Forestry for Minnesota Birds

A guide to improving habitat for Minnesota's forest birds.

Forestry for
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Introduction

Forestry for Minnesota Birds (FMNB) is a collaborative initiative designed to help forest managers, natural resources practitioners, and landowners learn how to sustainably manage their forests to benefit birds and other wildlife.

Golden-winged Warbler. © Ryan Pennesi

What is Forestry for Minnesota Birds?

Forestry for Minnesota Birds (FMNB) uses the best available science on avian ecology and sustainable forest management to provide strategies for creating bird habitat in contemporary forests. By collaborating with land managers, landowners, and forest stewards, the program aims to improve bird habitat and support bird populations through sustainable forest management practices. Recognizing that bird presence and abundance reflect overall forest health, the program promotes practices that benefit both habitat requirements of diverse bird species and human needs, such as timber production, hunting, and recreation. This approach, applicable to both public and private forest lands, underscores the interconnectedness of forest ecosystems and the importance of managing them for multiple values, including biodiversity conservation.

FMNB is about managing bird-friendly forests – enhancing, creating, and conserving habitat for birds and other wildlife while also:

- Providing options that align with a landowner's goals
- Keeping forests healthy and promoting resiliency
- Adapting to climate change
- Planning for future generations

WHY IS FORESTRY FOR MINNESOTA BIRDS IMPORTANT?

North America has lost nearly three billion birds, or roughly one in four birds, since 1970. Bird populations are declining for a variety of reasons including habitat loss and fragmentation. While documented population declines are substantial for the majority of bird species, it is important to note that conservation efforts have led to increases in populations of many raptor and waterfowl species over the same timeframe.

Birds serve as important indicators of environmental health, their populations reflecting habitat quality and ecosystem function. Their diverse roles as predators, prey, pollinators, scavengers, and seed dispersers highlight their integral place within intricate food webs. **Forest bird populations across North America have declined by 1.2 billion birds since 1970.**[1] The widespread, long-term decline of bird populations can result in disruption of these processes, leading to a cascade of negative effects on forest health and resilience.

Moreover, birds are culturally valuable and continue to inspire art, literature, and music, representing concepts like freedom and the interconnectedness of nature. Birding as a pastime continues to grow, with positive impacts for mental and physical well-being and significant contributions to local economies. The U.S. Fish and Wildlife Service estimates wildlife viewing, such as bird watching, contributes $600 million in economic benefit to Minnesota each year and $20 billion nationally. The future of Minnesota's forest bird populations depends on our commitment to conservation, with forest management playing an important role in mitigating the threats they face.

MAJOR THREATS TO BIRD POPULATIONS

Habitat loss and degradation remain the biggest threats to forest bird populations. While complete habitat loss is clearly the most detrimental outcome for birds, more subtle forms of habitat degradation can also have substantial negative impacts. For example, many birds are sensitive to the effects of forest fragmentation, where they are increasingly impacted by predators or competitors near forest edges.

Conversion of land for human uses, such as agriculture, development, resource extraction, roads, or utility line corridors, contributes to forest habitat fragmentation.

Migratory birds face habitat loss throughout their full life cycle: on their breeding grounds (i.e., here in Minnesota), along migration routes, and on their wintering grounds. Enhancing forest habitat on the breeding grounds can help to mitigate the impacts of habitat loss in other regions by increasing reproductive success and health entering migration.

Invasive species can directly alter forest bird habitat by outcompeting or killing native plants that birds rely on for food and nesting. For example, Emerald Ash Borer, a non-native forest pest, is predicted to kill one million acres of black ash trees in Minnesota's forests over the next decade, directly resulting in loss of forested habitat. Invasive species, such as buckthorn, can disrupt ecosystem processes and impact vegetation structure and food resources by outcompeting native species. When considering the most important native trees for birds and insects, certain families of trees, deemed "keystone genera," support far more caterpillars — a critical food source for both adult and nestling birds – than do most native or non-native plants.[2, 3] The top five tree family groups supporting caterpillars across North America include oaks, willow, cherries, pines, and poplar/cottonwood/aspens. These groups, especially the white oak group, are vitally important

to breeding birds and forest wildlife, as **96% of terrestrial birds rely on insects to feed their young.**[4] Oaks also provide desirable hard mast for many forest wildlife species and are long-lived as well as disease- and fire-resistant. Non-native, invasive plants that inhibit the growth of these groups are particularly detrimental.

Climate change is impacting forest birds in varying ways. A changing climate affects tree growing conditions and will shift tree species' ranges over time, thus changing habitat suitability for birds. Some tree species will continue doing well in our area or even see expanded habitat, while others are expected to decline across the landscape. The timing of bird migration has already shifted in many species, and timing mismatches (called asynchrony) with food sources on their breeding grounds can impact survival and breeding success. Many of our forest birds that breed in Minnesota experience the stressors of climate change and forest fragmentation, not only during the summer but also when they migrate to their wintering ranges. Climate change alters cycles of precipitation, fire, and forest health concerns (invasive insects and plants; bacterial, fungal, or viral infections), and increases the frequency and severity of major weather events. These altered cycles impact bird nesting success, migration, and food sources. Climate change impacts on forest habitat associations will be discussed specifically later in this guide.

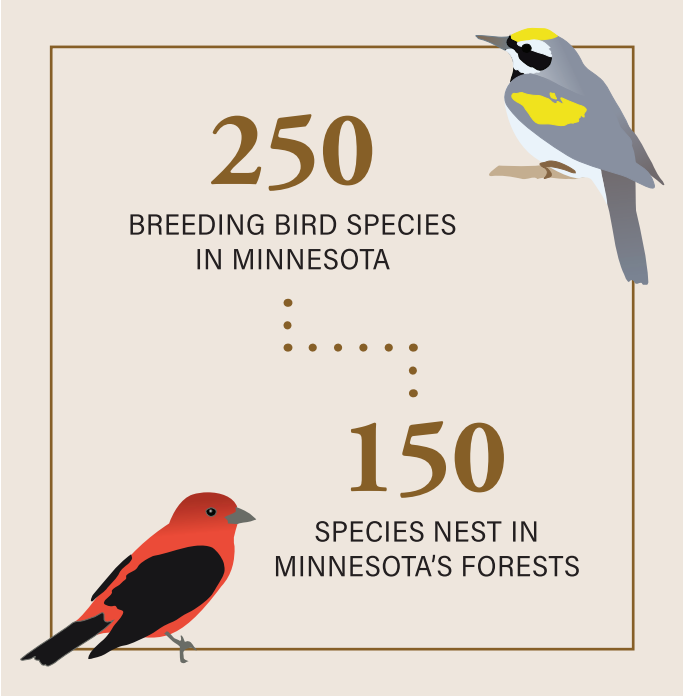
Additional threats drive overall bird population declines across North America. These include feral cat predation, pesticide use, and collisions with buildings, vehicles, and other structures. More information on these threats is available in Appendix C.

It is important to consider the full suite of threats to forest birds, however, landowners and managers in Minnesota cannot directly impact many of these other threats. This guide focuses on actionable strategies for how forest management in Minnesota can effectively support birds here on their breeding grounds. Enhancing habitat in Minnesota can mitigate these other threats by increasing reproductive success and survival.

