MINNESOTA'S WILDLIFE ACTION PLAN 2025-2035

CONSERVING HABITATS AND BIODIVERSITY

RIPARIAN AND FLOODPLAIN FOREST

DEPARTMENT OF NATURAL RESOURCES

NONGAME WILDLIFE PROGRAM

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Riparian and Floodplain Forest

Habitat Description

Riparian and floodplain forest habitats occur primarily on floodplains and associated terraces along major rivers and their tributaries (see also Rivers and Streams Chapter). Floodplain and terrace forests are seasonally wet forests that flood following spring snowmelt as well as unusually heavy rains. These forests are found on sandy or silty alluvium (soil deposited by flowing water) associated with streams and rivers throughout the Eastern Broadleaf Forest Province and are extensive along the Mississippi, Minnesota, and St. Croix rivers. In the Laurentian Mixed Forest Province, these forests also occur along major rivers but are not as extensive as in the Eastern Broadleaf Forest Province. These forests also occur in the Prairie Parkland and Tallgrass Aspen Parklands Provinces.

The canopy of these forests is dominated by deciduous trees that are tolerant of saturated soils, prolonged inundation, frequent erosion, and sediment deposition. Species less tolerant of these conditions occur on terraces, which flood only in very wet years. In southern Minnesota, silver maple (*Acer saccharinum*) (which often occurs as nearly pure stands), black willow (*Salix nigra*), and eastern cottonwood (*Populus deltoides*) are common canopy dominants. Less common species include river birch (*Betula nigra*), elms (*Ulmus spp.*), green ash (*Fraxinus pennsylvanica*), and swamp white oak (*Quercus bicolor*). In the north, black ash and silver maple are important canopy trees with lesser amounts of green ash, American elm (*Ulmus americana*), bur oak (*Quercus macrocarpa*), and basswood (*Tilia americana*). Canopy coverage in these forests is highly variable; areas of continuous canopy are punctuated with large gaps, which may be vegetated with ephemeral herbaceous plants or remain largely unvegetated if flood disturbance is repeated and severe. The understory is typically open, with few shrubs or saplings. Pools or mucky depressions in old river channels are often present on actively flooded sites. See also the DNR's Trees and Forests website for an overview of Minnesota forests.

Photo: DNR Ecological Monitoring Network crew in floodplain forest along the Mississippi River

The characteristics of old growth lowland hardwood forests vary by location within the state, but trees are at least 120 years old, often with diameters greater than 10 inches. In addition to old and medium-aged trees, old growth lowland hardwood forests will include seedlings and young trees. It is rare to find old growth of willow, cottonwood, aspen, birch, and balsam poplar, which require a lot of light (Characteristics of Old Growth).

Habitat Map

To depict Riparian and Floodplain Forest habitat (see Figure 3.13 we compiled spatial data from several sources: DNR's Native Plant Communities and the Midwest Terrestrial Habitat System created by the USFWS Midwest Landscape Initiative (for more information, see Habitat Map Methods in Chapter 3. Habitats). We note included sub-types below; underlined items have links to online descriptions.

Associated Native Plant Community Classes by Ecological Systems

Floodplain Forest (FF)

FFn57 Northern Terrace Forest (PDF)

FFn67 Northern Floodplain Forest (PDF)

FFs59 Southern Terrace Forest (PDF)

FFs68 Southern Floodplain Forest (PDF)

Midwest Terrestrial Habitat System

From the Midwest Terrestrial Habitat System we included these groups: Laurentian-Acadian Floodplain Forest and Midwest Floodplain Forest.

