiversity, SGCN, and landscape benefits, particularly across the Conservation Action Network.**
- 
**Strategy 2. Restore, enhance, and maintain lands and waters to benefit SGCN, biodiversity, and ecosystem resilience**
- 
**Strategy 3. Collaborate with conservation partners and landowners to enhance conservation delivery, particularly in the Conservation Action Network and Conservation Opportunity Areas**
- 
**Strategy 4. Monitor SGCN, native plant communities, habitats, and ecosystems for changes through time including responses to natural disturbances, conservation actions, and climatic conditions**
- 
**Strategy 5. Connect to develop, innovate, incentivize, and disseminate evidence-based habitat management practices to benefit SGCN habitat management practices to benefit SGCN**

## Potential Conservation Actions for Caves


Examples of conservation actions are grouped below under these five 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 will combine multiple strategies, in which case we present it under the one it fits best. In some cases, actions were not identified for all strategies. Also note that some strategies, such as Strategy 3, collaborating with partners, could truly be applied to all actions to most broadly and effectively implement them. Other actions, such as those related to monitoring, might be difficult to relate to a specific stressor, in which case they are marked as not applicable (NA).

- 
**Strategy 1. Protect, buffer, and connect high quality habitats to optimize biodiversity, SGCN, and landscape benefits, particularly across the Conservation Action Network.**

| Stressor  | Action   |
|---|--|
|  | Consider protection measures, such as purchase of land easements above known caves to help reduce run-off into caves and ground water. |
|  | Increase protection of important cave ecosystems from mining and quarrying.  |



## Strategy 2. Restore, enhance, and maintain lands and waters to benefit SGCN, biodiversity, and ecosystem resilience.

| Stressor  | Action   |
|---|--|
|  | Maintain stock limits and reduce capacity of confined feedlots in sensitive karst habitats where caves receive runoff that can contain contaminants. |






## Strategy 4. Monitor SGCN, native plant communities, habitats, and ecosystems for changes through time including responses to natural disturbances, conservation actions, and climatic conditions.

| Stressor | Action  |
|----------|---|
| NA       | Encourage cave-related research, such as through the <a href="#">Cave Research Foundation</a> |



## Strategy 5. Connect to develop, innovate, incentivize, and disseminate evidence-based habitat management practices to benefit SGCN

| Stressor  | Action  |
|---|---|
|  | Encourage and reward landowners who properly buffer sinkholes and other karst features that have direct relationships to groundwater. Promote best practices regarding runoff such as properly sealing wells and maintaining septic systems, reducing the use of nitrates, pesticides and fertilizers, increasing cover crops and developing denitrification wetlands.  |
|  | Encourage adoption of best practices for cavers and spelunkers to reduce effects when exploring caves, such as in guidelines set forth by the <a href="#">National Speleological Society</a> .  |
|  | Follow decontamination procedures when visiting caves to avoid spreading the causative fungus of White-Nose Syndrome. While effective treatments for widespread containment of the fungus causing white-nose syndrome or prevention of disease have yet to be developed, there are actions that can be taken to protect bats. Preventing the spread of fungal spores between caves and avoiding disturbance to hibernating bats are key methods to reduce further harm. Spores are not visible to the human eye and readily attach to clothing or gear carried into caves. Follow protocol for decontaminating gear after visiting any cave or underground feature, particularly if you travel to multiple caves. |

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