MINNESOTA'S WILDLIFE ACTION PLAN 2025-2035
CONSERVING HABITATS AND BIODIVERSITY

UPLAND DECIDUOUS FOREST AND WOODLAND


DEPARTMENT OF NATURAL RESOURCES

NONGAME WILDLIFE PROGRAM

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Upland Deciduous Forest and Woodland

Habitat Description

Upland deciduous forests, in the fire-dependent ecological system, are found throughout the Laurentian Mixed Forest and Eastern Broadleaf Forest provinces, and much less commonly in the Prairie Parkland and Tallgrass Aspen Parklands provinces. Fire-dependent forests can include aspens (*Populas spp.*), oaks (*Quercus spp.*), birches (*Betula spp.*), pines (*Pinus spp.*), spruce (*Picea spp.*), and balsam fir (*Abies balsamea*). Please see the Upland Conifer Forest sub-chapter for information on conifer-dominated forests. Soils, landforms, and disturbances, primarily fire, drive the distribution, patch size, ages, and composition of upland forests. See also the DNR's Trees and Forests website for an overview of forests in Minnesota.

Because the forest canopy blocks most of the sunlight before it reaches the understory, most understory plants have evolved some degree of shade tolerance. The amount of light reaching the understory also has a strong effect on the structural complexity of the forest. As these forests age, they become structurally more complex as canopy trees die, producing gaps in the canopy that allow growth of less shade-tolerant shrubs and trees. Standing large dead trees become more frequent, eventually becoming large down logs, which add to the structural diversity of older forests. Fire-dependent forests tend to have a more open canopy than Mesic Hardwood forests and a denser layer of shrubs such as hazelnuts (*Corylus spp*.), dogwoods (*Cornus spp*.), and mountain maple (*Acer spicatum*).

Fire-dependent upland deciduous forests include forests with a blend of dominance by tree species including oaks, aspen, and maples. Although there is a continuum, we can break the narrative to focus on oak-dominant and aspen-dominant.

Photo: Aspen and bur oak, Two Rivers Aspen Parklands Scientific and Natural Area, Eric Ogdahl

Oak-dominant forests and woodlands

Upland hardwood oak forest habitats occur on xeric (dry) to relatively mesic (moist) forest sites throughout the Eastern Broadleaf Forest Province. This habitat is found in portions of the western half of the Laurentian Mixed Forest Province but is uncommon in the northeast. On drier sites, northern pin oak (*Quercus ellipsoidalis*), bur oak (*Q. macrocarpa*), white oak (*Q. alba*), and, in the southeast, black oak (*Q. velutina*) are important canopy species. Associated canopy trees include black cherry (*Prunus serotina*), paper birch (*Betula papyrifera*), aspens, and shagbark hickory (*Carya ovata*). These forests occur on nutrient-poor, well-drained sandy soils on outwash plains, river terraces, and beach ridges, and in the past were strongly influenced by fire. The canopy of modern dry oak forests is relatively open, allowing for a dense shrub layer, typically dominated by American hazel (*Corylus americana*). Many of the drier oak forests contain open-grown trees indicative of a more open woodland or savanna prior to fire suppression.

Oak forest is considered old growth forest if the trees are at least 120 years old or have an average tree diameter between 10-15 inches. The oldest trees in an old growth oak forest are often 150– 200 years old or older with diameters of 20 inches in the north and 30 inches in central and southern Minnesota. These forests are typically dominated by red or white oak, with aspen, paper birch, black cherry in the north or black oak, bur oak, bitternut hickory, and pignut hickory in the southern part of the state (Characteristics of Old Growth).

Aspen-dominated Forest and Woodlands

Fire-dependent upland hardwood forest (aspen) is characterized by a canopy dominated by quaking aspen (*Populus tremuloides*), big-toothed aspen (*P. grandidentata*), paper birch, or a mixture of these species. These shade-intolerant tree species are the dominant trees in the early stages of a wide variety of native plant communities in fire-dependent and mesic hardwood forest systems. Thus, aspen forest is a cover type that may eventually develop into many other native plant communities. In the absence of disturbance, such as fire or timber harvest, aspen acres may decline across the landscape as they succeed to longer-lived species.

Aspen forests typically have a nearly complete canopy of aspen or birch, but the canopy is not as dense as that of sugar maple. As a result of higher light levels penetrating the canopy, these forests usually have a well-developed shrub layer dominated by hazelnuts (*Corylus* spp.) or dogwoods (*Cornus* spp.). The coverage and diversity of the herbaceous plant layer are highly variable depending on site conditions and stand history.

As aspen forests age, they typically increase in structural diversity. Historically, most aspen stands in northern Minnesota had a conifer component, which increased as the stand aged. Today, most aspen stands have little or no conifer understory, due to past management and slash fires. Still, many older aspen stands are relatively structurally diverse, with large trees, snags, down logs, and an understory containing more shade-tolerant hardwoods or conifers that will become the canopy dominants in the absence of stand-replacing disturbance. See also the Mesic Hardwoods Chapter.

Habitat Map

To depict Upland Deciduous Forest and Woodland habitat (see Figure 3.9), 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 System

In the Fire-dependent Forest system, some Native Plant Community Classes split up into different Types, with some in this Conifer Forest and Woodland sub-chapter with others in the Upland Deciduous Forest and Woodland sub-chapter. Types are idented and indicated with a letter following the number in the alphanumeric code.