Drumming Ruffed Grouse. © Ryan Pennesi

Minnesota's Biogeography and Bird Species Diversity

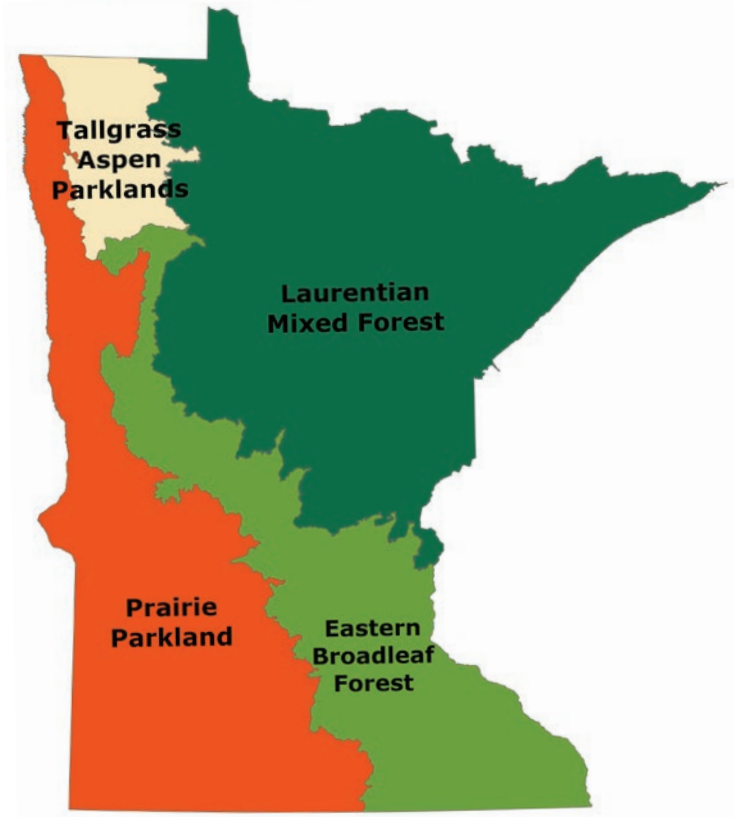
Minnesota is a state rich in different habitats that provide many bird species with the food and shelter they need to meet their life-cycle needs. Four different biomes (a distinct geographical region with specific climatic conditions, vegetation, and animal life) can be found in the state: **the Laurentian Mixed Forest** in the Northeast is characterized by long, cold winters, short summers, and conifer-rich forests; the **Eastern Broadleaf Forest** running diagonally from the Northwest to the Southeast through the center of the state, sometimes called the "Big Woods"; **Prairie Parklands** along the west edge of the state historically dominated by prairie plants and now largely agriculture; and the **Tallgrass Aspen Parklands** in the far Northwest corner with a diverse mosaic of aspen and bur oak woodlands, prairie, and cold water wetlands (i.e., fens). Temperature and annual precipitation are the primary drivers of these unique biomes, with climate generally getting colder as you move north and wetter as you move east. Fire (or the lack of) and wind have historically served as the disturbances that shape and reshape the plant community life stages in these biomes over time. Other disturbances such as climatic conditions, insect outbreaks, and browsing by large ungulates (e.g. deer) can also be significant. The Minnesota Breeding Bird Atlas[5] has identified 13 land cover types that together comprise about 99% of the state's land base. In order, from most to least dominant, they are: agricultural land (36%), upland grass, including pastures and hayfields, (11%), northern hardwood forests (8%), northern mixed forests (8%), lowland conifer forests (7%), open bog (6%), marshes and wet meadows (6%), developed land (5%), upland conifer forests (4%), shrub-dominated wetlands (4%), oak forests (2%), pine-oak barrens (1%), and pine forests (1%). Over a century ago, the landscape was vastly different: prairies dominated what are now agricultural lands (only 2% of the native prairie remains today), wetlands were nearly twice as extensive (since drained primarily for agriculture), and both northern hardwood and conifer forests were more widespread. Overall, just over 31% of Minnesota's land cover types are forested habitats.



Of Minnesota's 250 nesting bird species, approximately 60% (150 species) rely on forests and are among the most diverse in North America. These forest birds serve as indicators of habitat quality, with different species adapted to various forest types.

While some birds are generalists, thriving in diverse forest conditions, others are specialists, requiring specific habitat features. For example, birds such as Canada Warbler need a dense layer of shrub or regenerating trees that appear after

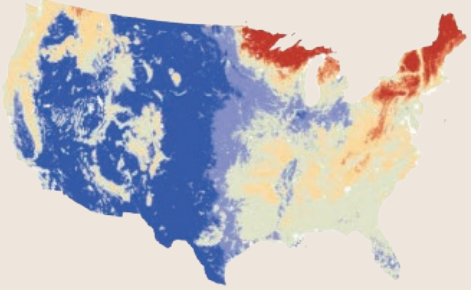
Ecological Provinces of Minnesota



Map: C. Nelson, Data: MNGEO

a tree falls and creates a gap in the canopy, whereas other species such as Yellow-bellied Sapsucker require large trees in mature forests for foraging and nest sites. Others still, such as Golden-winged Warbler, nest in young forests and shrubby wetland habitats that have retained trees and a dense shrub layer.

Larger, contiguous forest patches generally favor one suite of bird species that thrive in interior forest habitat, while smaller patches favor others that utilize forest edge habitat. Landscape-level factors also influence habitat quality which can alter microclimate and vegetation structure, affecting nesting success and foraging opportunities. Importantly, bird species respond to habitat and landscape features at different scales and throughout their annual cycle. For example, some species are associated with fine-scale variations within a forest patch, while others are more influenced by broad-scale patterns of forest cover and fragmentation. Habitat requirements and resources often change throughout the breeding season, and landscape context can be an important influence on juvenile survival. Promoting diverse habitats using forest management activities that mimic natural disturbances (i.e., "ecological forestry") can help provide a mosaic of tree ages, sizes, and configurations within stands and across the landscape.



The number of species that may be found on a forested breeding bird survey route.

Forest Ecology and Management

Minnesota forests, when functioning as healthy, intact, and resilient ecosystems, can play a critical role in reversing the population declines of forest birds. The relationship between humans and forests has been intricate and long-standing. Indigenous populations in the region, for instance, used fire as a tool to manage the landscape, promoting the growth of young vegetation that supported wildlife. European settlers in the late 19th and early 20th centuries had a significant impact on forest ecosystems, as they logged vast areas and disrupted patterns of disturbance and dramatically altered forest composition. Historically, natural disturbances like wind events and lightning-caused wildfires occurred throughout the forested landscape, eliminating groups of mature trees and creating space for young trees to regenerate. These uneven-aged pockets of trees created more resilient, structurally diverse forests. The recommendations in this guide strive to mimic natural disturbances using forest management techniques that increase or create beneficial habitat features for forest birds and wildlife while promoting ecologically resilient forests.

Sustainable forest management is crucial for balancing the diverse needs of ecosystems and human society. It considers the long-term health and resilience of forests while providing essential ecosystem services like clean water, wildlife habitat, and carbon sequestration. These management activities, which include timber harvesting, are carried out on a small fraction of the total forest area, typically around 1% of Minnesota's forests in any given year. Minnesota has a variety of tools that help educate and promote the use of sustainable forestry practices, including the Minnesota Forest Resource Council's voluntary site-level guidelines, forest certification standards, and the Minnesota Logger Education Program.

The scientific understanding of the dynamics of forest ecosystems has evolved significantly with the integration of advanced methodologies and interdisciplinary approaches. These scientific advancements have led to a deeper understanding of the role of forests in the global carbon cycle, their influence on climate, and the potential impacts of climate change on forest ecosystems. For instance, forest management strategies can be designed to enhance the capacity of forests to act as carbon sinks, thereby contributing to climate change mitigation efforts. As the world continues to grapple with the challenges of environmental change, the scientific study of forest dynam-

ics will be crucial in informing evidence-based policies and management practices that ensure the long-term sustainability and resilience of these vital natural resources.

Forest Habitat Types

Minnesota is home to nearly 18 million acres of forests[6], about 1/3rd of the state, and a diverse selection of forest types, each with a unique composition of tree species, herbaceous plant cohorts, soil types, and associated landforms. The U.S. Forest Service has recorded 71 different tree species in Minnesota.[7] This guide is focused on the four most common forest habitat type associations, which are grouped by tree species similarity, relation to one another on the landscape, and similar habitat features for Forestry for Minnesota Birds priority species. They are further broken down into seven subtypes to reflect important forest management differences. The four primary types are: **upland conifer, upland deciduous and mixed-conifer, lowland conifer, and bottomland hardwood.** The seven subtypes are pine, aspen-birch, oak, northern hardwoods, black spruce-northern white cedar-tamarack, black ash, and bottomlands. It is important to note the most abundant tree species found within each group help define it while being aware many other tree species can be found within a given forest habitat type. Nearly every forest stand exists on a continuum, often having minor components of other types within.

The forest habitat types used in this guide reflect how birds see, forage, nest, and shelter in forests, which may be different from how foresters or land management agencies classify forests. Birds are often more sensitive to structural characteristics such as tree age and size, canopy density, the presence or absence and distribution of different-sized gaps in the overstory tree canopy, presence or absence of a well-developed mid-story or shrub layer, and ground vegetation, rather than specific tree species. The four primary types reflect the bird's perspective, while the seven sub-types reflect differences in ecology, disturbance regime (native plant community system), and important silvicultural (i.e., forest management) differences and more closely align with traditional forest cover type classifications used by foresters in the state. Detailed information about the forest habitat ecology and common silvicultural systems are available in the appendices.

