



BIODIVERSITY TREND ANALYSIS

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SUMMARY

Our transportation infrastructure cuts through diverse ecosystems of land, water, plants, fish and wildlife that use these areas for habitat and food. Accordingly, transportation can have a significant impact on these ecosystems. Over time, many of Minnesota's natural habitats have been lost to development and cultivation since colonists began arriving in the state. Much of the undisturbed or infrequently disturbed lands surrounding transportation infrastructure are playing an increasingly important role in maintaining ecosystems.

The state's biodiversity is threatened by many factors, including the transportation system. Transportation infrastructure like roads, airports and railways can impact biodiversity in many ways. Infrastructure can divide habitats making it difficult for wildlife to safely navigate through its habitat. Transportation introduces invasive species by making international and intercontinental travel much easier and more frequent. In general, habitat loss, degradation and fragmentation are the three leading causes of biodiversity decline in the state. Today, 130 native Minnesota species are endangered within the state with additional species being added by the Minnesota Department of Natural Resources. Populations of monarch butterflies¹, rusty-patched bumble bees² and little brown bats³ in particular have declined dramatically in recent years.

There are strategies to limit the impact of transportation infrastructure on local ecosystems. Some of these strategies include creating safe passages along the routes that directly fragment habitats, discouraging wildlife entering roadways by using fencing, designing culverts and bridges to best allow fish and other aquatic organism passage and limiting the spread of invasive species in water and on land. Protecting the biodiversity of Minnesota is essential for the well-being of communities and the environment. Transportation agencies can be a part of reversing a trend of continued environmental and ecological degradation.

ROADSIDES

The highway system in Minnesota plays an important role in the health of the state's ecosystems. The highway system primarily impacts the environment through the land and water around it. As seen in figure 1, roadsides can become thriving habitats for native plants. Highway roadsides are primarily used for maintenance, potential road expansion or bicycle trails. MnDOT is responsible for maintaining nearly 14,000 miles of state highways, out of the 140,000 total road miles in Minnesota. Roadsides on these state highways include 255,000 acres of state land, of which 175,000 acres are generally infrequently disturbed green space. The roadside serves many functions such as

- Draining excess water away from roads through use of ditches
- Providing a safe space for vehicles that leave the travel lanes
- Storing snow in the winter
- Providing a location for public utilities (e.g. sewer, storm sewer, electric and communications lines)

¹ "2017 Annual Report." Minnesota State Agency Pollinator Report. Environmental Quality Board, 2018.

[https://www.eqb.state.mn.us/sites/default/files/documents/2017 State Agency Pollinator Report_accessible.pdf](https://www.eqb.state.mn.us/sites/default/files/documents/2017%20State%20Agency%20Pollinator%20Report_accessible.pdf).

² "In a Race Against Extinction, Rusty Patched Bumble Bee Is Listed as Endangered." Newsroom. U.S. Fish and Wildlife Service Midwest Region, January 10, 2017. <https://www.fws.gov/midwest/news/861.html>.

³ "Bat Population Decline Continues as Expected." Newsroom. Minnesota Department of Natural Resources, March 28, 2019. <https://www.dnr.state.mn.us/news/2019/03/28/bat-population-decline-continues-as-expected>.

- Containing vegetation that improves highway aesthetics and limits erosion and drifting snow
- Providing habitat for pollinators, nesting birds and other small wildlife

Figure 1. Native flowers growing on a roadside in Minnesota three years after seeding.



MINNESOTA WILDLIFE

Minnesota is home to 14 animals and four plants listed under the federal Endangered Species Act according to the U.S. Fish and Wildlife Service (Table 1).⁴ The State of Minnesota also maintains a list of that includes many endangered and threatened species (Table 2). There are 1,661 endangered or threatened species in the United States with an additional 20 proposed species and 14 candidate species to be added to the list. Proposed species have been reviewed, found to warrant listing and are currently in a period of public comment before final determination is made for listing. Candidates are reviewed each year to determine if they should still be listed as candidates and if they should begin the process of proposed species to be added to the endangered species list.