Fire-dependent Forest

FDc25-Central Dry Oak-Aspen (Pine) Woodland
- FDc25b Oak – Aspen Woodland

FDc34-Central Dry-Mesic Pine-Hardwood Forest
- FDc24b Oak – Aspen Forest

FDn22-Northern Dry-Bedrock Pine (Oak) Woodland
- FDn22c Pin Oak Woodland (Bedrock)

FDn33-Northern Dry-Mesic Mixed Woodland
- FDn33b Aspen – Birch Woodland

FDn43-Northern Mesic Mixed Forest
- FDn43b Aspen – Birch Forest

FDs27-Southern Dry-Mesic Pine-Oak Woodland

FDs27c Black Oak – White Oak Woodland (Sand)

FDs36-Southern Dry-Mesic Oak-Aspen Forest

FDs37-Southern Dry-Mesic Oak (Maple) Woodland

FDs38-Southern Dry-Mesic Oak-Hickory Woodland

FDw24-Northwestern Dry-Mesic Oak Woodland

FDw34-Northwestern Mesic Aspen-Oak Woodland

FDw44-Northwestern Wet-Mesic Aspen Woodland

Midwest Terrestrial Habitat System

From the Midwest Terrestrial Habitat System we included these groups: Midwest Oak-Hickory Forest, Eastern North American Native Ruderal Forest, and Northern Tallgrass Oak-Aspen Woodland.

Photo: Avon Hills Forest Scientific and Natural Area, Kelly Randall

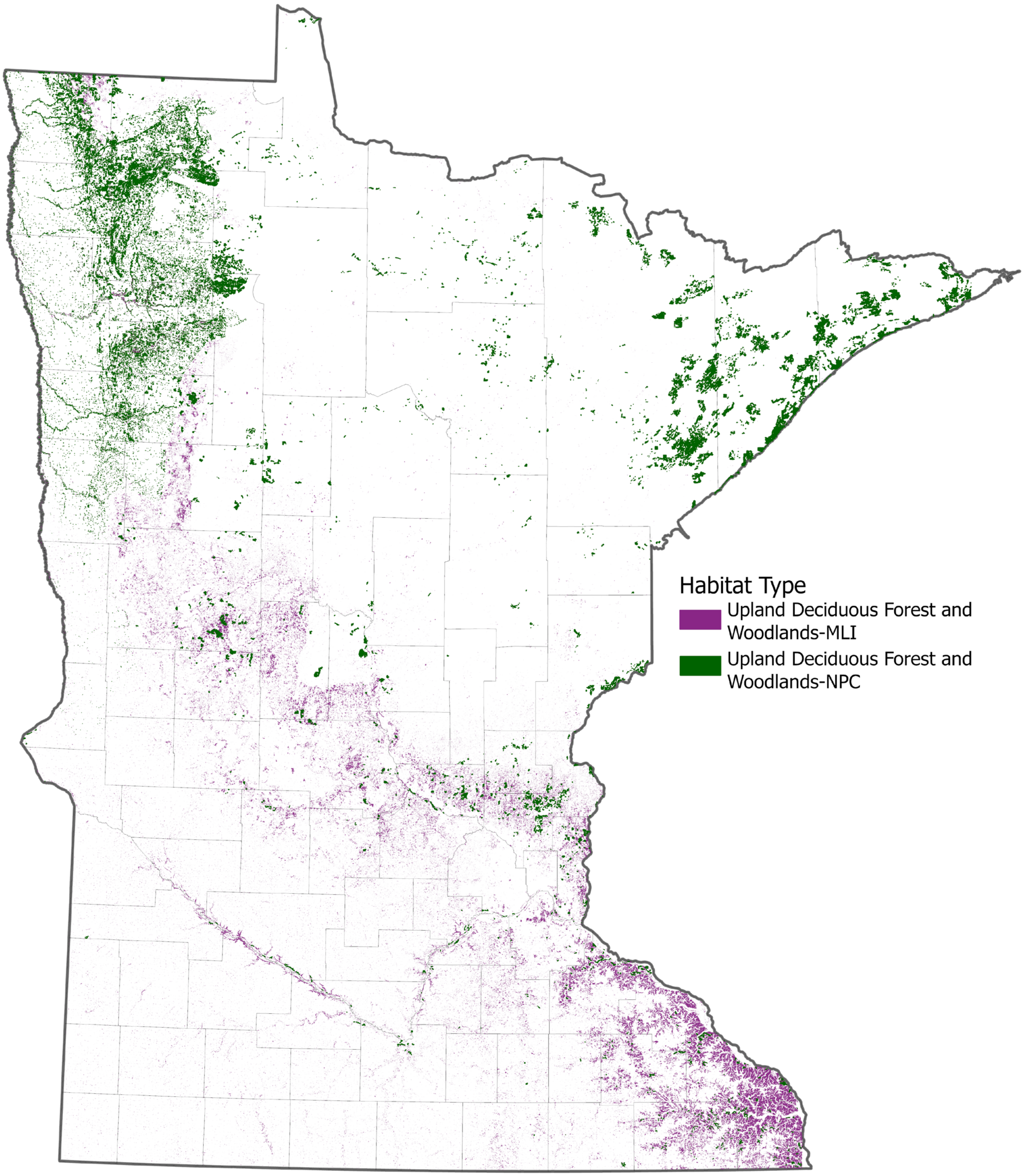

Figure 3.9. A map depicting Upland Deciduous Forest and Woodland habitat in Minnesota, including DNR Native Plant Community Classes in the Ecological Systems of Fire-dependent Forest/Woodland as well as three types from the Midwest Terrestrial Habitat System (see narrative).

Conservation Overview

Historically, wildfire played an important role at both the site and landscape level in these forests, but due to land use changes and fire suppression, wildfire is less common today. With the decline of fire frequency post Euro-American settlement, most upland deciduous forests remain on sandy, gravelly, or otherwise droughty sites where succession to closed-canopy mesic hardwood forest communities has been slowed by harsh growing conditions. In the past, fires in the deciduous woodlands could kill stands of trees and other aboveground vegetation under the right climate, fuel, and topographic settings. However, even intense fires in these deciduous woodlands did not generate the kinds of conflagrations possible in closed-canopy coniferous forests. By comparison, fires in upland deciduous woodlands were more regenerative than destructive. Following a crown fire, a variety of biological legacies, or features of the pre-disturbance ecosystem that persist after disturbance, remain in the young regenerating forest (Perry and Amaranthus 1997). These include standing dead trees, large trees that escaped the fire, downed logs, small patches of unburned vegetation, and surviving propagules and organisms (such as buried seeds, surviving roots, mycorrhizal fungi and other soil microbes and invertebrates). Such features are important ecologically and can provide habitat for SGCN. At the landscape level, wildfires create a shifting mosaic of native plant communities with a variety of ages and structural characteristics that provide habitats for SGCN.