Saw-whet Owl. © Ryan Pennesi

How to Manage Bird-Friendly Forests

Managing bird-friendly forests can be broken down into six steps:

1. Setting Goals

People own forests for a variety of reasons. Some have inherited land, others have acquired it recently, and others manage land on behalf of federal, state, or county agencies or for tribes, industry, and non-profits or other entities. Some rarely visit their woodland, while others intimately know the trees and terrain. Many landowners enjoy viewing or hunting wildlife on their property. For some landowners, monetary revenue from their land is important, and for others it is not. The first step in developing any forest management plan is to articulate the owner's goals for their land. Fortunately, the values of wildlife, recreation, scenic beauty, and financial benefits are compatible, especially over the long term.

2. Assessing Habitat

Forest management plans include a description of the forest stand conditions. In addition to measuring timber volume, these stand descriptions can include assessing different aspects of habitat value. For example, a forest inventory can include an estimate of dead and dying trees for suitable habitat or large logs on the ground. Getting to know the birds on your property can help you understand how they utilize forest features. How healthy are the trees in your forest? What kind of habitat does the forest provide, and how much quality habitat is used by birds and other wildlife? What seems to be missing? Table 1 provides an overview of key habitat features that are important for Minnesota's breeding birds. Additional details and descriptions of these features can be found in Appendix A. Moreover, we provide a *Forest Habitat Assessment Worksheet* that can aid in identifying habitat features and opportunities for management (Appendix D).

3. Picturing the Future Forest

Based on the current state of the forest, a forester can provide recommendations for forest management options that put the forest on a path toward fulfilling the landowner's goals. What would you like to see in your forest? Based on site conditions, what is possible? What birds will benefit from thoughtful tending of the woods? When picturing the future forest, it is important to imagine what the woods will look like right after a harvest, then five and ten years later, and decades later. It can also be important to consider what the forest might look like if there is no harvest, if rotation ages are extended, or if other management options are considered. The forest is ever-changing, and the wildlife that call it home constantly change with the evolving landscape.

4. Making a Plan

A forest management plan written by a professional forester should include prescriptions for each forest stand on a property. These prescriptions are rooted in silviculture, the science of why trees grow the way they do, and the art of manipulating the growing space of those trees to maximize the forest's long-term health and productivity. A management plan can also include recommendations that benefit forest birds and other wildlife. When landowners and foresters "see the forest for the birds," it becomes easier to work together and incorporate bird habitat enhancements into the management plan.

5. Implementing a Plan

Foresters work with landowners and use their knowledge to oversee timber harvests. Loggers are also guided by the landowner's forest management plan through communication with the forester. This makes communication between the forester and the landowner a critical component of the process to ensure landowner goals are met.

6. Assessing Outcomes

If forest management activities were implemented, it's important to assess how successful those activities were in achieving the goals identified when making the plan and envisioning the future forest. Were the expected results achieved? Are there follow-up actions that could take place, and on what timeline? All actions should be based on site conditions, the landowner's goals and objectives, and a well-thought-out forest management plan. Actions should be reassessed periodically to assure the actions implemented are effective and, if not, adjusted as needed.

TABLE 1: **Overview of Key Habitat Structures and Importance for Minnesota Bird Species**

Vertical structure diversity/ canopy cover	Vertical structure diversity, or differing levels of canopy cover in the over-, mid-, and understory, provides habitat to many forest breeding birds.
Horizontal structure diversity	Diversity in horizontal structure, or the arrangement of species and woody structure on a plane parallel to the ground, provides habitat to many forest breeding birds.
Canopy gaps ("gaps")	Create canopy openings that allow sunlight to penetrate down to the forest floor to help regenerate desired tree species and to diversify habitat for forest breeding birds.
Native biodiversity/ invasive species	Manage to create a diversity of native forest plants to ensure that birds have available food sources, including insects and mast. Eliminate invasive plants that may interfere with tree and shrub regeneration.
Large-diameter trees	Provides structural elements for nesting, roosting, perching, and feeding habitat for many forest breeding birds. Can become large snags, cavities, and down woody material over time.
Conifer inclusions	Retain or create clusters of conifer trees, for habitat, winter shelter, and to increase forest resilience to climate change and other stressors.
Snags or cavity trees	Provides structural elements for nesting, roosting, perching, and feeding habitat for many forest breeding birds.
Downed woody material	Provides structural elements for ground nesting birds as well as habitat for invertebrate food sources.
Leaf litter and duff	An adequate layer of duff is essential to ground-nesting birds and invertebrate populations; in oak-dominated hardwood forests, it may hinder natural oak regeneration.
Riparian and wetland forests	Water features, including seasonal ephemeral ponds, and the surrounding vegetation provide beneficial habitat elements for forest bird breeding and migrating birds.

Minnesota Focal Forest Bird Species

For each forest habitat type, we identified 3–4 bird species that are indicators of high-quality habitat at various successional stages (i.e., developmental stages of a forest over time). Additional consideration was given to species that are common, charismatic, and relatively easy to identify, species that perform vital roles in forest ecosystems (e.g., cavity excavation), and species that are of conservation concern in Minnesota.

Each of the 18 focal species are described in detail on the following pages, which are organized by forest cover types. These accounts include a photo, a description of each bird's characteristics and sounds, and strategies for enhancing habitat for the species.

Each account also includes at least one icon from each of the categories below to identify key habitat needs. Additionally, we've created habitat feature cross- sections that highlight the key habitat characteristics each species is looking for in the forest. The cross- sections illustrate the key habitat features to recognize and enhance for each species. They also indicate where you are likely to find the birds' nests.

We used the results of the population trends from the Breeding Bird Survey (BBS, 1966–2019) at the range-wide and Minnesota-only scales. It should be noted that trends at the two different scales do not always reflect the same trajectory. For example, some species may show range-wide population declines but stable populations in Minnesota (e.g., Golden- winged Warbler). Conversely, some species are declining in Minnesota but are stable range-wide (e.g., Ruffed Grouse). The terminology used to describe the significance of the trends aligned with terminology used by the Breeding Bird Survey (i.e., increasing,

stable (no significant trend), decreasing). When BBS data was lacking, we also used trends from other relevant monitoring programs[8, 19] to provide additional insight into forest bird population trends.

Partners in Flight (PIF) Continental Concern Score is based on a combination of the species' global population size, global breeding and non-breeding distribution, threats to its breeding and non-breeding range in North America, and its overall population trend in North America. Scores are ranked from low conservation need (populations are stable or increasing) to high conservation need (populations are declining or have declined significantly or are threatened) as developed by Partners in Flight and reported in the Minnesota Breeding Bird Atlas.[5]

Species of Greatest Conservation Need (SGCN) are native animals, nongame and game, whose populations are rare, declining, or vulnerable to decline and are below levels desirable to insure their long-term health and stability in the state. This list is developed by the Minnesota Department of Natural Resources and approved by the U.S. Fish and Wildlife Service. Also included are species for which Minnesota has a stewardship responsibility, because the majority of the existing population breeds within the state. All state listed species and federally listed species that occur in Minnesota are automatically SGCN. Additional non-listed species are SGCN based on specific criteria and expert review.[9]

A climate vulnerability score (low, moderate, or high vulnerability) provides insight into how much a bird species range will be impacted with a **3°C** (5.4°F) **rise in average global temperatures by 2080.** We present the climate vulnerability scores related to the model, which assumes that if nothing is done to reduce global carbon and greenhouse gas emissions, we will experience a 3°C increase in average global temperatures. **Climate vulnerability** is a function of a bird species' exposure to climate change, sensitivity (projected current range loss), and its adaptive capacity (the ratio of projected range gain to loss). For more specific climate vulnerability information for selected birds, visit audubon.org/climate/survivalbydegrees.[10]

For additional information on bird species' population trends, range, and distribution, visit AllAboutBirds.org.[11]

Community Associates: Bird species that are commonly found in similar habitats with priority species.

Habitat Features & Management Recommendations: This section describes the unique habitat and stand-level features that are used during different stages of the breeding season. Management recommendations focus first on the site level and then may address landscape level considerations.

FOCAL BIRD SPECIES IN MINNESOTA


Blackburnian Warbler


Magnolia Warbler


Pine Warbler


American Woodcock


Canada Warbler


Golden-winged Warbler


Pileated Woodpecker


Ruffed Grouse


Red-headed Woodpecker


Scarlet Tanager


Wood Thrush


Yellow-bellied Sapsucker


Connecticut Warbler


Golden-crowned Kinglet


Winter Wren


Cerulean Warbler


Prothonotary Warbler


Yellow-billed Cuckoo

KEY TO SPECIES PROFILES

Canopy Gaps: Openings in the forest canopy that allow more light to reach the mid- and understory layers.