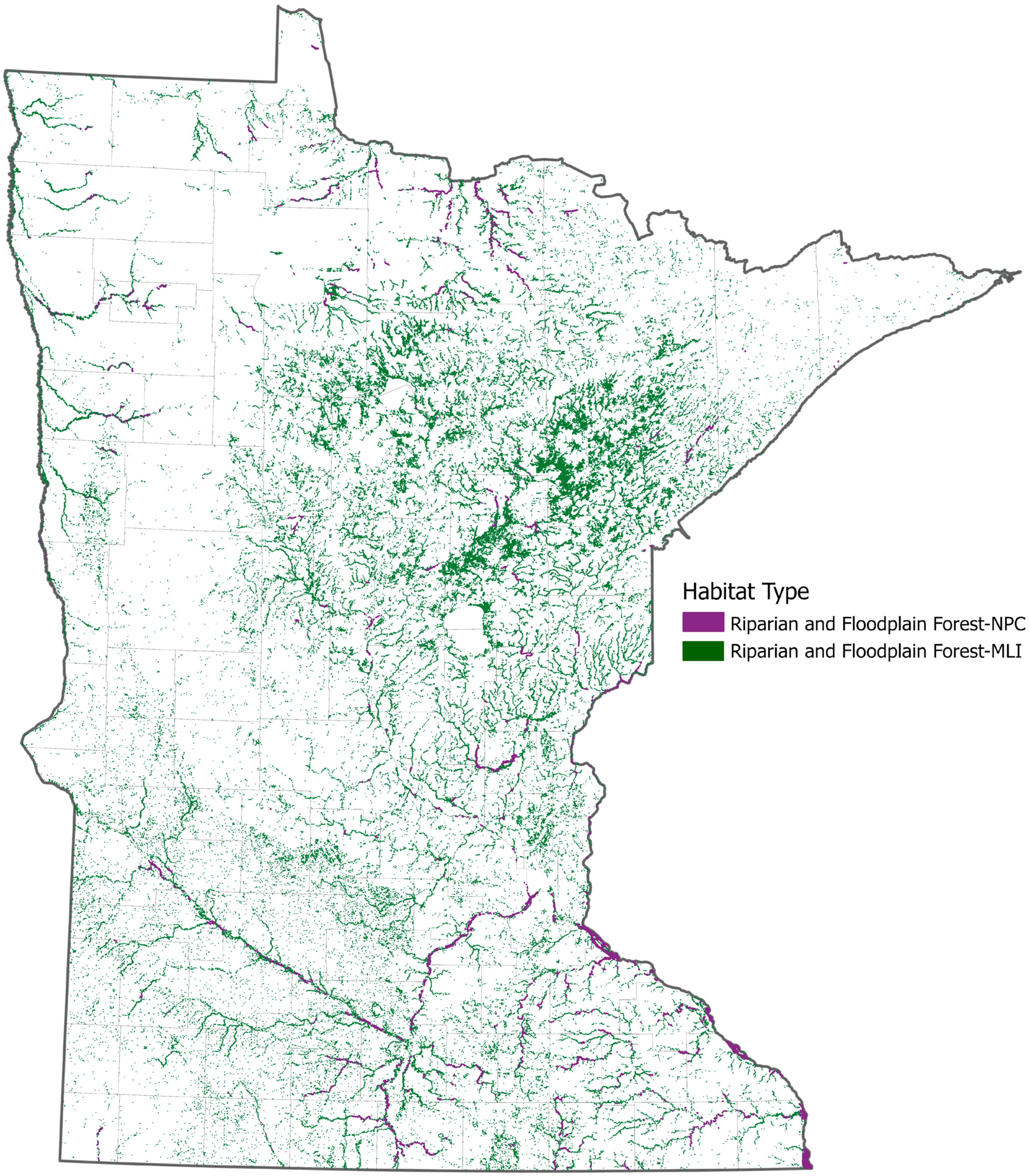

Figure 3.13. A map depicting Riparian and Floodplain Forest habitat in Minnesota, including DNR Native Plant Community Classes in the Ecological System of Floodplain Forest, and the Laurentian-Acadian Floodplain Forest and Midwest Floodplain Forest from the Midwest Terrestrial Habitat System.

Conservation Overview

Riparian and floodplain forest habitats occur along major rivers, rivers, and streams statewide (see also Rivers and Streams Chapter). Riparian and floodplain forests in southern Minnesota are among the most disturbed native habitats in the state. Even prior to European settlement, large swaths of forests were logged to provide fuel for riverboats. Since settlement by people of European descent, large areas of floodplain forests in southern Minnesota have been lost due to urbanization and conversion to agriculture. Now, these forests, which once formed continuous bands of habitat along the major rivers in southeastern Minnesota, persist as a broken chain of forest patches. In addition, the damming of major rivers has greatly reduced the annual pulse of flooding that maintained the ecological integrity of the floodplain forests. Other factors that have reduced the value of the habitat for wildlife include the loss of most canopy American elms from Dutch elm disease and the spread of reed canary grass (*Phalaris arundinacea*), which impedes establishment of seedlings of native plants. The recent loss of ash trees to emerald ash borer (*Agrilus planipennis*) and elm (*Ophiostoma spp.*) to Dutch elm disease shifted the composition of the Mississippi River floodplain forest towards a composition of largely Silver Maple and Oak, particularly along pools 1 – 10. The loss of ash trees is also pronounced along the Minnesota River.

Riparian and floodplain forests are prone to stress from larger and longer flood events (see Climate Profile) that facilitate the spread of invasive species and impede the recruitment of tree seedlings. There are also other disturbances such as windthrow and loss of trees to disease and pathogens in mature stands. In many places there appears to be reduced regeneration of riparian forest because of these changing flood patterns and a lack of advance tree regeneration under mature forest canopy, such that there are insufficient understory and midstory trees to rebuild future forest.

Protecting riparian forest along river corridors is important to facilitate movement of wildlife and the movement of nutrients and energy between the river and the surrounding landscape (see also the Rivers and Streams Chapter). In addition to the habitat they provide for many resident animals and nesting birds, millions of migrating birds depend on the Mississippi River and its associated floodplains each spring and fall as one of the most important migratory flyways in North America.

Old growth forests are recognized in Minnesota for their ecological, scientific, educational, aesthetic, and spiritual significance, including biological features that have developed over centuries (see DNR's Old Growth Forests). In addition to the presence of taller, older trees, these forests include relatively complex stand structure with more snags (dead standing trees), fallen logs and woody debris, all of which contribute to providing nesting, foraging, and denning sites for wildlife including more than 40 species of birds and mammals. The DNR manages network of old growth forest sites on state lands (estimated at 44,000-acres across all types in 2025) with the goal of maintaining "a viable network of high-quality old growth forest sites along with relatively undisturbed, natural-origin younger forests that will be managed to promote old growth characteristics in the future (i.e., future old growth)" (Old Growth Forests). In general, stands of old growth forest are protected from harvest, road-building, and other similar disturbances, unless for ecological benefit. Site-level management decisions in old growth forests typically mimic natural processes to promote regeneration and maintain and restore ecosystem integrity, and use the least intensive methods available, such as hand tools rather than mechanical equipment (Managing Old Growth Forests).

Climate Profile for Floodplain Forests

Riparian and Floodplain Forest was profiled in the report "Effects of Climate Change on

Midwestern Ecosystems: Temperate Flooded and Swamp Forest" published by the Midwest Climate Adaptation Science Center (Ratcliffe et al., 2025). The most impactful changes in climate for this system include more frequent and larger flood events (see Figure 3.14), also with more frequent late summer drought periods.