Plants that occur in this community have seeds or vegetative structures that can survive fire and are good at colonizing burned sites. Many plants are opportunists that can take advantage of the short periods following fire when nutrients are relatively abundant and light levels are high. Such plants must also survive frequent drought and potentially long periods between fires when light levels decrease beneath increasingly dense shrub and tree canopies. The most evident characteristic of plants in this community is their ability to sprout prolifically. The trees, shrubs, and many of the herbs can store considerable amounts of carbohydrates below ground in roots, rhizomes, or other specialized organs and then sprout vigorously after aerial stems are destroyed by fire. These plants seem to be particularly plastic in allocating resources to underground or aboveground tissues, depending on the effect of fire on their overall vigor.

With fire less frequent in these forest stands, forest management activities including timber harvests are now the most prevalent form of disturbance. Sustainable forest management includes planning when and where timber harvest can be used as an effective tool to address a range of values and priorities, including forest health and productivity, critical ecological functions, and habitat restoration from historical disturbance events. During timber harvest planning, it's important to consider forest compositional and structural diversity at meaningful scales and pursue efforts to replicate natural disturbance regimes that define these plant communities. Planning efforts must strive to ensure that a balance of forest habitat conditions (e.g. younger and older forest, small and large patch sizes) are available for plant and animal species across the landscape over time. The multiple uses of forests can limit the ability to provide these habitat parameters, such as in the case of school trust lands, which by Minnesota law must be managed "for maximum long-term economic return…consistent with…sound natural resource conservation and management principles" (see Minn. Stat. sec. 127A.31). The DNR's duties to manage for maximum long-term revenue are not discretionary and take precedence in the event of conflicting management objectives (see Minn. Stat. sec. 84.027 subd. 18(a-b)).

Conversion to other uses such as agriculture, urban development, and transportation corridors has fragmented forests across the state. This is most evident in southeastern and central Minnesota where few large patches of upland forest remain. The remaining forests in these regions typically lack the ecological complexity of pre-European settlement forests due to several factors such as, grazing, invasive plants and animals, edge effects, changes in native animal populations, and consumptive uses. Even in the largely forested areas of northern Minnesota, rural sprawl has greatly reduced the extent of large, contiguous forest areas; most forest areas are within 25 kilometers (15.5 miles) of small housing settlements (Radeloff et al., 2005).

Aspen-dominated Forest

Today, aspen forest is the most abundant forest habitat in Minnesota and much more widespread than it was prior to settlement by people of European descent. An analysis of General Land Office bearing tree records from the late 1800s and Forest Inventory and Analysis plots from the 1990s shows that in the Laurentian Mixed Forest Province, aspen forest communities have increased nearly tenfold (Friedman and Reich 2005). However, it is thought that aspen forests are structurally less diverse than they were historically, and on average younger than that of pre-European settlement aspen forests. Currently, about 60% of the aspen age class distribution is 1-40 years old, and about 18.5% of the cover type is over 60 years old statewide (U.S. Department of Agriculture, Forest Service, FIA Program, 2025). The location of older aspen stands shift across the landscape over time as old stands are harvested or succeed to other tree species, and young-mature aspen stands that aren't harvested age. Older, more structurally diverse aspen forests have high value to some SGCN, such as American goshawk (*Astur atricapillus*). The configuration of that habitat on the landscape (e.g. tract size, proximity to other forest types) also relates to its suitability and significance as habitat for SGCN.

Oak-dominated Forest and Woodlands

Historically, fires in the oak habitat were more regenerative than destructive. The typical cycle involved top-killing of plants and vegetative recovery by resprouting. Fires enhanced plant reproduction by exposing mineral soil, triggering seed dispersal, breaking seed dormancy, and increasing light and heat conditions on the ground. In the absence of fire, relatively mesic or fire-sensitive species such as bitternut hickory (*Carya cordiformis*), basswood (*Tilia americana*), and red maple (*Acer rubrum*) are increasing in abundance in this habitat. Without fire, there is little natural oak regeneration in most dry oak stands.

Some oak forest stands have been colonized by invasive species such as buckthorn (*Rhamnus cathartica*) and non-native bush honeysuckles (*Lonicera* spp.). Like other forest habitats, most oak forest habitats in the Eastern Broadleaf Forest Province and southern and western portions of the Laurentian Mixed Forest Province have been fragmented by agriculture and development.

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

The anticipated effects of a changing climate on upland deciduous ecosystems were profiled in the report "Effects of Climate Change on Midwestern Ecosystems: Central Interior Oak Forest, Woodland and Savanna" published by the Midwest Climate Adaptation Science Center (Ratcliffe et al., 2025). This Climate Profile section is derived from that report for the North Central Oak-Hickory Forest and Woodland National Vegetation Classification habitat type (and please see the report for source citations). This habitat type typically occupies well-drained soils ranging from more xeric to mesic and characterized by a drought and fire tolerant canopy. Periodic low to moderate frequency surface fires maintained somewhat open conditions. Fire suppression has created conditions for fire intolerant woody species to increase and shade out more fire adapted and shade intolerant understory species. This can lead to "mesophication" where a more closed canopy favors more mesic plants and can contribute to a loss of biodiversity and structural heterogeneity. Non-native invasive species are also prominent stressors in this system.