Table 1. U.S. Fish and Wildlife Service endangered or threatened species⁵

Federally Listed Endangered or Threatened Species	Minnesota	U.S.
Animals	14	718
Plants	4	943
Total	18	1,661

⁴ "Listed Species Believed to or Known to Occur in Minnesota." Environmental Conservation Online System. U.S. Fish and Wildlife Services, March 15, 2020. <https://ecos.fws.gov/ecp0/reports/species-listed-by-state-report?stateAbbrev=MN&stateName=Minnesota&statusCategory=Listed&status=listeds>.

⁵ "Listed Species Summary." Environmental Online Conservation System. U.S. Fish and Wildlife Service, March 16, 2020. <https://ecos.fws.gov/ecp0/reports/box-score-report>.

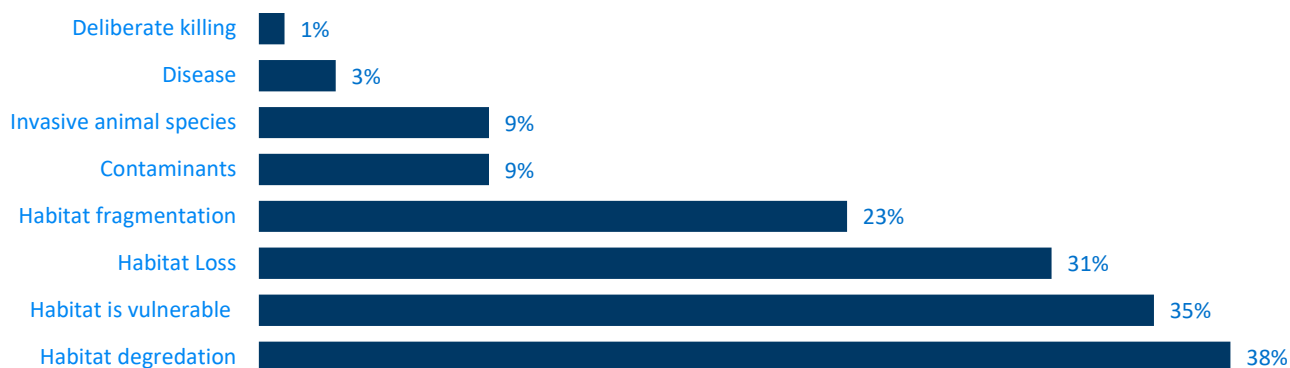
Table 2. Minnesota Endangered or Threatened Species under the state's statute ⁶

Minnesota Endangered or Threatened Species	Number of Species
Animals	30
Plants	90
Other (Fungi, Lichens)	10
Total	130

Minnesota is home to many thousands of native wildlife species, but the vast breadth of diversity of species means there are many more species in the state than are currently known. Currently, 346 species are identified as “Species in Greatest Conservation Need (SGCN)” in Minnesota's 2015-2025 Wildlife Action Plan, because they are rare, their populations are declining, or they face serious threats that may cause them to decline. The number has risen from 292 total species on this list in 2005. However, the species found in the Wildlife Action Plan only covers animals. Separately, the Minnesota DNR recognizes 130 species of animals, plants, fungi and lichens as endangered or threatened in the state as seen in Table 2.

Minnesota's Wildlife Action Plan 2015-2025 showed that habitat-related stressors were leading factors associated with animals being listed as SGCN (Figure 2).⁷ Only 1% of Minnesota's native prairie land remains from pre-settlement levels. Many deciduous forests have been fragmented or severely degraded. Nearly all of Minnesota's old growth forests have been logged and forested land has dwindled from an estimated 31 million acres in pre-settlement Minnesota to 18 million acres today.⁸ Water resources have been severely impaired throughout the state. Millions of acres of wetlands have been filled in and lost. Many lakes and streams have been altered and polluted and shorelines have been extensively developed. For more information on Minnesota's waters see the Water Quality trend paper. These factors and those listed below interact with each other and can cause a cumulative impact on species' population decline, playing an important role in the growth of the MnDNR's list of SGCN.