Down Woody Material: Logs and limbs on the forest floor.

Forest Structure: Arrangement of woody vegetation in the forest; may be classified as the following layers:

- **Overstory:** Uppermost layer of forest vegetation including twigs, branches, cavities, and trunks in the tallest trees.
- **Midstory:** Intermediate layer of forest vegetation including young trees and shrubs.
- **Understory:** Lower layer of forest vegetation including tree seedlings, small shrubs, grasses, and herbaceous vegetation.

Hardwoods: Broad-leaved deciduous trees.

Leaf Litter: Fallen leaf accumulation on the forest floor.

Snags: Standing dead trees.

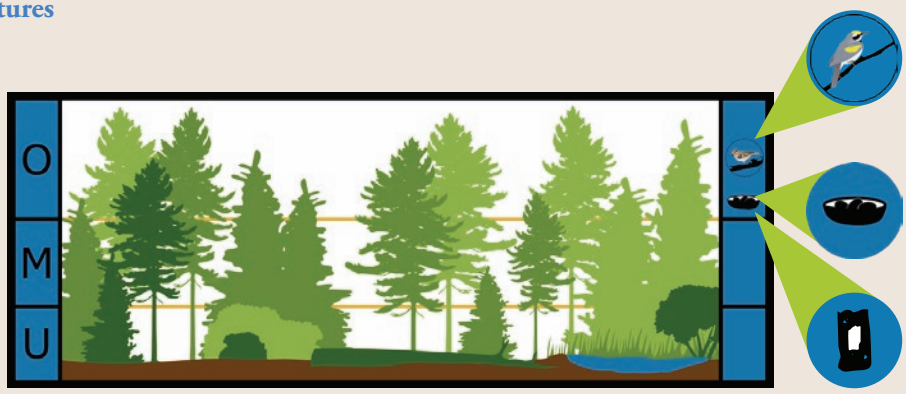
Softwoods: Coniferous trees with needles.

Migration:

- **Resident:** Year-round resident of Minnesota;
- **Short-distance migrant:** Breeds in Minnesota and winters in the Southern U.S.;
- **Medium-distance migrant:** Breeds in Minnesota and winters in the Caribbean, Central America, and Mexico.
- **Long-distance migrant:** Breeds in Minnesota and winters in South America.

Key to Habitat Features

FOREST STRUCTURE: Yellow lines divide overstory (O), midstory (M), and understory (U).



BIRD: Indicates in which layer birds typically sing and forage.

NEST: General nest placement and type (cavity nest or cup nest).

Vegetation Key

CONIFERS HARDWOODS SNAGS SHRUBS FERNS LEAF LITTER DOWN WOOD

Habitat illustrations created by Dakota Wagner, Forest Stewards Guild.

Blackburnian Warbler *(Setophaga fusca)*

© Trent Jonas, iNaturalist

BACKGROUND: Blackburnian Warbler is a medium- to long-distance migrant that primarily breeds in the Appalachian Mountains and boreal forest of eastern North America and winters in southern Central America and northwestern South America. In Minnesota, they are found in the northern portion of the state and breed in white pine forests, mature aspen-spruce-fir, jack pine, and red pine forests. Blackburnian Warblers are black and white with a bright orange face and throat. Their song is a rapid *"zip zip zip zip zip zip zip zip tititiiti tseeeeee."* They eat arthropods (e.g., insects and spiders) , including spruce budworm, gleaned from foliage of conifers. Nests are found in the canopies of coniferous trees.

POPULATION STATUS: Blackburnian Warbler populations have been declining but are considered stable in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Stable	Moderate	No	High

COMMUNITY ASSOCIATES: Canada Warbler, Magnolia Warbler, Mourning Warbler, Northern Parula, Ruby-crowned Kinglet, Swainson's Thrush, White-throated Sparrow, Winter Wren

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Blackburnian Warblers breed in mature, upland conifer-dominated forests with diverse age classes, dense canopy cover (>75% canopy cover), and a dense midstory. They require large, contiguous forests with components of large overstory white spruce, balsam fir, and white pine. Recommended management actions include: 1) Maintain or increase the conifer component, particularly where white spruce or white pine are present, 2) Promote structural diversity by using variable retention harvesting or other similar strategies, and 3) Use a patchwork of large-gap management to create a shifting mosaic of spruce and fir in diverse age classes across the landscape.

Magnolia Warbler *(Setophaga magnolia)*

© mannac, iNaturalist

BACKGROUND: Magnolia Warbler is a short- to medium- distance migrant that breeds in the Appalachian Mountains and boreal forest of North America and winters in the Southern U.S., Mexico, the Caribbean, and Central America. In Minnesota, they are found in forests dominated by young balsam fir and white spruce. Magnolia Warblers have a black mask and neckband along with yellow throats and bellies. Their song is a short, whistled *"sweet, sweeter, SWEETEST."* They forage on arthropods, particularly caterpillars, including spruce budworm, and spiders gleaned from foliage. Magnolia Warbler nests are found in conifer trees near the ground.

POPULATION STATUS: Magnolia Warbler populations are considered stable range-wide, including in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Stable	Stable	Low	No	High

COMMUNITY ASSOCIATES: Black-throated Blue Warbler, Canada Warbler, Chestnut-sided Warbler, Mourning Warbler, Nashville Warbler, Northern Parula, Ruby-crowned Kinglet, Swainson's Thrush, White-throated Sparrow, Winter Wren

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Magnolia Warblers breed in young, dense conifer forests usually dominated by balsam fir and white spruce. It is also commonly found in mixed forests that have conifer in the understory. Recommended management actions include: 1) Retain conifer trees and softwood inclusions especially in dense patches, and 2) Create dense patches of young conifers by planting or seeding to increase horizontal and vertical structures, and 3) Increase conifer component across the landscape.

Pine Warbler *(Setophaga pinus)*

© tate.putman, iNaturalist

BACKGROUND: Pine Warbler is a short-distance migrant that breeds throughout the eastern forests of the United States and winters in the Southeast. In Minnesota, it is a common inhabitant of the northern forests in pine or mixed pine-deciduous forests. Pine Warblers are yellowish birds with olive backs, whitish bellies, and two prominent white wing bars on gray wings. Their song is a fast trill of 10–30 notes, usually on one pitch, lasting a few seconds. They forage on caterpillars and arthropods and are the only warbler that eats large amounts of seeds. Nests are in the tops of conifer trees.

POPULATION STATUS: Pine Warbler populations are increasing range-wide, including in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Increasing	Increasing	Low	No	High

COMMUNITY ASSOCIATES: Chipping Sparrow, Hermit Thrush, Nashville Warbler, Red-breasted Nuthatch

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Pine Warblers breed in mature coniferous forests that have dense canopy cover and contain large white and red pines. They may use harvested areas, as long as mature pine trees have been retained. Recommended management actions include: 1) Retain or increase the conifer component, particularly where red or white pine are present, and 2) Create or maintain structurally diverse pine forests with multiple age classes using variable retention harvesting practices, and 3) Retain mature, large diameter trees when possible.

American Woodcock *(Scolopax minor)*

© Sam Wegner, iNaturist

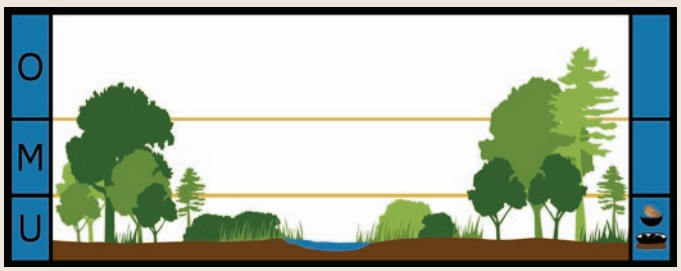
BACKGROUND: American Woodcock is a short-distance migrant that breeds across the eastern half of North America and winters in the southern U.S. In Minnesota, they are found throughout the forested region of the state in shrubby, young, deciduous forests. American Woodcocks have light brown, black, buff, and gray feathers and have a long, straight bill. They have a buzzy, nasal "peent" while on the ground. In the air, males chirp melodically for up to 15 seconds while displaying. They forage on the forest floor by probing moist soil for earthworms and other invertebrates. Nests are on the ground.