A major concern for Floodplain Forests is more frequent and more intense flooding events. More precipitation will mean more sediment deposition as well as habitat changes. This projected increase in flooding will favor pioneer and early successional species, while limiting the growth of more stable species. Large increase in flood frequency and intensity is projected to occur in the spring, as both winter and spring precipitation is projected to increase. Coupled with warmer temperatures leading to an earlier snowmelt, large floods are predicted to continue to greatly affect this system.

Floodplain Forests will also be affected by warmer and dryer summers, which will cause soil drying and an overall reduction of habitat in these water-dependent ecosystems. Further habitat change will occur due to more frequent summer droughts, which will affect plant growth and favor drought dependent species. These climate-induced changes may promote the spread of invasive species.

Key Climate Change Effects:

- **Habitat Structure:** Flooding events will cause erosion and remove valuable habitat components from Floodplain Forests such as streambanks and large woody debris, especially in flooding prone regions, such as agriculture dominated landscapes. Flooding also has a negative effect on tree mortality. Flooding may also increase habitat viability by bringing in new sediment, introducing water into usually dry areas, and carrying nutrients (as well as pollutants).
- **Community Composition:** Floodplain Forests will transition away from mast-producing oaks (*Quercus* spp.) and hickories (*Carya* spp.) to more flood resistant species, such as ashes (*Fraxinus* spp.), willows (*Salix* spp.) and maples (*Acer* spp.). Drought resistant species will be favored during warmer and dryer summers, while more moisture dependent species, like tamarack (*Larix larcinia*) and black Spruce (*Picea mariana).*
- **Invasive Species:** As the climate warms, species from warmer regions may begin to move into the Midwest in search of cooler conditions, pushing out native species, like willows (*Salix spp.)* and cottonwoods (*Populus spp.)*. Climate-driven disturbance such as flooding events, will increase the threat to native species, as opportunities for out-competition by non-natives increases.
- **Pests and Pathogens:** Increasing temperatures will also likely cause ranges of some pest species expand, populations increase, and hosts become more susceptible to infection with rising temperatures. Plant communities will be hit harder by pests as warmer winters protect pest populations and enable additional annual broods. Pests like the spongy moth (*Lymantria dispar)*, emerald ash borer, and hickory bark beetle (*Scolytus quadrispinosus)* are predicted to benefit from warmer winters and drying summers, leading to increased tree mortality.
- **Herbivory:** Warmer winters will benefit white-tail deer (*Odocoileus virginianus)* populations because of boosted survival rates and better access to forage, furthering the currently observed trend of white-tailed deer population growth. (All of this Climate Profile content is from Ratcliffe et al., 2025.)