Figure 2. Percentage of Minnesota's species in greatest conservation need affected by various stressors.



⁶ “Minnesota's List of Endangered, Threatened, and Special Concern Species.” Minnesota Department of Natural Resources, August 13, 2013. https://files.dnr.state.mn.us/natural_resources/ets/endlist.pdf.

⁷ “Minnesota's Wildlife Action Plan 2015-2025.” Natural Resource Planning. Minnesota Department of Natural Resources, 2016. <https://www.dnr.state.mn.us/mnwap/index.html>.

⁸ “Forestry Timeline.” Forest History Center. Minnesota Historical Society, n.d. <https://www.mnhs.org/foresthstory/learn/timeline>.

POLLINATORS

Pollinators play an important role in the health of the environment. Many food sources and wildflowers depend on pollinators. In addition to pollinators listed on the federal endangered and threatened species list, the State of Minnesota has eight state-listed endangered pollinators, one threatened, ten of special concern and 19 not listed species in greatest conservation need. Across the country, honeybee colonies are in drastic decline. Honey bee losses have continued to worsen with a total winter loss of almost 54% in 2017.⁹ A total of five bumble bees are identified as Species in Greatest Conservation Need in the State's Wildlife Action Plan, with the rusty-patched bumble bee also listed under the federal Endangered Species Act. Bumble bees are important for the health of fruits, wildflowers, vegetables and animals that rely on these for food. Without pollinators many of the food and flowers that exist today will disappear, which will have severe consequences for the ecology of the state and impact the state's agriculture and natural resources.

Monarch butterflies live in prairie land during summer months and migrate south to avoid freezing temperatures. A healthy monarch population is a good indicator of a healthy ecosystem. Habitat loss and herbicide use has caused an 80% reduction in the population since the mid-1990s.¹⁰ During that time, herbicides have killed native plants like milkweed and other nectar sources. These plants provide monarchs with habitat for breeding, resting and refueling during migration.¹¹

Without action, populations of pollinators in Minnesota will continue to decline with negative implications for other aspects of our environmental and economic wellbeing. MnDOT can play an important role in improving the wellbeing of pollinators statewide. Some of these actions will be discussed below, like the establishment of the Monarch Highway along Interstate 35 (I-35). Other actions could include creating and maintaining an accurate inventory of roadside vegetation, developing corridor and site-specific management plans, employing multiple vegetation management strategies, incorporating vegetation considerations into roadway design and more, according to the Federal Highway Administration (FHWA).¹²

SUPPORT AND PROTECTION OF NATIVE PLANTS

Much of Minnesota's landscape is flowerless and lacks floral diversity. Providing native prairie land is an important step in stopping the decline of pollinators. Today, only 1%, or less than 200,000 acres, of the original native prairie land in Minnesota is still in existence. The majority of land on highway roadsides can be used to reverse the loss of native plants and pollinators. These areas of native plants not only help pollinators but also upland birds and provide places to filter water and reduce stormwater runoff before it enters the state's bodies of water. Some of our roadsides are among the last remaining habitats of rare plants. For example, one of only two remaining locations of western prairie fringed orchid, a federally threatened plant species in southeast Minnesota, is in a state highway roadside. The only known location of the prairie shooting star in the entire state is also in a state highway roadside. Other roadsides harbor populations of other

⁹ "2018 Annual Report." Minnesota State Agency Pollinator Report. Environmental Quality Board, 2019.

https://www.egb.state.mn.us/sites/default/files/documents/EWR_461_19%20State%20of%20MN%20Poll_A11Y.pdf

¹⁰ "2017 Annual Report." Minnesota State Agency Pollinator Report. Environmental Quality Board.

¹¹ "Get Involved with Rights-of-Way." Save the Monarch Butterfly. U.S. Fish and Wildlife Service, October 8, 2019.

<https://www.fws.gov/savethemonarch/rights-of-way.html>.