Climate projections include projected increases in annual temperatures of 6.2 – 10.7 degrees F by the end of century (2070-2099), depending on emissions levels (Table 26 in Ratcliffe et al., 2025). Precipitation levels are on average projected to increase modestly 1.7 to 2.9 inches by the end of century depending on emissions (Table 27 in Ratcliffe et al., 2025), with an expectation that rainfall is more variable, with more extreme events and drier summers.

The most prominent climate factors for upland deciduous forests are drought and fire. Summer vapor pressure deficit, which incorporates temperature and water use via evapotranspiration, are projected to increase 36-72% over historical levels by end of century, depending on emission levels (Table 28 in Ratcliffe et al., 2025). These higher rates of water loss can exacerbate drought conditions and increase fire risk. Annual extreme fire danger (based on days with very low fuel moisture) is projected to increase 65%-81% over historical levels by end of century, depending on emission levels (Table 29 in Ratcliffe et al., 2025).

Key Climate Change Effects (from Ratcliffe et al. 2025; please reference for the source citations):

Habitat structure can be altered by drought that increases soil drying and reduces herbaceous cover, soil microbial activity and decomposition, which can lead to reduced nutrient availability and increased erosion particularly on sandy soils. A greater incidence of high-intensity fires would exacerbate degradation of soil structure and erosion.

- **Community composition** may shift toward more xeric species such as drought-tolerant warm-season grasses although extreme drought or drought with an absence of fire may favor shrubs and encroaching trees. Drought conditions will likely be more favorable for oaks over maples and birches, although extreme drought could inhibit oak recruitment and survival.
- **Invasive species** with broad tolerances and rapid recovery strategies can be favored by drought, such as brome (*Bromus*) species. Fire can be effective in suppressing some invasive shrubs, but is less effective in suppressing some such as invasive honeysuckles (*Lonicera* spp.), common buckthorn (*Rhamnus cathartica*), and autumn olive (*Elaeagnus umbellata*) that are persistent in the

seed bank and recover readily after fire, particularly on more mesic sites.

- **Pests and pathogens** may become more prevalent as trees are stressed by drought, such as oaks becoming more susceptible to oak borer species. Rising temperatures may increase outbreaks in some pathogens such as moths and bark beetles. Root rots may be diminished by drought or may flourish under fluctuating moisture regimes.
- **Herbivory** could be expected to increase if warming winters support higher populations of white-tailed deer. Increased browsing pressure could inhibit the reproduction of oaks and reduce forb diversity. In addition, drought can inhibit plants investments in chemical defenses.

Species in Greatest Conservation Need

Upland deciduous forests and woodlands provide primary or secondary habitat for 68 animal and 33 plant SGCN (see Table 3.9). 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. Habitat associations for insects were not differentiated into primary and secondary habitats and are shown in the total column. For plants, only a single primary habitat was identified per species.

Table 3.9. Numbers of Species in Greatest Conservation Need associated with the Upland Deciduous Forest and Woodlands as either primary or secondary habitat.

Species Group	Primary Habitat	Secondary Habitat	Total
Amphibians	3	0	3
Birds	4	8	12
Mammals	2	19	21
Reptiles	9	1	10
Bees	-	-	9
Beetles (terrestrial)	-	-	1
Moths	-	-	4
Snails (terrestrial)	3	3	6
Spiders	1	1	2
Plants	33	-	33
Total	**55**	**32**	**101**

Animals with more general habitat requirements are associated with multiple habitat types, while specialists are associated with one or few. 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).

Of the 130 terrestrial vertebrate SGCN identified in the 2025-2035 SWAP, 35% (46) occur in upland deciduous forests and woodlands. A large proportion (69%) of the 31 mammal SGCN occur in this habitat. Like other fire-dependent habitats, plants found in the upland deciduous forests only represent 7% of the 447 that are designated as SGCN. Examples of selected SGCN are described below; state-listed species are linked to their account in the Rare Species Guide.

Amphibians

Three salamander SGCN – spotted salamander (Ambystoma maculatum), four-toed salamander (*Hemidactylium scutatum*), and Eastern newt (*Notophthalmus viridescens*) – are strongly associated with mature forest habitats. They primarily occupy deciduous forests but will also use mixed deciduous-conifer forest types. Access to wetlands, such as vernal pools, are critical for these species, which use them in the spring to breed. Eggs are laid in or near the water, and larvae remain in the pools until metamorphosis occurs. Four-toed salamanders specifically lay their eggs in moss hummocks next to wetlands. Eggs are laid in or near the water, and larvae remain in the pools until metamorphosis occurs. Four-toed salamanders specifically lay their eggs in moss hummocks next to wetlands. Four-toed salamanders occur most frequently in mature upland forests on glacial moraine landscapes with frequent isolated wetlands that include an alder margin and moss hummocks adjacent to pockets of open water.

Birds

SGCN birds more typical of Mesic Hardwood Forest can also occupy dry-mesic fire-dependent forests in certain landscape settings (e.g., when part of a larger forested site where forest types co-occur, depending on slope, aspect, and soils). For example, dry-mesic oak forests often occur on south- or west-facing slopes, forming an important component of forested stream valleys important to Acadian flycatchers (*Empidonax virescens*), cerulean warblers (*Setophaga cerulea*), and Louisiana waterthrushes (*Parkesia motacilla*). Such forests must have the same structural components important to these species as Mesic Upland Forest (i.e., mature trees, closed-canopy, structurally diverse understory/subcanopy, etc.).

Similarly, SGCN found in savanna (e.g., eastern whip-poor-will (*Antrostomus vociferus*), red-headed woodpecker (*Melanerpes erythrocephalus*) or dry conifer woodlands also occur in semi-open deciduous woodlands that have the necessary habitat components. Dry sand or gravel soils and an open ground layer are important to whip-poor-wills, while red-headed woodpeckers require dead trees and snags without bark (see Savanna sub-chapter).