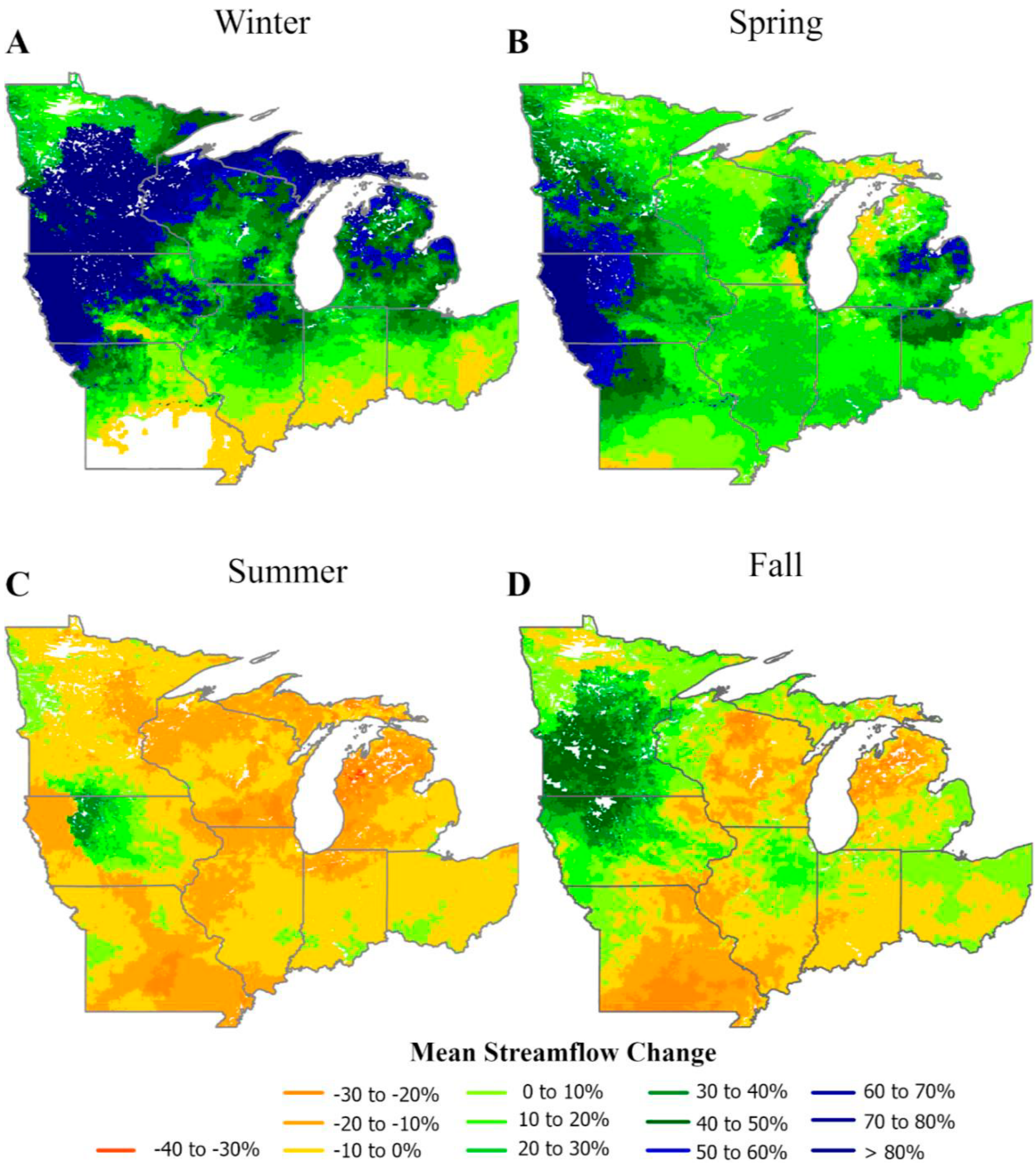

Figure 3.14. (Figure 1 in Ratcliffe et al. 2025). Projected changes in mean streamflow in the Midwest. Projections use gridded simulations of daily runoff based on CMIP5 climate models under the high-emissions (RCP 8.5) scenario. Values show the percent change in mean daily streamflow (cubic feet per second) for each season (winter, December–February; spring, March–May; summer, June–August; fall, September–November) at the end of the century (2070–2099) compared to historical data (1977–2006). Data and metric definitions are provided by the U.S. Stream Flow Metric Dataset (Authors (in review); U.S. Department of the Interior, Bureau of Reclamation, 2014; USDA Forest Service Office of Sustainability and Climate, 2022; Wenger and others, 2010).

Species in Greatest Conservation Need

Riparian and Floodplain Forests provide primary or secondary habitat for 26 animal and 22 plant SGCN (see Table 3.13). 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. Habitat associations for insects were not differentiated into primary and secondary habitats and are shown in the total column. Plant species were only associated with their single most primary habitat. Detailed tables associating each SGCN with the 15 habitats identified in the 2025-2035 SWAP can be found in Appendix D (animals) and Appendix E (plants). Examples of selected SGCN are described below; state-listed species are linked to their account in the Rare Species Guide.

Twenty-one (16%) of the 130 terrestrial vertebrate SGCN are associated with Riparian and Floodplain Forests, including ten of the mammals (31% of the 31 mammal SGCN). 22 plant SGCN associate with Riparian and Floodplain Habitats as their primary habitat (5% of plant SGCN).

Table 3.13. Numbers of Species in Greatest Conservation Need associated with Riparian and Floodplain Forests as either primary or secondary habitat.

Species Groups	Primary Habitat	Secondary Habitat	Total
Amphibians	2	0	2
Birds	3	3	6
Mammals	1	9	10
Reptiles	2	1	3
Beetles (terrestrial)	-	-	2
Moths	-	-	1
Spiders	0	2	2
Plants	22		22
Total	**30**	**15**	**48**

Amphibians

Blanchard's cricket frog (*Acris blanchardi*) are found in riparian areas right along the water's edge; open areas with muddy shorelines and dense emergent vegetation are preferred. They reside near water throughout the summer but, during dry conditions, they may seek out wetter conditions elsewhere. Crayfish burrows or small openings along the bank of a wetland or river provide sites for hibernation. Less than 2 inches in size, their breeding call is similar to that of yellow rails and Virginia rails, making visual identification or expert verification via audio recording essential. A state endangered species, Blanchard's cricket frogs have a limited range in portions of central, southeast, and southwestern Minnesota as of 2025.

Photo: Pickerel frog, Jeff LeClere

Pickerel frogs (*Lithobates palustris*) are also found in Riparian Forests and Floodplains, preferring the edges of ponds, small rivers, and streams that flow through wooded areas or open habitats (Moriarty & Hall, 2014). They rarely venture far from the water's edge or from nearby wet meadows. Winter months are spent hibernating in their water habitats. Pickerel frogs are restricted to the far southeastern corner of the state; county records are available from Goodhue, Fillmore, Houston, Mower, Olmsted, and Winona counties (Moriarty & Hall, 2014).

Birds

Floodplain forests in riparian zones provide key habitat to many SGCN. The only SGCN bird restricted to floodplain forest is the prothonotary warbler (*Protonotaria citrea*). They are most often found along medium- to large rivers such as the Mississippi, Minnesota, and St. Croix. A cavity-nesting species, it requires large trees or snags, often situated right over the water (Pfannmuller et al., 2017). See Climate Spotlight below.

Climate Spotlight: Prothonotary Warbler

This profile is excerpted from "Effects of Climate Change on Midwestern Ecosystems: Temperate Flooded and Swamp Forest" published by the Midwest Climate Adaptation Science Center (Ratcliffe et al., 2025).

"The prothonotary warbler (*Protonotaria citrea*) is a small cavity-nesting songbird that breeds in riparian and floodplain forests in the central Midwest and winters in mangrove forests of Central and South America. Climate-driven hydrological changes and sea-level rise threaten both its breeding and non-breeding habitats. The species has been documented expanding its breeding range northward, including into the Mississippi River Valley, and its population remains relatively stable (NatureServe, 2008).