POPULATION STATUS: American Woodcock populations are declining range-wide, including in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Declining	Moderate	Yes	Moderate

COMMUNITY ASSOCIATES: American Redstart, Chestnut-sided Warbler, Golden-winged Warbler, Mourning Warbler, Ruffed Grouse, Veery

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: American Woodcock breed in a matrix of young to mature deciduous and mixed forests. Males use recently cut areas and forest openings for territorial breeding displays. Females use multiple seral stages (i.e., forest ages) for rearing their broods. Recommended management actions include: 1) Create small openings for male territorial displays, 2) Promote growth of dense shrubs or saplings and retain downed woody materials to provide cover for nests and brood-rearing, 3) Use a patchwork of even-aged management to create a shifting mosaic of diverse age classes of deciduous and mixed forests across the landscape, and 4) Refer to detailed management recommendations for this species, which are available in Appendix C.



Canada Warbler *(Cardellina canadensis)*

© mannac, iNaturalist

BACKGROUND: Canada Warbler is a long-distance migrant that breeds in the Appalachian Mountains and boreal forest of North America and winters in northern South America. In Minnesota, they are found in the northern portion of the state and breed in mixed forests with a dense understory and often near riparian zones. Canada Warblers have a gray back with yellow underparts and a distinct black "necklace" across their chest. Their song often has an introductory chip note "t" followed by a cheerful "chip chip dippity chipety dip." They forage on insects and spiders on foliage and in leaf litter. Nests are on the ground under dense shrubs or ferns.

POPULATION STATUS: Canada Warbler populations are declining range-wide but are currently stable in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Stable	High	No	High

COMMUNITY ASSOCIATES: Black-throated Blue Warbler, Mourning Warbler, Northern Parula, Ovenbird, Red-eyed Vireo, Winter Wren

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Canada Warblers use a variety of cover types but prefer upland deciduous and mixed forests. They breed in forests with a structurally diverse canopy that have a dense mid- and understory and are often found in moist riparian areas. Recommended management actions include: 1) Use group selection to create gaps of 0.5–2 acres to promote second growth and dense shrub layers, 2) Promote understory diversity and transitional zones (feathered edges) between open areas and mature forest, and 3) Detailed management recommendations for this species can be found in Appendix C.

Golden-winged Warbler *(Vermivora chrysoptera)*

© Ryan Pennesi

BACKGROUND: Golden-winged Warbler is a long-distance migrant that breeds in the Appalachian Mountains, Upper Midwest, and southern Canada and winters in Central and South America. In Minnesota, it is distributed throughout the northern portion of the state in young forests and shrubby wetlands. Golden-winged Warblers are small and gray with golden coloring on the head and wings, and males have a distinct black throat and mask. They have a two-part song that starts with a long, high-pitched note followed by shorter notes: "bee-bz-bz-bz." They forage on foliage and have a preference for leafroller caterpillars. Nests are on or just above the ground.

POPULATION STATUS: Golden-winged Warbler populations are declining range-wide but are currently stable in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Stable	High	Yes	High

COMMUNITY ASSOCIATES: Alder Flycatcher, American Redstart, American Woodcock, Chestnut-sided Warbler, Common Yellowthroat, Mourning Warbler, Veery, Yellow Warbler

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Golden-winged Warblers breed in young forest and shrubby wetland habitats with adjacent forest of more mature age classes. This species uses a diverse mix of forest ages for breeding and post-fledging movement. Habitat characteristics include dense patches of herbaceous vegetation and shrubs with scattered mature trees that provide 10–30% canopy cover. Recommended management actions include: 1) Create young forest patches with retained shrub clumps and 10–15 residual overstory "perch trees" per acre, 2) Create transitional zones (feathered edges) between open areas and mature forest, 3) Use a patchwork of even-aged management to create a shifting mosaic of diverse age classes of deciduous forests across the landscape, and 4) Detailed management recommendations for this species can be found in Appendix C.

Pileated Woodpecker *(Dryocopus pileatus)*

© John Krampl, iNaturalist

BACKGROUND: Pileated Woodpecker is a year-round resident throughout eastern North America and the boreal forest. In Minnesota, they are found in mature deciduous or mixed deciduous-coniferous woodlands throughout the forested portion of the state. Pileated Woodpeckers are a large black and white woodpecker with a distinctive red crest. Their call is a repetitive "wuk, wuk, wuk." They are bark gleaners and excavators that forage primarily on ants and larvae of wood- boring beetles. They also often forage on downed woody material. Pileated Woodpeckers nest in cavities that they excavate in large trees. Their abandoned cavities are in turn used by several other species of birds and mammals.

POPULATION STATUS: Pileated Woodpecker populations are increasing range-wide, including in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Increasing	Increasing	Low	No	Low

COMMUNITY ASSOCIATES: Black-throated Green Warbler, Eastern Wood-Pewee, Hermit Thrush, Least Flycatcher, Ovenbird, Red-eyed Vireo, Rose-breasted Grosbeak, Ruffed Grouse, Scarlet Tanager, White-breasted Nuthatch, Yellow-bellied Sapsucker

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Pileated Woodpeckers breed in mature deciduous or mixed deciduous forests. Large-diameter trees (>16 inches diameter at chest height) are used for nesting, roosting, and foraging. Recommended management actions include: 1) Maintain the presence of large-diameter trees, 2) Retain live and snag trees as well as large, downed wood, and 3) Ensure intact landscape with diverse age classes with a high percentage of mature, large trees.

Ruffed Grouse *(Bonasa umbellus)*

© Ryan Pennesi

BACKGROUND: Ruffed Grouse are year-round residents across the boreal forests and mountain ranges of North America and are widely distributed across Minnesota. In Minnesota, they are found in quaking aspen and early successional to mature hardwood and mixed forests. Ruffed Grouse are well-camouflaged with the forest floor, with mottled browns, grayish, and reddish tones. Instead of singing, territories are defended by drumming the air with their wings while sitting on a log. They forage on leaves, fruits, and insects. Nests are on the ground.

POPULATION STATUS: Ruffed Grouse populations are stable range-wide but are declining in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Stable	Declining	Low	No	Moderate

COMMUNITY ASSOCIATES: American Redstart, Black-throated Green Warbler, Chestnut-sided Warbler, Eastern Wood-Pewee, Hermit Thrush, Mourning Warbler, Ovenbird, Red-eyed Vireo, Scarlet Tanager, Veery, Wood Thrush, Yellow-bellied Sapsucker

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Ruffed Grouse breed in an interspersed matrix of young to mature deciduous and mixed forests, especially those where logging, burning, and other disturbances create patches of early successional forests within a landscape of mature forest. They prefer hardwood or aspen stands with dense overstory cover. Recommended management actions include: 1) Implement management strategies that create or maintain dense understories, 2) Retain downed logs over 10-inches in diameter, 3) Maintain or create a shifting mosaic of diverse age and size classes of forests across the landscape through a patchwork of small even-aged management disturbances or through small group selection, 4) Keep forest stands connected without breaks 5) Detailed management recommendations for this species can be found in Appendix C.

Red-headed Woodpecker *(Melanerpes erythrocephalus)*

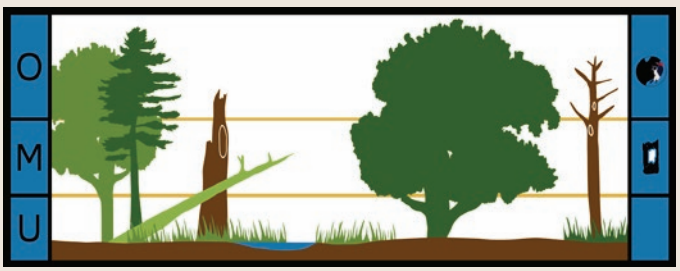
BACKGROUND: Red-headed Woodpecker is a short-distance migrant that primarily occurs in the eastern and central United States and may spend winters just south of where it breeds. In Minnesota, they are regular breeders in the southern and western portions of the state and utilize oak savanna habitats and woodlands with a fairly open canopy such as flooded wet forests. Red-headed woodpeckers have a bright red head, white belly, and black and white wings. Their song is a shrill churr. They forage on a variety of seeds, insects, and fruits. Nests are excavated in dead or dying trees, and they also use existing cavities.