Young (early successional) upland deciduous forest, including edges, is an important component of golden-winged warbler (*Vermivora chrysoptera*) habitat. However, a mosaic of seral (intermediate) stages is important, including mature forest. Suitable early successional habitat may occur in several forest types – not just Upland Deciduous. Aspen and birch are frequent dominants, although other tree species can be suitable for golden-winged warblers. Early successional habitat may occur in monocultures following disturbance (e.g., fire, windthrow, silvicultural activities), in naturally fragmented mosaics (e.g., upland forest interspersed with wetland openings, shrub swamps, lowland conifers, lake or river shores) as well as along road or utility corridors through forested landscapes.

Mammals

Upland Deciduous Forests and Woodlands support a very similar mammalian SGCN fauna as Upland Conifer Forests. Once again, all 7 bat SGCN are reported in Upland Deciduous Forests but it is considered primary habitat for just one, the Tri-colored bat (*Perimyotis subflavus*). This cave-hibernating species commonly roosts during the spring, summer and fall among the leaves of live or recently dead hardwood trees. As noted by the USFWS, tri-colored bats have been devasted by the effects of white-nose syndrome, causing an estimated decline of more than 90% in the species' hibernating colonies across North America. One other species that is more likely to be seen in Upland Deciduous Forests is the plains spotted skunk (*Spilogale interrupta*). This species is also found in a range of other habitats, especially open or brushy edge habitats.

Reptiles

Eastern hog-nosed snakes (*Heterodon platirhinos*) are most common in and around woodland edge habitats. Key habitat features for these species include down woody debris (for cover, nesting sites, and basking sites) and burrows or crevices as overwintering sites. Eight other reptile SGCN's also utilize Upland Deciduous Forests and Woodlands as primary habitat including six snakes: North American racer (*Coluber constrictor*), timber rattlesnake (*Crotalus horridus*), Eastern hog-nosed snake (*Heterodon platirhinos*), smooth greensnake (*Opheodrys vernalis*), Western ratsnake (*Pantherophis obsoletus*), and gophersnake (*Pituophis catenifer*). All of these species can be found in a wide variety of habitats. The North American racer, common five-lined skink (*Plestiodon fasciatus*) and timber rattlesnake use deciduous forests and woodlands for foraging and temperature regulation, if they are close to rock

Photo: Western ratsnake, Jeff LeClere

outcrops and cliffs that are important for basking, overwintering and denning. While primarily associated with large non-forested wetland complexes, Blanding's turtles will also utilize Upland Deciduous Forests and Woodlands during terrestrial movements in the spring and summer related to breeding, foraging, and nesting, as well as hatchling movements in the fall.

Plants

Fire dependent upland forests and woodlands are habitat to a number of unique and rare plant species that help make up the complexity of these native plant communities (see Appendix E). For example, black huckleberry, (*Gaylussacia baccata*), is a rare, fire adapted species with a limited range in Minnesota. Much of its habitat is fragmented and lacks the fire needed to maintain its habitat. Without fire, fire-sensitive and more shade tolerant species can invade black huckleberry's habitat. Prescribed fires are needed to approximate natural wildfires and allow black huckleberry to persist.

Case Study: The American Goshawk and Upland Deciduous Forest

The American goshawk (previously known as the Northern goshawk) was listed in Minnesota as a species of special concern in 2013. Since 2003, a partnership including federal, state, academic and tribal entities have monitored American goshawk territories in northern Minnesota collecting data on occupancy, nest success and number of young produced. The results of this long-term effort have highlighted some continuing challenges and concerning details about the American goshawk population trend in Minnesota. Over the past 20 years, the average territory occupancy rate is 71%, nest success is 70%, and the productivity rate averages 1.5 fledglings annually. These Minnesota averages are on the low end or lower than national average. In addition, through DNA analysis of feathers under nest sites, the DNR has been able to identify 107 individuals and has confirmed a high level of site fidelity (i.e., females using the same nest territory year after year), which is an important factor when it comes to habitat considerations. Goshawks commonly nest in upland deciduous forest, with 71% of nests occurring in large aspen trees. Stand age and structure appear to be the most important features within habitat, with 81% of nest occurring in stands that are 60+ years old and the average aspen stand age being 69 years old. While American goshawk is not necessarily an old growth dependent species, it does require large tracts of mature and older forest (Crozier, MOU Presentation 2022).

Photo: American goshawk, Michael Furtman

Throughout the many years of goshawk monitoring, it has become clear that determining population trends is difficult given this species' relatively low abundance over a broad range (Bruggeman et al. 2011). The DNR and the University of Minnesota recently completed some habitat modeling analyses for goshawks to assess which habitats were correlated with successful goshawk breeding areas. Overall, nest attempts and success were positively related to the amount of mature aspen and birch forests in the territory (230 meter radius area surrounding nests) and negatively related to the amount of young aspen/ birch forest, mature lowland conifer forest, and total area of harvest (Bruggeman, 2022). Based on these habitat association models; one strategy has been to look at the rate of habitat change over time as a proxy to the goshawks population trend in Minnesota. A conservative assessment of change for all land management types shows a 6% decline in older aspen/birch between 2003-2015 (Crozier, 2022). However, some challenges with this approach remain, such as a lack of information about the quality of habitat or goshawk use of private lands. Habitat changes over time were also assessed in the long-term monitoring project and showed the average of 26% loss of preferred habitat within known goshawk territories over a 10-year period. This highlights that occupied goshawk territories may be at higher risk to habitat change than the trends detected on a statewide scale across all management types.

The American goshawk remains a species of conservation concern, and its apparent declining population trend will be watched closely in the coming years. Minnesota has a long-standing tradition of integrated, landscape-scale forest management which may benefit the species. This kind of management is coordinated across ownership boundaries and strives to maintain a diverse landscape for all forest-dependent species (MNBBA).