¹² "Roadside Best Management Practices That Benefit Pollinators: Handbook for Supporting Pollinators through Roadside Maintenance and Landscape Design." Environmental Topics. Federal Highway Administration, December 2015.

https://www.environment.fhwa.dot.gov/env_topics/ecosystems/Pollinators_Roadsides/BMPs_pollinators_landscapes.aspx.

state and federally listed plant species. Much of Minnesota's remaining prairie is being degraded by excessive mowing, drifting herbicides used in farming, invasive species and other disturbances.

The quality of native habitat can vary depending on its management. Certain features must be present in order to create an environment conducive for native species to flourish. A high-quality native prairie land includes these characteristics:¹³

- High-diversity and abundance of native plants that bloom continuously throughout the growing season
- Adequate food and nesting resources
- Minimal pesticide use
- Plants that are buffered from herbicide drift
- High-quality habitat and pollinator species
- Connectivity to another pollinator habitat

To enhance habitat in transportation right-of-way, construction projects must use strategies to encourage planting native seeds and discourage invasive plants through early detection and actions like prescribed fire. MnDOT is increasingly planting native seeds on new construction projects. Between 2010 and 2019, native seed mixes were used in 40% of MnDOT project areas, resulting in 4,210 acres of pollinator-friendly habitat. Diverse roadside vegetation improves the overall health and resiliency of roadside infrastructure, enabling it to more effectively perform the critical functions it provides for safety, soil stabilization, drainage and stormwater treatment.

In 2016, MnDOT signed onto the "Monarch Highway" I-35 initiative to create "a cooperative and coordinated effort to establish best practices and promote public awareness of the monarch butterfly and other pollinator conservation."¹⁴ The initiative covers the entire stretch of I-35, from its northern terminus in Minnesota, through Iowa, Missouri, Kansas, Oklahoma to the southern border of Texas and Mexico. The I-35 initiative is important to monarchs because it is in the flyway the butterflies use during their annual migration. The FHWA and five other state transportation agencies will provide habitat for monarch butterflies to use during their yearly migration.

OTHER ANIMALS AT RISK

BATS

Minnesota is home to eight bat species, four of which migrate south for the winter and four of which hibernate in the region. While bats in the state are not viewed as pollinators, they do have several ecological benefits including pest control. Studies have shown that the little brown bat can eat anywhere from three hundred to three thousand insects in a single night.¹⁵ They also help farmers by controlling pests that damage crops. Some farmers build their own bat houses in order to help increase the bat population and manage pests.

The populations of many bat species are declining. This is attributed to human impacts such as habitat destruction, direct killing, wind turbines, disturbance of hibernating and maternity colonies, light pollution, cave vandalism and use of pesticides and other chemical toxins. The most extreme event which has reduced bat populations nationwide is the disease

¹³ "2017 Annual Report." Minnesota State Agency Pollinator Report.

¹⁴ "What Is the 'Monarch Highway'?" Question and Answer. Monarch Joint Venture, 2020. <https://monarchjointventure.org/resources/faq/monarch-highway>.

¹⁵ "Little Brown Bat Species Page." The Virtual Nature Trail at Penn State. Penn State University, July 22, 2014. https://www.psu.edu/dept/nkbiology/naturetrail/speciespages/little_brown_bat.html.

known as white-nose syndrome. The disease has resulted in a collapse of hibernating bats in Minnesota since 2015, with population declines of greater than 90%.¹⁶ The syndrome is caused by a fungus that is very contagious and can spread through other mammals and equipment that humans bring into caves. The disease does not have a direct impact on humans or livestock, but indirectly impacts them through the loss of the ecological benefits bats provide. The decline in bat populations may lead to increased mosquito populations which will increase the risk of diseases mosquitoes transmit to humans like West Nile Virus and Zika Virus.