POPULATION STATUS: Red-headed Woodpecker populations are declining range-wide, including in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Declining	Moderate	Yes	High

COMMUNITY ASSOCIATES: Eastern Bluebird, Eastern Wood-Pewee, House Wren, Tree Swallow, White-breasted Nuthatch, Wood Thrush, Yellow- throated Vireo

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Red-headed Woodpeckers breed in oak or pine savannas or woodlands with a relatively open canopy, clear understories, and dead trees or snags available for nesting. Recommended management actions include: 1) Retain or create large-diameter snags, especially along forest edges, 2) Retain oaks, and 3) Create or maintain an open understory using techniques such as brushing or prescribed fire, 4) Maintain or increase large diameter trees in agricultural areas, especially in shelterbelts, 5) Grazing/pasture can create and maintain an open understory.



Scarlet Tanager *(Piranga olivacea)*

BACKGROUND: Scarlet Tanager is a medium- to long-distance migrant that breeds in the deciduous forests of eastern North America and winters in Panama and northwestern South America. In Minnesota, they are found in mature deciduous or mixed forests. Scarlet Tanagers are slim, bright red birds with jet- black wings and a tail. Their song is described as a "raspy robin" and a distinctive "chick-burr" call note. They forage on insects found in the forest foliage or by catching flying insects from a perch (i.e., "hawking"). Nests are found high in the canopy of deciduous trees.

POPULATION STATUS: Scarlet Tanager populations are slightly declining range-wide, including in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Slighty Declining	Declining	Moderate	No	High

COMMUNITY ASSOCIATES: Black-throated Green Warbler, Eastern Wood-Pewee, Hermit Thrush, Least Flycatcher, Ovenbird, Red-eyed Vireo, Rose-breasted Grosbeak, White-breasted Nuthatch, Wood Thrush, Yellow-bellied Sapsucker

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Scarlet Tanagers breed in mature deciduous and mixed forests and are often associated with oak-dominated forests. They are sensitive to habitat fragmentation and require large, intact forest blocks. Recommended management actions include: 1) Preserve, enhance, or create an oak component and provide scattered large overstory trees, 2) Consider crop-tree release strategies or single-tree selection to promote dense canopies, and 3) Retain large tracts of forest across the landscape.

Wood Thrush *(Hylocichla mustelina)*

© cebye, iNaturalist

BACKGROUND: Wood Thrush is a medium- distance migrant that breeds in the deciduous forests of eastern North America and winters in southern Mexico and Central America. In Minnesota, they are found in the forested region of the state and breed in deciduous and mixed-conifer forests. Wood Thrush are a robin-sized bird with a brown back, a heavily spotted white breast, and warm reddish-brown upperparts. Their song is a flute-like "ee-oh-lay." They forage on the ground and consume a variety of insects (primarily soil invertebrates) and fruits. Nests are an open cup and placed on a lower limb of a tree or shrub in the sub- canopy or understory.

POPULATION STATUS: Wood Thrush populations are declining across their range; however, they are increasing in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Increasing	High	Yes	High

COMMUNITY ASSOCIATES: Eastern Wood-Pewee, Great-crested Flycatcher, Ovenbird, Red-eyed Vireo, Scarlet Tanager, White-breasted Nuthatch, Yellow-throated Vireo

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Wood Thrush breed in mature mesic upland forests, showing a strong preference for mature northern hardwood and aspen forests. They use forests with a diverse canopy, moderate density of understory shrubs, and an open forest floor with thick leaf layer. Recommended management actions: 1) Consider single-tree or group selection harvest to maintain mature forest conditions and promote a diverse understory, 2) Maintain large tracts of mature forest with 12 inches or greater diameter trees and >80% canopy cover with diverse understories and abundance of leaf litter, and 3) Detailed management recommendations for this species can be found in Appendix C.

Yellow-bellied Sapsucker *(Sphyrapicus varius)*

© Ryan Pennesi

BACKGROUND: Yellow-bellied Sapsucker is a short- to medium-distance migrant that is widely distributed across the Appalachian Mountains and boreal forest of North America and winters in the Southern U.S., Mexico, the Caribbean, and Central America. In Minnesota, Yellow-bellied Sapsuckers are found in upland deciduous and mixed forests throughout the state. Yellow-bellied Sapsuckers are black and white woodpeckers with a red forehead, black bib, white wing patch, and a yellowish wash across the belly. Their call is a loud *"QUEEAH";* their drum starts out rapidly, then tapers out to single taps. They forage on sap from a diversity of woody plant species by drilling and maintaining sap wells along the trunk below the crown and also consume fruit, insects, and inner bark cambium layers, and are known to fly- catch. Cavities for nesting are excavated in dead or live trees with a central decay column.

POPULATION STATUS: Yellow-bellied Sapsucker populations are increasing range-wide and are stable in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Increasing	Stable	Low	No	High

COMMUNITY ASSOCIATES: Black-and-white Warbler, Great-crested Flycatcher, Pileated Woodpecker, Ruby-throated Hummingbird, Wood Thrush

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Yellow-bellied Sapsucker breed in mature deciduous to mixed deciduous-coniferous forests and also use northern hardwood and floodplain forests. They require trees greater than 9 inches DBH for nesting with a strong preference for aspen. Recommended management actions include: 1) Retain live and dead trees of various sizes and trees bearing sapwells, 2) Leave snags and cavity trees in clusters or centered around sapwell-bearing trees and in untreated areas, and 3) Use a patchwork of even-aged management to create a shifting mosaic of diverse age classes of deciduous forests across the landscape.

Connecticut Warbler *(Oporornis agilis)*

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BACKGROUND: Connecticut Warbler is a long-distance migrant that breeds in a narrow range of boreal forests in Canada, Michigan, Wisconsin, and Minnesota and winters in South America. In Minnesota, they breed in the northern portion of the state in lowland conifer forests dominated by black spruce and tamarack. Connecticut Warblers are a larger-bodied warbler, with a gray hood, white eye- ring and yellow underparts. Their song consists of a repetition of "chippy-choppy" notes. They forage on or just above the ground for insects, spiders, and other arthropods. Nests are typically built on the ground in sphagnum moss and are well hidden by dense overgrowth.

POPULATION STATUS: Connecticut Warbler populations are declining range-wide, including in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Declining	Moderate	Yes	High

COMMUNITY ASSOCIATES: Boreal Chickadee, Dark-eyed Junco, Golden-crowned Kinglet, Nashville Warbler, Palm Warbler, Ruby-crowned Kinglet

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Connecticut Warblers breed in mature, lowland coniferous forests consisting of moderately scattered black spruce and tamarack. They are structure specialists that prefer forests with semi-open canopy and a rich ground layer of sphagnum moss with a uniform low shrub understory. Recommended management actions: 1) Avoid clearcutting. If harvest is necessary, consider strip-cuts, group selection, single tree selection or variable density thinning to promote structurally diverse canopy and understory, and 2) Maintain large tracts of black spruce and tamarack.

Golden-crowned Kinglet *(Regulus satrapa)*

© andrewdressel, iNaturalist

BACKGROUND: Golden-crowned Kinglet is a short-distance migrant that breeds in boreal and montane coniferous forests of North America and winters in the Southern U.S. In Minnesota, they are found in the northeastern portion of the state in lowland conifer forests. Golden- crowned Kinglets are a tiny bird that have a bright yellow and orange crown patch with black and white stripes on the face. Their song is a series of high- pitched "tsee" notes, followed by a musical warble at the end. They glean small arthropods from canopy foliage. Nests are built in the tops of conifer trees.

POPULATION STATUS: Golden-crowned Kinglet populations are declining range-wide but are stable in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Stable	Low	No	Moderate

COMMUNITY ASSOCIATES: Boreal Chickadee, Canada Jay, Hermit Thrush, Nashville Warbler, Swainson's Thrush, Winter Wren, Yellow-bellied Flycatcher, Yellow-rumped Warbler

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Golden-crowned Kinglets breed in lowland conifer forests but also use other conifer habitats that feature mature, dense forests with large trees. Recommended management actions include: 1) Emulate natural disturbance regimes such as fire when harvesting, including patch retention, particularly in areas dominated by conifers, 2) Consider strip-cuts, group selection, single tree selection, or variable density thinning if harvest is necessary, and 3) Retain mature, older lowland conifer forests across the landscape.

Winter Wren *(Troglodytes hiemalis)*

© matthew6416, iNaturalist

BACKGROUND: Winter Wren is a short-distance migrant that breeds in the Appalachian Mountains and boreal forest of North America and winters in the Southern U.S. In Minnesota, they are found most abundantly in the northern part of the state in lowland hardwood forests but also breed in conifer and mixed conifer forest stands. Winter Wrens are tiny, plump brown birds with dark barring on the wings, tail and belly, and a stubby tail. Their song consists of a long series of bubbly, musical, bell-like notes. They forage on the forest floor and lower undergrowth for a wide variety of insects, spiders, and other arthropods. They build nests in brush piles, in natural cavities associated with upturned trees or rotten tree stumps or snags.