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

Residential, commercial, and industrial development can all directly alter forest ecosystems by removing, degrading, or fragmenting forest cover and habitat. Fragmentation of forests is a growing concern, and occurs when a large, contiguous forest land mass is divided into smaller tracts through sale and subdivision, road construction, or clearing of forests for agriculture, housing, or other commercial developments. This often creates smaller forest pockets, which are interspersed with non-forest land activities. Fragmentation can inhibit the natural migration of many plant and animal species, increase the risk of wildfires at the wildland urban interface, restrict public recreational access, reduce the habitat value and ecological complexity of forest lands, and contribute to the spread of invasive species. Because of their natural beauty, diversity, recreation opportunities, and abundant natural resources, forested landscapes are appealing places to live; even in the largely forested areas of northern Minnesota, rural development has greatly reduced the extent of large, contiguous forest areas; most forest areas are within 25 kilometers (15.5 miles) of small housing settlements (Radeloff et al., 2005). Forested lands adjacent to lakes and rivers are especially attractive sites for development.

Development can also indirectly affect forests, through modification of ecosystem hydrology, introduction of non-native species, altered disturbance regimes, reduced connectivity to other habitats, increased abundances of competitors and predators, altered microhabitat conditions, increased direct human disturbance, and avoidance by wildlife that evolved to use large areas of habitat embedded in a landscape dominated by native ecosystems.

Crop Production

Historically, many of the upland deciduous and mesic hardwood forests were converted to cropland, leaving a patchwork of widely scattered wood lots, averaging 40 to 80 acres in size, across central and southeastern Minnesota. The conversion of forests to agricultural use is ongoing in some locations.

Livestock Management

Minnesota currently has over 650,000 acres of mesic, upland deciduous, and riparian forests on farms that are grazed by livestock (Zamora et al., 2017, Garrett et al., 2004). Properly managed grazing can stimulate plant diversity and create diverse vegetative structure across the landscape. Overgrazing, if left unchecked, can reduce diversity in vegetative cover and structure, and have severe negative effects on biodiversity, ecosystem function, soil health, and forage production.

Historically, grazing by livestock in forested landscapes likely became very intensive during the droughts of the 1930s as farmers struggled to find enough forage (Hartman & Steele, 2015). These habitats likely became overgrazed and became subject to varying degrees of erosion, while the forest vegetation was subject to trampling, grazing, fraying, and bark stripping all of which can affect regeneration. (Hartman and Steele, 2015). From the 1960's to present, grazing practices have changed. This includes reductions in the types of livestock raised by agricultural producers to primarily cattle, as well as the elimination of grazing on many bluff prairies and associated savannas altogether. This reduction in grazing has led to an increase of woody vegetative cover and the reduction of bluff prairie and savanna habitats. Best management practices associated with silvopasture, or the practice of intentionally combining management of trees, forage, and grazing as one integrated practice, has the potential to contribute to the restoration of Oak-dominant forests and woodland habitats.

Mining and Quarrying

Forests, when they co-occur with mineral, oil, or gas deposits, are at risk of degradation due to the direct and indirect effects of mining activities such as permanent forest loss, soil compaction, introduction of invasive species, human disturbance, waste discharge and pollution, and forest fragmentation (Sonter et al., 2018). Mining projects can trigger additional, cascading land use change with the establishment of associated infrastructure such as improved road access.

Roads, Trails, and Railroads

Roads, trails, and railroads can create fragmentation and edge effects in large tracts of forest. Increase in the number of roads and trails increases human disturbance and the potential for introduction of invasive species further into the forest. Repeated use and soil compaction associated with roads and trails also can modify the vegetation within the area of use. Temporary winter logging trails may become rutted while materials used to stabilize the trails for heavy vehicles may remain in place, leaving behind wood planks and wood chips, although Minnesota's forest management guidelines are designed to avoid or promptly address these effects. Trails that provide winter access to upland deciduous stands can disturb forest wildlife, especially species that begin nesting in late winter, such as many forest raptors.

Utility Corridors

Utility corridors transect forested habitats throughout the state. These corridors can contain a variety of utility infrastructure. This includes pipelines, telephone lines, and power lines. These lines can be aerial, above ground, or below ground. Regardless of type, utility corridors can fragment habitat based on their size, purpose, and the upkeep required to maintain them.

The initial construction of the associated utility infrastructure as well as the long-term maintenance of that infrastructure can have lasting effects on native plant communities and the SGCN associated with them. Increased funding for rural broadband, conversion of aboveground powerlines to belowground, and development of new utilities (solar, wind, etc.) continue to threaten forested habitats.

These corridors and the increased travel from vehicles and equipment that they require act as vectors for invasive plant species. The required vegetative management practices often include herbicide applications, removal of woody vegetation, and/or mowing. This increased disturbance increases the likelihood of establishing invasive plant species within the corridors and then spreading to adjacent lands.

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. Even-aged harvests (e.g. clear or seed-tree cuts) are mostly used in fire-dependent forests and are similar to stand replacing fires of historical disturbance regimes. Methods to enhance biological legacies at local and landscape scales in even-aged harvests need more study and application.

Oak forests become more susceptible to disease with age and can spread disease from old oaks to seedlings; these forests are commonly managed with full even-aged harvests. Even-aged management may create forests that differ from forests experiencing more natural disturbance which may in turn impact habitat conditions for SGCN. Many wildlife species benefit from managing for within-stand species and structural diversity in large habitat patch sizes to provide habitat for area-sensitive species and to minimize habitat fragmentation effects. Long term impacts of oak harvest, incorporating regeneration dynamics, forest health, and landscape-scale age class distributions should be considered. The multiple uses of forests can limit the ability to provide these habitat parameters, such as in the case of school trust lands, which by Minnesota law must be managed "for maximum long-term economic return…consistent with… sound natural resource conservation and management principles" (see Minn. Stat. sec. 127A.31). DNR's duties to manage for maximum long-term revenue are not discretionary and take precedence in the event of conflicting management objectives (see Minn. Stat. sec. 84.027 subd. 18(a-b)).