Photo: Prothonotary warbler, Julia Geschke

Prothonotary warblers nest in tree cavities over standing water, making them highly sensitive to hydrological extremes (Cooper and others, 2009). High magnitude flooding with high water depths can directly affect reproductive success (Flaspohler, 1996; Graber and others, 1983). Prolonged floodplain inundation can also alter predator foraging behavior by limiting non-arboreal options, increasing warbler nest depredation by predators like raccoons (Cooper and others, 2009). However, partial flooding appears to provide optimal protection against predation (Cooper and others, 2009; Hoover, 2006; Hoover, 2009). Conversely, drier conditions expose dense ground cover, removing the protective influence of standing water and increasing rates of nest depredation (Cooper and others, 2009; Kirsch, 2009). Despite these direct influences of hydrology, altered hydrological regimes appear unlikely, except in the most severe instances of flooding, to reduce the abundance of most preferred nesting tree species, which include red maple (*Acer rubrum*), sugarberry (*Celtis laevigata*), and silver maple (*Acer saccharinum*) (Gabbe and others, 2002; Kirsch and Wellik, 2017; Wuebbles and others, 2021)....As forested wetlands face increasing climate stress, climate-informed restoration may be a key adaptation strategy for this species. For example, in the Cache River watershed, habitat restoration increased prothonotary warbler density and nesting success (Hoover, 2009). Additionally, artificial nesting structures offer a promising conservation strategy, as these warblers readily use nest boxes, which have shown no recorded depredation (Mueller and others, 2019)."

Other deciduous forest SGCN birds will occupy both upland and floodplain forests, with preferences often varying by region. Cerulean warblers require large tracts of mature deciduous forest. Although it is found in mesic hardwood stands in much of its Minnesota range this canopy-dwelling species occupies floodplain forests along the Minnesota, Mississippi, and St. Croix rivers. Similarly, red-shouldered hawks are most frequent in floodplain forests along larger rivers in southeastern and east-central Minnesota. Oxbow lakes and other floodplain forest openings are an important feature in broad floodplains. Red-shouldered hawks prefer nesting sites in large-diameter trees in high, thick canopies. Louisiana waterthrushes (*Parkesia motacilla*) are most closely associated with mesic hardwoods bordering small, clear water streams, but will also occupy mature floodplain forests, particularly along larger rivers in east-central Minnesota such as the Kettle and St. Croix. In these broad floodplain forests, smaller side channels seem to be a key feature. The Acadian flycatcher (*Empidonax virescens)* is much more frequent in mesic hardwoods but is occasional in true floodplain forests. The bird most tightly associated with mature riparian floodplain forests in Minnesota is the Prothonotary warbler. Although it is uncommonly found in floodplains of small streams and rivers, nearly all the records in Minnesota are along the Mississippi and Minnesota rivers. Although often thought of as species restricted to savannas or upland deciduous woodlands, red-headed woodpeckers are also found in floodplain forests in areas where excessive flooding or other disturbances have created openings with dead trees and snags lacking bark.

Many other birds also use river corridors, beyond those formally associated with it for a primary or secondary habitat, for breeding, migration, and wintering habitat. In particular, large, old trees provide important habitat for nesting herons, egrets, barred owls, wood ducks, and bald eagles. Riparian corridors provide vital migratory stopover habitat, and mortality during migration exceeds that during breeding or wintering periods for many adult migratory songbirds (Sillett and Holmes, 2002). Quality and availability of stopover habitat may be important factors affecting their populations. Some SGCN that do not specialize in riparian forest for breeding but may rely on it for stopover habitat include Connecticut warbler (*Oporornis agilis)*, black-throated blue warbler, olive-sided flycatcher, bay-breasted warbler, Swainson's thrush, and Cape May warbler. Because riparian forests are often linear and relatively contiguous, they are well suited to migration and may be especially important as stopover habitat compared to other habitats.

Climate Spotlight: Red-shouldered Hawk

This profile is excerpted from "Effects of Climate Change on Midwestern Ecosystems: Temperate Flooded and Swamp Forest" published by the Midwest Climate Adaptation Science Center (Ratcliffe et al., 2025).

"The red-shouldered hawk (Buteo lineatus) is a medium-sized raptor found throughout the eastern and central U.S. In the Midwest, these hawks typically occupy mature forests (Henneman and Andersen, 2009; Woodford and others, 2008) with favorable proximity to wetlands to forage for amphibians and reptiles (Balcerzak and Wood, 2003).

During the breeding season, while cooler temperatures combined with heavy precipitation may reduce nestling survival, warmer temperatures can increase prey activity, foraging efficiency, and reproductive rates, suggesting a positive effect of climate change on the species (Bednarz and Dinsmore, 1982; Craighead and others, 1969; Dykstra and others, 2021; Henneman, 2006; Jacobs and Jacobs, 2002). Climate change-driven loss of wetlands and reductions in forests, especially coniferous forests, adversely affect their reproductive success and survival (Dykstra and others, 2021). Despite these challenges, red-shouldered hawks demonstrate adaptive capacity through their flexible diet and habitat use, and even successfully occupying suburban habitats (Dykstra and others, 2019).

Climate change may reduce suitable habitat for red-shouldered hawks in the Midwest Floodplain Forest by decreasing contiguous forest cover and increasing the frequency and size of canopy gaps. These gaps are associated with increased rates of nest predation and increased competition from red-tailed hawks (Buteo jamaicensis) (Bednarz and Dinsmore, 1982; Craighead and others, 1969; Henneman, 2006; Jacobs and Jacobs, 2002). More frequent flooding may have mixed effects on prey populations, potentially reducing some small mammal populations while creating canopy gaps that benefit others (Chamberlain and Leopold, 2003; Scharine and others, 2009). Moreover, key nesting trees such as American beech (Fagus grandifolia), oaks (Quercus spp.), and sugar maple (Acer saccharum) are likely to be negatively affected by increased flooding and higher pest pressure from forest tent caterpillars (Malacosoma disstria) and spongy moths (Lymantria dispar) (Cuthrell and others, 2003; Jacobs and Jacobs, 2002).