POPULATION STATUS: Winter Wren populations are stable range-wide but decreasing in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Stable	Declining	Low	Yes	High

COMMUNITY ASSOCIATES: Black-throated Blue Warbler, Black-throated Green Warbler, Brown Creeper, Northern Parula, Northern Waterthrush

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Winter Wrens occupy a wide variety of forest cover types but generally are associated with mature lowland hardwood forests. Moderately wet conditions along with coarse woody debris and upturned roots at the base of fallen trees are common at most breeding sites. Recommended management actions include: 1) Use "messy" forestry techniques, leaving coarse woody debris, downed logs, upturned roots, stumps, and snags, 2) Consider habitat enhancements such as girdling trees to create downed logs, retaining slash piles and light, variable spaced thinning to enhance understory development, 3) If harvest is necessary, use strip-cuts, group selection, single tree selection, and variable density thinning to maintain mature forest conditions, and 4) Maintain large tracts of unfragmented mature forest.

Cerulean Warbler *(Setophaga cerulea)*

© dejackson2256, iNaturalist

BACKGROUND: Cerulean Warbler is a long- distance migrant that breeds throughout the eastern United States and in the lower Great Lakes Region of Canada and winters in northern South America. In Minnesota, they are found in the southeast portion of the state in riparian areas and breed in lowland hardwood and forested wetlands. Cerulean Warblers have a blue head and back, white throat and belly, and two white wing-bars. Their song is a series of three short buzzy notes followed by four fast warbles and ends with a higher-pitched buzzy trill. They forage on small insects and other arthropods found on leaves in the canopy. Nests are open cups, usually placed high near canopy gaps of deciduous trees.

POPULATION STATUS: Cerulean Warbler populations are declining range-wide, including in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Declining	High	Yes	High

COMMUNITY ASSOCIATES: Acadian Flycatcher, Louisiana Waterthrush, Prothonotary Warbler, Wood Thrush, Yellow-billed Cuckoo, Yellow-throated Vireo

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Cerulean Warblers breed in lowland forests with mature deciduous trees and a structurally diverse canopy with approximately 85% canopy cover and scattered small to medium forest openings. Recommended management actions include: 1) Retain and promote large-diameter trees (>16 inches DBH), 2) Create canopy gaps of 400-1,000ft^2 using group-selection to improve and promote early successional habitat and increase structural diversity, 3) Retain large tracts (1,700+ acres) of forest along riparian areas, and 4) Refer to detailed management recommendations for this species, which are available in Appendix C.

Prothonotary Warbler *(Protonotaria citrea)*

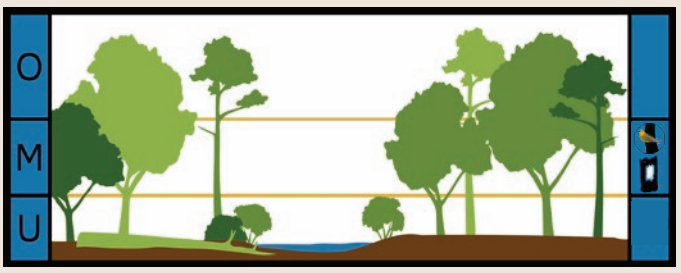
BACKGROUND: Prothonotary Warbler is a medium- to long-distance migrant that primarily breeds in the eastern and southeastern part of the United States and winters in Central and South America. In Minnesota, local populations can be found extending north along major river valleys, where they breed in lowland hardwoods and forested wetlands. Prothonotary Warblers are bright yellow birds with blue-gray wings. Their song is a loud series of 4–14 high-pitched notes, likened to shouting *"tweet-tweet-tweet-tweet."* They forage on a variety of arthropods throughout the subcanopy foliage, fallen logs, and tree branches. They are secondary cavity nesters that generally nest in the sub-canopy and canopies of forests.

POPULATION STATUS: Prothonotary Warbler populations are declining throughout their range, including in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Declining	High	Yes	Low

COMMUNITY ASSOCIATES: Cerulean Warbler, Red-headed Woodpecker, Wood Thrush, Yellow-bellied Sapsucker, Yellow-billed Cuckoo, Yellow-Throated Vireo

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Prothonotary Warblers breed in lowland hardwood forests that are seasonally flooded. These areas are characterized as having a relatively open understory, >50% canopy cover and are in areas where there is slow-moving water. They prefer stands that are over 250 acres in size. Recommended management actions include: 1) Retain dead and dying trees with potential nest cavities, 2) Ensure riparian buffers that are at least 100 feet wide, 3) Protect large, unfragmented stands of bottomland forests, particularly along the floodplains of major rivers, and consider planting to assist regeneration, and consider placing nest boxes in suitable habitat.



Yellow-billed Cuckoo *(Coccyzus americanus)*

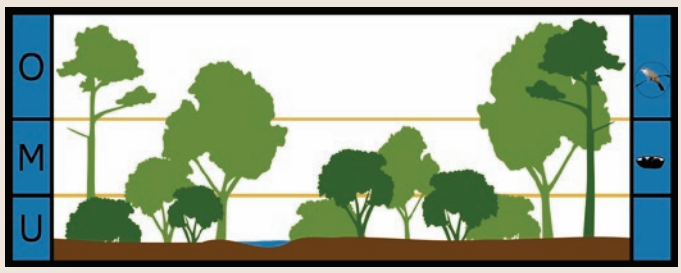
BACKGROUND: Yellow-billed Cuckoo is a long-distance migrant that breeds in the east, central, and southwest United States and the Great Lakes Region of Canada and winters in South America, especially east of the Andes Mountains. In Minnesota, they are found in temperate deciduous forests and breed in northern hardwoods, aspen forests, and lowland hardwoods. Yellow-billed Cuckoos are a jay- sized bird with a yellow bill, white breast and large white spots on its long tail. Their song is a slow cooing, with repetitive *"kow-kow-kow"* notes. They forage on large insects such as hairy caterpillars, cicadas, grasshoppers, crickets and Eastern tent caterpillars. Nests are typically built in thick vegetation within the understory and shrub layer.

POPULATION STATUS: Yellow-billed Cuckoo populations are declining range-wide and slightly declining in Minnesota.

Range-wide	MN	PIF	SGCN	Climate Vulnerability
Declining	Slightly Declining	Moderate	Yes	Low

COMMUNITY ASSOCIATES: Prothonotary Warbler, Wood Thrush, Yellow-throated Vireo

HABITAT FEATURES & MANAGEMENT RECOMMENDATIONS: Yellow-billed Cuckoos breed in lowland forests with dense shrubby vegetation such as willow and alder thickets. They will also use open woodlands with clearings that have a dense shrub layer that are near rivers and streams. Recommended management actions include: 1) Avoid harvesting in riparian areas, 2) Consider planting to maintain and diversify forested wetlands as well as dense young forests or shrubby wetlands, and 3) Avoid the use of pesticides that affect caterpillars.



Forest Management – Why?

Forests change. They change in response to natural events like windstorms and fires, they change in response to wildlife, insects, invasive species, and climate change. Forests even change by themselves over time as trees age and are replaced by others. Even if we do nothing ourselves, forests change.

Nearly every acre of trees in the state have been influenced by human hands over time. Some of the earliest Indigenous people in the state, moving north as the glaciers receded 10,000 years ago, used fire to promote new, young growth that helped feed game species like elk and woodland caribou, to clear brush to make hunting or travel easier, or to clear areas for habitation. Those fires also influenced the composition of the plant communities in this state. Today nearly 20% of Minnesota's Eastern-Broadleaf forests and over 30% of the Laurentian Mixed forest is classified as "fire dependent", meaning fire, or forest management implemented to replicate fire's effects, must be employed to keep them healthy and functioning and to keep the same tree species on the land. In the late 19th and early 20th century European settlers logged millions of acres of trees, the wood being used to build cities like Minneapolis and Chicago. This had a profound effect on the forests which can still be seen today. Today, forest management activities, like timber harvest, occur on roughly 1 percent of Minnesota forests, or nearly 180,000 acres, in any given year. The next year another, different 180,000 acres, may see activity, and so on. Forests, nearly all of them, have been shaped by human hands. It's hard to know where to draw the line between nature and people as they've been intertwined for thousands of years.