Recreation

In addition to the effects that may be caused by recreational trails (discussed above), recreational activities themselves can spread invasive species. Seeds of invasive plants such as common tansy (*Tanacetum vulgare*) and garlic mustard (*Alliaria petiolata*) can become embedded in the wheels of vehicles or the shoes of individuals and eventually become established along compacted trails where conditions for their growth may be more favorable. Earthworm egg cases, which are problematic for moonwort (*Botrychium*) species, can also be spread in mud. Increased use of roads and trails also increases human disturbance in the forest.

Fire Management

A history of fire suppression, insufficient fire frequency, and the exclusion of cultural burning practices contributes to the ongoing homogenization of composition and structure in upland, fire-dependent forest habitats (Hanberry et al., 2012). In the absence of fire, open forests can transition into closed forest ecosystems, leading to decreased structural diversity and a decline in the diversity of associated plant and animal species. Woody densification also creates a positive feedback loop of mesophication, where cool, damp, and shaded conditions increase ecosystem moisture and further reduce flammability (Nowacki and Abrams, 2008). Oaks, in particular, have declined dramatically and have been outcompeted by fire-sensitive and shade-tolerant canopy trees (e.g., elms, boxelder, maples, American basswood, and ashes). Today, in the absence of fire, even-aged timber harvests (e.g., clear or seed-tree cuts) are frequently used in fire-dependent forests. Oak regeneration following timber harvest can be challenging. Poor oak seedling recruitment (especially if a poor acorn crop preceded the harvest), competition with other tree species, and deer browsing can all reduce successful regeneration (Jacobson et al. 2019).

Invasive Species (Problematic Non-native Species)

Invasive plant species, such as buckthorn (*Rhamnus cathartica*) and non-native bush honeysuckles (*Lonicera* spp.) often outcompete native plant species for light, space, and water and repress understory plant species leading to modified habitats unsuitable for SGCN. Dense canopies formed by invasive shrubs also inhibit the regeneration of native tree species due to the increase in shade. While a concern statewide, upland deciduous forests in central and southern Minnesota are currently most affected by these invasive shrubs.

Invasive animals, primarily invertebrates, cause profound ecological changes in forests (Frelich et al., 2019). First, Eurasian earthworms 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), salamanders (Maerz et al., 2009, Ziemba et al., 2016), and likely other vertebrates.

Second, the spongy moth (*Lymantria dispar*) is an invasive forest pest that feeds on more than 300 species of deciduous trees and shrubs, including aspen, oak, and birch. Repeated removal of leaves, or defoliation, stresses trees and can leave them vulnerable to disease or other pest infestations that can kill trees. Once it becomes established in a location, the spongy moth has cycles of large population outbreaks every eight to 12 years, leading to widespread defoliation and nuisance from caterpillars.

Other invasive insects defoliate trees but typically do not cause significant mortality. Elm zigzag sawfly (*Aproceros leucopoda*) is an invasive defoliator of elm trees that was reported in Minnesota in July 2024 for the first time.

Problematic Native Species

Overbrowsing by deer can severely limit natural tree regeneration (Matonis et al., 2011; De Jager et al, 2013), especially for preferred species, such as oak. Elevated deer populations also reduce populations of palatable ground layer plants, including orchids (Knapp and Wiegand, 2014), members of the lily family (Balgooyen and Waller 1995; Augustine and Frelich, 1998; Fletcher et al., 2001), and rare species (McGraw and Furedi, 2005). Decades of cumulative effects have resulted in profound changes to the composition of native plant communities (Wiegmann and Waller, 2006; Frerker et al., 2014; Nuttle et al., 2014; Flagel et al., 2016; Anderson et al., 2017; Sabo et al., 2017). The effects of deer browsing often interact with those of invasive earthworms (Fisichelli et al., 2013; Davalos et al. 2014).

Diseases and Pathogens

Oaks are susceptible to several types of disease and pathogens, such as oak wilt (caused by the invasive fungus *Bretziella fagacearum*), sudden oak death (caused by the water mold *Phytophthora ramorum*), and bur oak blight (caused by a native fungal pathogen, *Tubakia iowensis*). Individual trees tend to be more susceptible when under stress, which may interact then with other threats, such as if future climatic conditions bring more frequent late summer droughts. Older oak trees are more susceptible to interacting stressors including drought, heavy seasonal precipitation, insects, and diseases. Wetter springs may increase the prevalence and severity of fungal diseases as spores spread from the diseased leaves by rainwater, exacerbated by earlier spring rainstorms brought on by Minnesota's changing climate.

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. Warming can indirectly affect all of Minnesota's forest communities by altering the effect of invasive species, insect pests and diseases, winter burn, drought, and deer herbivory (Galatowitsch et al., 2009; Handler et al., 2014).

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

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. 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.

Restoration activities could also be disrupted by causing seedling mortality and shifts in community composition if there are multiple seasons with insufficient rain. Short funding windows for restoration efforts exacerbate the problem by inducing restoration plantings even in dry periods. Prolonged drought has stressed trees in the south east making some particulalry susceptible to native pests and pathogens. Changes in precipitation interact with the age class distribution of tree species such as oak, in which old trees are more susceptible to stress from drought, heavy seasonal precipitation, in turn making trees vulnerable to insects and and diseases.

Heavy rain events have been increasing in frequency and severity in Minnesota in recent decades. Forests on steep slopes, common in the state's southeastern counties, are vulnerable to landslides during these events.

Priority Habitat Conservation Strategies

To implement the Habitat Goal of this Plan (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.