Management implications. The goals and methods of forest management in response to climate change may offer the greatest opportunity for climate adaptation for this species. Although red-shouldered hawks tolerate small patches of open habitat, intensive and even standard harvest practices that reduce forest density produce unsuitable habitat for this species (Henneman and Andersen, 2009; Naylor and others, 2004). Active management that maintains relatively dense forests may include pest control, the establishment of fuel breaks to reduce fire risk, and the introduction of tree species suited to future conditions (Swanston and others, 2016). In addition, increasing tree species richness and diversity, increasing the quantity of down woody debris, and protecting forested wetlands can all foster the retention of red-shouldered hawks on the landscape (King and others, 2011)."

Photo: Red-shouldered hawk, Julia Geschke

Mammals

Mammal SGCN that utilize Riparian and Floodplain Forests are nearly identical to those identified occupying Deciduous Wet Forests. The woodland vole (*Microtus pinetorum*) is the only species for which Riparian and Floodplains Forests has been designated its primary habitat. Other primary habitats for the species include Mesic Hardwoods and Deciduous Wet Forests. The voles prefer loose, well-drained soils and humus layers to construct burrows and sub-surface runways. Grazing by cattle, which compacts the soil, and the presence of invasive non-native earthworms, which destroy the humus, may make forests within its' limited range in southeastern Minnesota unsuitable for this species. Loose, well-drained soils and humus layers are important for constructing burrows and sub-surface runways. Grazing by cattle, which compacts the soil, and the presence of invasive non-native earthworms, which destroy the humus, may make forests within its' limited range in southeastern Minnesota unsuitable for this species. A state Special Concern species, the vole is restricted to two southeastern counties: Winona and Houston.

Other SGCN mammals that utilize riparian and floodplain forests include six of Minnesota's seven bat SGCNs (all except for the tri-colored bat (*Perimyotis subflavus*)). The edges of the water and riparian zone are ideal sites for drinking and foraging on insects.

Reptiles

Many other species in greatest conservation need rely on a combination of upland and stream habitats to complete their life cycles. Both wetlands and sandy uplands are necessary for the Blanding's turtle (*Emydoidea blandingii*) to complete its life cycle. Fluvial outwash plains, such as those in Weaver Bottoms along the Mississippi River, provide nesting habitat for Blanding's turtles, gopher snakes (*Pituophis catenifer*), eastern hog-nosed snakes (*Heterodon platirhinos*), and map turtles (*Graptemys spp.*). The wood turtle (*Glyptemys insculpta*) hibernates in rivers, nests on undisturbed sandy banks, but spends much of its time in nearby upland forests. Floodplains and riparian are used as primary habitat when vegetative conditions are optimal and there is no flooding; this is especially true for males who tend to remain closer to water during the summer months. Fox snakes (*Elaphe vulpina*) live in forested riparian habitats See also the Rivers and Streams Chapter for more information on aquatic species such as mussels and fish.

Plants

Dwarf trout lily (*Erythronium propullans*) is a federally endangered species endemic to Floodplain Forests in southeastern Minnesota. The plants are typically found on the lower to mid-portions of the slopes descending toward the floodplain. Habitat loss due to development is a main threat to this species. Also, large-scale precipitation events, made more likely by climate change, have recently increased erosion in this species' floodplain habitats, threatening the persistence of some populations. Erosion control or shoreline stabilization measures could minimize the effects of flash flood events.

Primary Stressors in this Habitat

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.

Development

Urban development disproportionately expands to riparian corridors and adjacent landscapes. Because of their natural beauty, diversity, recreation opportunities, and abundant natural resources, riparian corridors and adjacent landscapes are appealing places to live. Urban development can directly remove habitat, but it can also have indirect effects on protected habitat. Development in landscapes adjacent to riparian forest can affect habitat quality, particularly for many bird species. Urban development in the adjacent landscape can reduce corridor width, reduce connectivity to other habitats, increase abundances of competitors and predators, alter microhabitat conditions, increase density of non-native plants, simplify habitat structure, increase direct human disturbance, and prompt avoidance by wildlife that evolved to use large chunks of habitat embedded in a landscape dominated by native ecosystems.

Timber Harvest

Timber harvest is a forest management tool that can affect wildlife habitat by changing forest and woodland structural and compositional diversity. Forest management decisions, including inaction, typically have positive effects for some species and negative effects for others. Timber harvest can result in failed regeneration and loss of a riparian forest if management activities do not take into consideration many of the unique aspects of these stands. These include the seasonal fluctuation and importance of changing water levels, invasive species, forest pathogens, and changing flood patterns due to climate change, dams, and watershed- wide land use changes. If a harvest is not well enough planned, a riparian forest may convert to a grassland (particularly reed canary grass) or a shrubland (particularly alder, or buckthorn [*Rhamnus cathartica*] in more upland areas). Many riparian and floodplain forests lack young trees to regenerate and succeed the older trees after they are harvested. Selective harvest practices that initially focus on logging the largest and healthiest trees, followed by a second harvest years later, can also result in a stand dominated by reed canary grass, and shrubs. Assessing site-specific characteristics and designing management including timber harvest or invasive species control and prevention measures can help meet management goals and objectives while minimizing negative outcomes.

Recreation

Recreational use can contribute to altered hydrology through soil compaction on trails as well as the introduction of non-native invasive species by inadvertently bringing in seeds on footwear, gear, and boats.