During construction projects, some bat habitat might be impacted but not eliminated. Some bat habitat was lost during construction of the I-90 Bridge near La Crosse, Wisconsin. Thousands of bats were using the area underneath the bridge as a home. When the bridge went under construction, the Minnesota and Wisconsin Departments of Transportation partnered to build bat houses to give the bats somewhere to live during the construction period and hopefully into the future. Actions like these help to limit habitat damage from transportation construction projects.

WILDLIFE CONFLICTS AND CROSSINGS

Roadways and roadsides cover approximately only 1% of total land in the United States, but it is estimated that 15% to 20% of land is directly impacted by roads and vehicles.¹⁷ High volume highways represent the greatest impact on wildlife presenting an almost impassable barrier for many smaller wildlife species. The impacts on wildlife populations from roadways can be far reaching. Roadways can cause the direct loss of habitat through road and roadside building and roadway mortality from vehicle impacts, but also has many non-direct impacts, these impacts are listed in Table 3 below.¹⁸

Table 3: Roadway impacts on wildlife.

Impact on Wildlife	Description
Habitat fragmentation	Many rural roadways are built through existing established wildlife habitats. These roadways reduce the amount of interior habitat while increasing edge habitat, which can increase the prevalence of predators and parasites.
Road avoidance	Some wildlife avoid roadways due to road noise and human activity, decreasing potential habitat size and creating greater fragmentation. Road avoidance has been documented in native Minnesota species like wolves, turkeys, bobcats and moose.
Reduced access to vital habitats	Many roadways were not planned or built with wildlife habitats in mind. Many roadways separate wildlife populations from vital areas necessary for the sustained survivability like food sources, spawning grounds, nesting areas or migration routes.

¹⁶ "Bat Population Decline Continues as Expected." Newsroom. Minnesota Department of Natural Resources, March 28, 2019. <https://www.dnr.state.mn.us/news/2019/03/28/bat-population-decline-continues-as-expected>.

¹⁷ Jackson, S.D. 2000. Overview of Transportation Impacts on Wildlife Movement and Populations. Pp. 7-20 In Messmer, T.A. and B. West, (eds) Wildlife and Highways: Seeking Solutions to an Ecological and Socio-economic Dilemma. The Wildlife Society. https://ag.umass.edu/sites/ag.umass.edu/files/pdf-doc-ppt/tws_overview_ms.pdf

¹⁸ Ibid.

Impact on Wildlife	Description
Population isolation and fragmentation.	Due to the above noted effects of roadways on wildlife. Wildlife population may become isolated from one another and fragment. This can lead to greater likelihood of local extinction of native species due to environmental variability, genetic diversity loss and natural catastrophes.
Disruption of regional population maintenance	The geographic dispersal of populations has been shown to be important for the genetic variability and local population survival in the face of potential extinction events. The barriers to population dispersal that roadways represent present a major factor affecting the long-term persistence of wildlife populations.

An example of roadway impacts and an area of concern today is the impact on turtles. Turtles can nest on the shoulders of the highway, attempt to cross a road near wetlands and other waterways and be hurt by materials used during construction and passing vehicles. The Minnesota Department of Natural Resources (DNR) has developed potential solutions to help minimize the impact highways can have on turtle habitat.¹⁹ These guidelines have been incorporated into planning done for turtle habitat, but can also be used for a wide variety of different species where transportation infrastructure bisects natural habitat. A turtle tunnel was built in Washington County in 2014 in response to high mortality on a roadway which separated turtle species from a vital wetland. This tunnel has been successful in not just helping turtles cross the road but other small wildlife as well.²⁰ In addition to turtles, wildlife crossings and other actions can be used for all types of wildlife to reduce impacts on habitat:

- Fences can be built to direct movement away from dangerous roads.
- Grading of gravel shoulders near lakes and wetlands should be avoided during mid-May to August.
- Roads can be designed with bridges or other over or underpasses for turtles and other wildlife to cross.
- Traditional curb and gutter designs can be adapted to minimize threat.
- Culvert sizes should be optimized and designed for minimal aquatic impacts.