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 Upland Deciduous Forests and Woodlands

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 projected effects on areas of biological significance such as high value conservation forests, old growth forests, and Important Bird Areas when making decisions and policy that are expected to affect upland deciduous forests (e.g., mining and quarrying, planning for new development of energy sources and any associated new road or trail construction).
	Engage in forest planning to collaborate and share interdisciplinary knowledge, supporting conservation of SGCN habitat and addressing values of biodiversity, rare features, structural and compositional plant diversity and wildlife needs. Maintain, adapt, or develop policies and procedures guiding habitat management that are based on the best available science. On state lands, all actions must align with existing Minnesota statutes and policy guidance, such as in the case of School Trust Lands that must be managed "for maximum long-term economic return…consistent with…sound natural resource conservation and management principles" (Minn. Stat. sec. 127A.31).

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

Stressor	Action
	Explore the potential use of silviopasture management regimes (the practice of intentionally combining management of trees, forage, and grazing as one integrated practice) to help restore some upland deciduous forests that do not spring ephemerals or other sensitive SGCN species (UMN Extension: Silvopasture: Establishment and Management Principles for Minnesota 2013)
	Attempt to minimize forest fragmentation when planning the location of new roads and trails.
	Encourage the use of existing corridors for new trails, roads, and utility corridor development to minimize the construction of new roads and trails that would increase forest fragmentation.
	Apply knowledge of SGCN habitat use into landscape forest planning efforts, to help balance habitat for SGCN and other values according to management requirements and objectives. Consider natural area designations and other ways to enhance and preserve key mature stands. Conduct research and model anticipated changes with different forest management scenarios for effects on wildlife habitat. Consider the ecological values of various forest ages and how they relate to SGCN habitat when determining desired future conditions and planning sustainable management to advance those conditions.
	Limit the use and operation of heavy equipment when road or site conditions are vulnerable to damage per best management practices. For instance, depending on the site characteristics, conducting timber harvests during frozen ground conditions can reduce soil compaction and rutting effects.
	Provide information on important habitat types, landscape configurations, and conditions most beneficial for SGCN. Support forest management that reflects ecological disturbance goals and SGCN habitat needs such as stable amounts of older forest. Communicate and document the benefits of alternative management techniques (i.e., variable density thinning, natural seeding), reference to natural disturbance intervals, natural regeneration methods, and to increase habitat quality for SGCN.
	Retain old and dead standing trees (snags) in forests when practical as habitat for wildlife, including cavity-nesting birds.
	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.
	Implement control strategies for invasive species, such as buckthorn, and ensure sufficient timeframe for follow-up management that extends for many years. Support funding for these activities, and consider expanding restoration resources to make sure they can be applied to woodland systems, which are sometimes in between funding opportunities aimed at prairies or forests.

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

Stressor	Action
	Support local governments in measures that minimize fragmentation and encroachment into high quality forests and woodlands such as protecting high quality areas, zoning that guides housing developments, lot sizes that support local forests, and land use planning and development guidance.
	Collaborate across forest ownerships and managers to implement sustainable forestry at the site and landscape level to create habitat conditions important to SGCN, such as unfragmented older mesic hardwood forests to create larger forest patches and reduce forest fragmentation. Support forest management approaches that are informed by ecological processes, increase structural and compositional complexity and diversity, and assist in resilience towards future stressors (e.g., climate change, disease outbreaks, invasive species). Promote forest management strategies that mimic landscape disturbance patterns (for example, retaining large blocks of mature habitat and creating more small forest openings as gaps or strips), maintain or enhance connectivity among forest patches to enable wildlife movement, and retain biological legacies (at site level) such as large trees with cavities. Consult Native Plant Community Classification silvicultural strategies for forest stand prescriptions. Enrolling forests in forest sustainability certification programs, such as by Forest Stewardship Council and Sustainable Forestry Initiative, also may help in implementing sustainable forestry.
	Manage for a diversity of forest growth stages across the landscape to promote vegetation characteristics that maintain habitat for a wide range of plant and animal species, promote resiliency to insect and disease outbreaks, and mitigate the adverse effects of climate change. Ensure mature, older forest and old forest qualities are retained on the landscape in amounts and areas that provide critical habitat to SGCN animals and plants; encourage management that sustains mature and old growth forests in forest planning efforts. Apply management practices to create young, early successional forest on the landscape to provide vegetation characteristics and edge habitat between young and mature forest that support plant and animal species.
	Droughts are becoming more frequent and can challenge the success of restoration plantings; extending the duration of grants and contracts for restoration projects could help to allow conservation practitioners to plant when conditions are more favorable.

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
	Monitor the responses of SGCN to various types of forest management at the site-level and landscape-scale. Collaborate with MFRC site-level guideline monitoring and NPC silvicultural case studies to incorporate SGCN monitoring (Silviculture Case Studies). Develop models of habitat configurations for various SGCN and consider how current harvest forecasts and conversion rates (i.e., one forest type to another; natural origin habitat to plantation) relate to those models in terms of sustainability for maintaining habitat for SGCNs.
	Collaboratively explore techniques to promote forest regeneration for oak, with an emphasis on forests of high conservation value.
	Support the collection of accurate and reliable biological and forest inventory data to inform management practices and monitor forest dynamics
	Explore opportunities to burn upland deciduous forest stands with a significant oak component to investigate and then monitor the results for oaks as well as other vegetative components of the forest stands. Include other considerations to improve outcomes such as a good acorn crop year prior to the burn and management to stem the growth of competing species.

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, homeowners, and farmers 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.
	Managing for an increased diversity of dominant species, and age classes when appropriate, in a site may assist in resilience toward future disease outbreaks, susceptibility to some pathogens, and invasive species. For instance, oak forests with a higher diversity of additional species can be more resilient to oak wilt's overall effect. For more information, see DNR Oak Wilt Management and DNR Oak Decline.
	Seek additional funds to assist with the management of woodlands and forests to increase their resilience to pathogens and invasive species. Also consider pairing invasives management with other incentivized management activities to create efficiencies.

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