Dams and Water Management

Dams alter the hydrology and ecology of adjacent floodplain forest. For example, seasonal flood cycles are disrupted, the deposition of sediments and nutrients are reduced, water quality declines, the amount of forest cover decreases, and the natural regeneration of trees is disrupted and altered. Additional run-off from precipitation changes observed with climate change and land use changes are also problematic. This can be seen on the Mississippi River corridor south of the Minneapolis/St. Paul area. The resulting habitat may lack species and structural diversity and ability to regenerate following disturbances including flooding, disease or windstorms.

Invasive Species (Problematic Non-native Species)

Riparian areas and floodplain forests are particularly vulnerable to colonization by invasive species due to the constant influx of seed sources via waterways and the high frequency of flooding events that scour substrates and make open substrates for invasive species to colonize. Garlic mustard (*Alliaria petiolata*), a biennial herbaceous plant, does well in shaded, moist, and disturbed environment and is a common invasive in Minnesota's floodplain forests. In addition to its rapid establishment, studies have documented its ability to disrupt the symbiotic relationship of the roots of many native species with soil fungi, a mechanism that can reduce diversity in the herbaceous ground layer (Rodgers et al., 2022).

Emerald ash borer is an invasive insect that has killed millions of ash trees throughout the eastern half of the U.S. and southeastern Canada. In floodplain forests in northern Minnesota, black ash is often a dominant canopy tree. Its loss is predicted to have major effects on the structure, composition, and nutrients in ash-dominated habitats. Black ash is also a culturally important tree to some Native American Tribes in the state.

Eurasian earthworms are another invasive disruptor of natural communities, including floodplains. They upend the traditional soil profile (Hale et al., 2005; Fahey et al., 2013), remove the accumulated layers of organic leaf litter (Holdsworth et al., 2008, 2012), and alter the community of soil mycorrhizal fungi (Paudel et al., 2016). These changes cascade through the ecosystem, including ground layer vegetation (Hale et al., 2006; Holdsworth et al., 2007), leaf litter fauna (McCay and Scull, 2019), and salamanders (Maerz et al., 2009; Ziemba et al., 2016). In addition, the presence of earthworms may also benefit invasive plant species (Nuzzo et al., 2009, Whitfeld et al., 2014). Jumping worms (*Amynthas* and *Metaphire* species) are newer species to Minnesota that are predicted to have negative effects on Minnesota forests as they spread.

Photo: Goats helping with management in riparian forest, browsing on invasive species including buckthorn and garlic mustard

Problematic Native Species

Reed canary grass (*Phalaris arundinacea*) is a hardy, aggressive, cool-season grass that can form dense, monotypic stands in wetlands. Despite recent research suggesting that reed canary grass found in Minnesota is predominantly native, it can outcompete other native wetland species, posing challenges for wetland restoration and mitigation efforts. Source: University of Minnesota Extension (Reed canary grass).

Diseases and Pathogens

Dutch elm disease was first found in Minnesota during the summer of 1961 (French, 1993). Peak losses to all three native elm species that occur in the state (American elm, *Ulmus americana*; red or slippery elm, *U. rubra*; and rock elm, *U. thomasii*) occurred in the late 1970s and 1980s. American elm, in particular, was a dominant species in floodplains across the northeastern United States; today large elm trees are uncommon in floodplain forests and have largely been replaced by silver maple. When present, elms rarely reach heights over 10 meters; this is the height when they become susceptible to Dutch elm disease (UMN extension).

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 (Minnesota Pollution Control Agency and Minnesota Department of Commerce 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 sub-chapter in Chapter 6. Implementation.

Higher summer temperatures with decreased summer precipitation are projected to increase evaporation, decrease soil moisture, and increased water vapor deficits (Ratcliffe et al., 2025). See Climate Profile section above for more detailed information. Warming temperatures are not likely to directly adversely affect most of the tree species that comprise riparian forest. Indeed, many of the species that comprise riparian forest in Minnesota are southerly-distributed and may respond positively to warming temperatures. However, many of the invasive plants that compete with these trees, especially as seedlings, also are likely benefitting from warming temperatures; an example is garlic mustard.

The ranges of some birds are shifting in response to warming temperatures (NAS 2019). Some of the more southerly-distributed birds that use riparian forest in Minnesota and are predicted to move north as the climate warms include Acadian flycatcher, Louisiana waterthrush, and prothonotary warbler (NAS 2019).

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).

Photo: Mississippi River Islands Scientific and Natural Area, Kelly Randall

Future projections indicate continued increases in annual precipitation, especially during the winter and spring months, which are likely to exacerbate flooding risks. Flood timing has shifted so they occur both earlier and later in the season and with longer durations. Though the plants in these riparian forests evolved to survive in floods and even exploit flooding, these changing patterns can result in unsuitable conditions. They may not kill mature trees, but they affect the vegetation and structure of the vegetation on the forest floor, reduce regeneration of young trees, and favor invasives. In particular, these conditions make it difficult for many tree seedlings to establish and survive. Today we are witnessing reduced regeneration of riparian forest because of these changing flood patterns. Combined with other disturbances, such as windthrow in mature stands, and a lack of advanced regeneration of trees under mature forest canopy, there might be insufficient understory and midstory trees to replace future forests. One example of the detrimental effect of increased large-scale precipitation events can be seen in declines in the quality of habitat and subsequent population declines among populations of the federally endangered dwarf trout lily (*Erythronium propullans*). These high-intensity events have led to the erosion and scouring of finer, silty soils preferred by the species.