FISH PASSAGE

Barriers to fish passage can be created when roadways and waterways intersect. The natural flow of species like trout and northern pike are affected by the type of road design used to cross a waterway. Span bridges are the best solution for water crossings from an ecological perspective, but culverts are typically less expensive and faster to install. Culverts with smooth bottoms and undersized culverts can cause faster water flow and limit fish passage. In 2019, MnDOT, in consultation with the DNR, U.S. Forest Service and other experts, released new culvert design guidelines intended to limit damage to the

¹⁹ "Roadways and Turtles Solutions for Safety." Helping Turtles across the Road. Minnesota Department of Natural Resources, 2011. <http://files.dnr.state.mn.us/assistance/nrplanning/community/roadsidesforwildlife/road-turtles.pdf>.

²⁰ Lindgren, Suzanne. "After Success with Turtle Tunnel, Crossing Tallies Continue." countrymessenger.com. The Country Messenger, April 29, 2017. http://www.countrymessenger.com/news/after-success-with-turtle-tunnel-crossing-tallies-continue/article_219d03e2-29d0-11e7-8ebc-c3c80e825fa8.html.

natural environment including streams and other bodies of water from roadway projects. The guidelines will make environmentally friendly designs quicker to permit and easier for contractors to build.²¹

INVASIVE SPECIES

ELIMINATION OF INVASIVE ROADSIDE WEEDS

Proper land management not only improves ecosystems for native plants and pollinators, but also eliminates invasive and harmful roadside weeds. Many foreign plants are introduced to Minnesota ecosystems without their natural enemies. These weeds are called either invasive species or noxious weeds. Improperly managed roadsides facilitate the spread of invasive species across the landscape. This allows species to invade adjacent land and degrade the habitat and biodiversity that the land contains. With effective management, however, roadsides become an important venue for early detection and rapid control of new invasive species. This reduces the long term impacts that invasive species could otherwise have on adjacent lands.

The Minnesota Department of Agriculture developed a Noxious Weed List, which lists all of the noxious weeds in the state, most of which are also classified as invasive species.²² Vegetation management on 175,000 acres of green space on Minnesota highway roadsides takes a variety of tactics including biological control, appropriate herbicides, mowing and prescribed fire. Each approach is considered to ensure that it actively benefits native species while limiting spread of invasive species along Minnesota's roadways. This varied approach improves environmental health by reducing the amount of herbicides used and mowing done on roadways. Still, some roads are mowed at times that disrupt the natural habitat.

AQUATIC INVASIVE SPECIES

Opening the Great Lakes Seaway to modern shipping in the mid-20th century increased the risk of aquatic invasive species spreading on ships or through ballast water. The impacts of aquatic invasive species are wide and varied. The ecological and environmental impacts of invasive species like the zebra mussel, sea lamprey, spiny and fishhook water fleas, Eurasian milfoil and purple loosestrife range from being a nuisance to potentially devastating to local ecosystems. Invasive species outcompeting native species has caused extinctions of some native plants and animals elsewhere in the world. This risk exists in Minnesota as well. Despite recent efforts to prevent the introduction of aquatic invasive species, new discoveries of these species were made in recent years that resulted from aquaculture, intentional or unintentional releases, shipping, recreational boating and water gardening.

Several invasive carp species pose potential negative impacts for Minnesota's aquatic ecosystems, economy and outdoor heritage. Perhaps the most well-known invasive carp species in Minnesota is the Silver Carp. Silver Carp and other invasive carp alter ecosystem food chains and may put severe pressure on native species.

The DNR tracks water bodies infested with certain aquatic invasive species that could spread to other waters.²³ About 8% of the more than 11,000 lakes in Minnesota are on the infested waters list in 2020. Two hundred fourteen Minnesota lakes

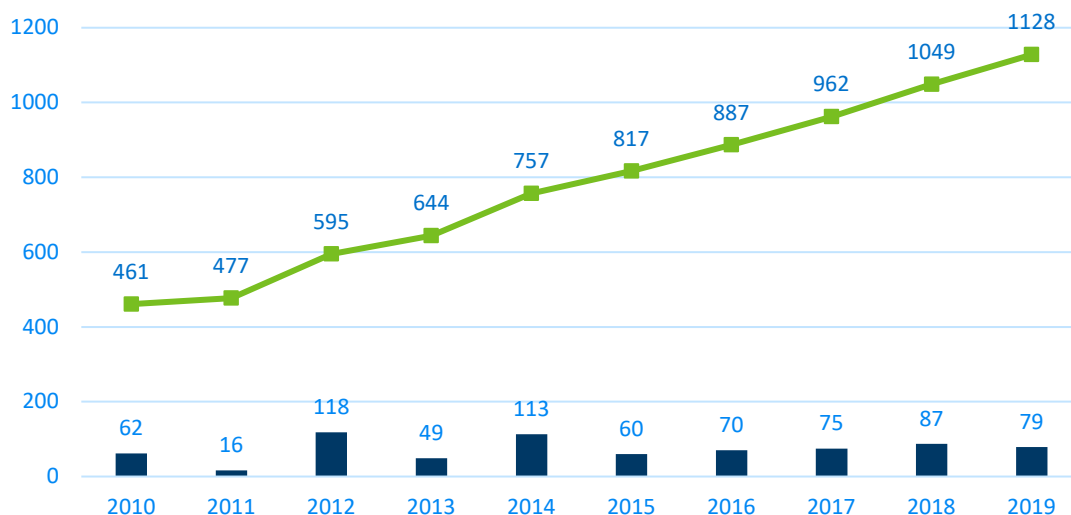
²¹ Hernick, Matt, Jessica Kozarek, Christian Lenhart, and John Nieber. Minnesota Guide for Stream Connectivity and Aquatic Organism Passage through Culverts, Minnesota Department of Transportation § (2019). <http://www.dot.state.mn.us/research/reports/2019/201902.pdf>.

²² "Minnesota Noxious Weeds." Roadside Vegetation Management. Minnesota Department of Transportation, February 5, 2020. <http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf>.

²³ The Minnesota DNR includes lakes, rivers, ponds and wetlands in the definition of water body.

and wetlands, or less than 3%, are listed as infested by zebra mussels. Figure 3 shows the number of water bodies that were added to the infested waters list by year and the cumulative total of infested waters. The number of infested water bodies have seen a hastened increase through the 2010s. At the end of 2019, there are a total of 1,128 water bodies listed on the infested waters list.

Figure 3. Number of water bodies added to infested waters list by year (bar) and cumulative (line) total over the previous decade.²⁴



CONCLUSION

Minnesota is home to diverse and important environments that provides essential habitat for wildlife. Minnesota's native ecosystem has been radically altered since the 19th century. The loss of prairie land, fragmentation of woodlands, loss of wetlands, introduction of invasive species and damage done to the ecosystem has major effects on environmental quality including vitally important species like pollinators and native wildlife. Transportation infrastructure has played a role in this ecosystem degradation; roadways bisecting habitats, waterways introducing invasive species, expanding development encroaching upon and disturbing natural systems among others. Through improved roadside management, fighting off invasive species, native plantings and wildlife habitat protection and enhancement, these trends can be reversed. As highlighted in this trend paper, Minnesota's roadways and other transportation assets can also serve as respites for wildlife and become a key aspect of restoring our damaged environment.

RELATED TRENDS

- Air Quality
- Climate Change
- Health

²⁴ "Infested Waters List." Aquatic Invasive Species. Minnesota Department of Natural Resources, February 11, 2020. <https://www.dnr.state.mn.us/invasives/ais/infested.html>.

The cumulative total includes duplicate bodies of water which are infested with more than one invasive species.

- Race
- Water Quality

Minnesota's vision for transportation is known as Minnesota GO. The aim is that the multimodal transportation system maximizes the health of people, the environment and our economy. A transportation vision for generations, Minnesota GO guides a comprehensive planning effort for all people using the transportation system and for all modes of travel. Learn more at MinnesotaGO.org.