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). Also see Climate Profile section above. 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 sub-chapter in Chapter 6. Implementation.

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

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. 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).

Potential Conservation Actions for Riparian and Floodplain Forests

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

Stressor	Action
	Landscape and urban planning can ameliorate development pressure on floodplain forests and riparian areas by guiding where and how this development occurs and considering where increased habitat protection and management would be most beneficial. Support local governments in measures that minimize fragmentation and encroachment into high quality forests such as protecting high quality areas, zoning that guides housing developments, lot sizes that support local forests, and incorporate ecological values into land use planning and development guidance.

Stressor	Action
	Since many animals require both upland and stream habitats for their life cycles, it is essential to manage for connectivity of both habitat types. Planning at watershed scales should maintain the corridor characteristics of the floodplain and strong connectivity from upland to aquatic habitat. Protect habitats along river corridors to allow movement of wildlife and facilitate movement of nutrients and energy between the stream and surrounding landscape. Management options include modified lock or dam construction and operation, such as rock arches or weirs, and removal of obsolete dam structures, as well as larger scale watershed actions such as erosion control measures.
	Prioritize protection and management of habitat that provides the elements required by floodplain forest wildlife, but that are less prone to flooding. In particular, maintain and restore floodplain forest along the primary tributaries to the Mississippi River including the Root, Vermillion, Whitewater, and Zumbro rivers in southeastern Minnesota.

Strategy 2. Restore, enhance, and maintain lands and waters to benefit SGCN, bio-diversity, and ecosystem resilience

Stressor	Action
	Planting tree saplings prior to harvest may help prevent riparian forest from converting to problematic species after harvest (i.e. to grassland, (particularly reed canary grass) or shrubland (alder or buckthorn)). Planting a diversity of species provides an opportunity to maintain a riparian forest habitat and increase its resilience in the face of changing climatic conditions and greater flooding intensities and frequencies.
	Timber harvest activities in floodplain forests require careful planning for imperiled species that rely on mature riparian forest, such as cerulean warbler, Acadian flycatcher, and red-shouldered hawk. Adequate acreage of suitable mature riparian forest should be available in the landscape before a harvest is implemented. Manage stands to retain biological legacies (at site level) such as large trees with cavities.

Stressor	Action
	Consider restocking floodplain forests with larger tree saplings rather than seedlings. Because there is minimal natural regeneration of forests along the Mississippi River floodplain planting tree seedings is often a requirement to get sufficient regeneration to ensure lowland forest is maintained and persists at a site. Direct seeding can be successful given the right site conditions, site preparation, and abiotic factors. However, container stock that is larger than bare-root stock has been increasingly used in the region (such as by the DNR, the National Audubon Society, and the Army Corps of Engineers. For instance, larger container stock (e.g., 3-gallon) has a better chance of survival than bare roots; they can survive long-term floods where the bare root seedlings would likely drown with 10-20 days of flooding and can be held for planting any time the site isn't flooded. The larger trees are 4-6 feet in height and can be protected from deer browse with tree tubes or deer repellent; protection from other animals, like voles that can girdle trees, may also be needed. Once the leaves are above the level of reed canary grass and the deer browse, the trees have a better chance of surviving to maturity. Fall plantings may be effective because spring floods are uncertain and can affect access to sites where restoration is planned. The planting could occur prior to harvest, prior to anticipated disturbance (such as an area prone to flooding), or as the forest ages and trees are near dying. If the saplings survive and grow, they can reduce growth of reed canary and other problematic species that respond to an opening canopy. Primary challenges for this strategy are the relatively high cost for saplings versus seeds and having a suitable seed source and vendors that grow and sell these trees.
	Explore countering increased flood intensities by raising the elevation of the habitat so it is less prone to flooding but still maintained as riparian forest. This might be most applicable and feasible during a planned habitat restoration effort. An example of this is thin layer placement on constructed islands along the main channel of the Mississippi River by the U.S. Army Corps of Engineers.

Strategy 3. Collaborate with conservation partners and landowners to enhance conservation delivery, particularly in the Conservation Action Network and Conservation Opportunity Areas.

Stressor	Action
	Maintaining the contiguity, resilience, and diversity of native habitats will depend on local people conserving privately owned lands because they have incentives to maintain ecological integrity on their land and in the surrounding landscape.
	Participate and collaborate in interdisciplinary and interagency forest planning, providing information on important habitat types, landscape configurations, and conditions most beneficial for SGCN. Pursue opportunities to collaborate across forest ownerships and encourage the implementation of sustainable forestry at the site and landscape levels to create and maintain habitat conditions important to SGCN. Values such as regional biodiversity, rare species protection, native plant community growth stage diversity, and certain wildlife habitat needs are best considered at larger landscape scales (DNR 2025).

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

Stressor	Action
	Promote and consider further development of tax incentives that enable landowners to gain value for maintaining conservation values on their properties. Provide increased levels of incentive payments for woodland owners to help protect woodlands and forests from further reduction due to development pressure. Support and promote education and technical assistance to maintain or restore forest habitat.
	Encourage climate-smart forestry practices (see Case Studies).
	Where people recreate, provide outreach and education on cleaning gear and equipment to reduce the introduction and spread of invasive species. The DNR's Prevent the Spread webpage includes specific actions for different land based activities like biking, hiking and off-highway vehicle riding. At trailheads, add invasive species prevention messages, such as those on the boot brush kiosks developed by the PlayCleanGo: Stop Invasive Species in Your Tracks program.
	Research and develop management practices for minimizing the effects of reed canary grass on open substrate, plant diversity, and new tree growth.

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