Forest management is today's science-based human attempt to tend forests towards specific goals. These goals may include providing bird habitat, clean water, game species habitat, pleasant views, plant diversity, recreational opportunities, and wood products to name but a few. Many goals can be achieved simultaneously on the same ground while others must be pursued separately in either time or place. Sometimes doing nothing is appropriate as the forest may already be meeting objectives, and other times intentional, goal-oriented management activities may be warranted. Meeting any goal is often more quickly done, or even possible, through active management rather than by waiting for nature to take its course.

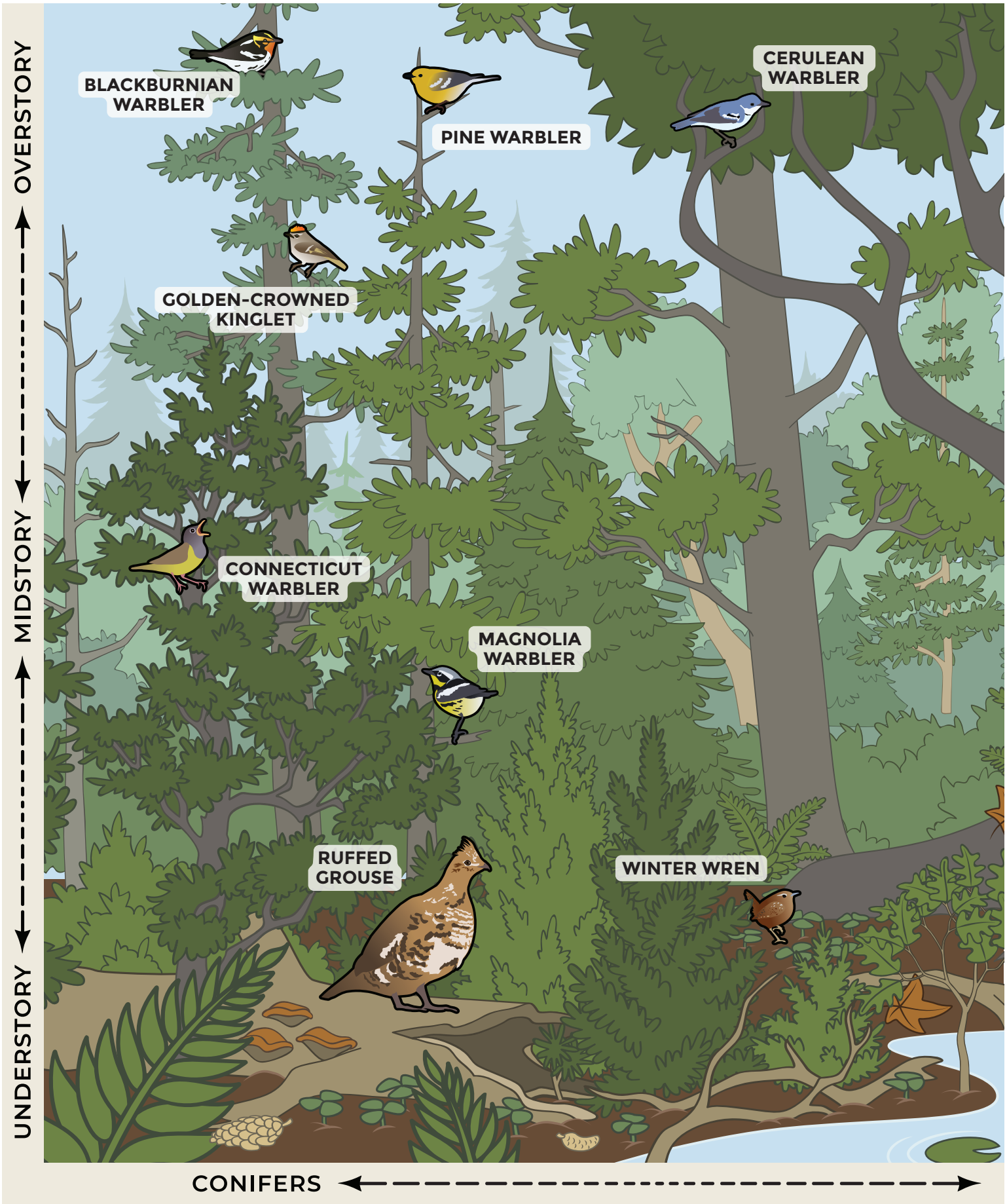
Aspen forest. © USDA Forest Service photo by Ryan Pennesi

Processor in action. © Brian Nordstrom

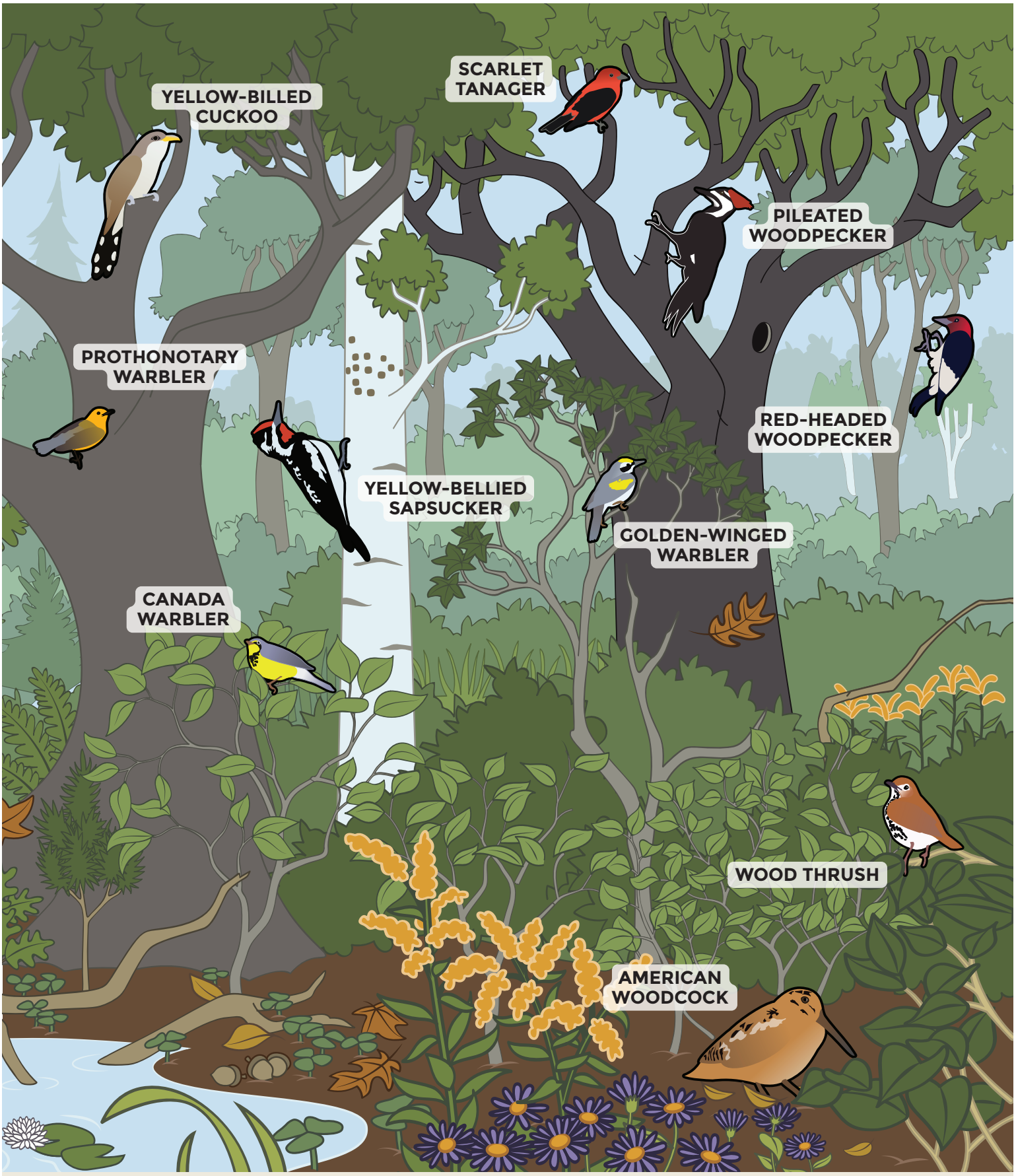
Red Oak sawlogs. © Michael Lynch

Blackburnian Warbler. © Matt Felperin, iNaturalist

Forest Habitats for Minnesota Birds



Forest Habitats for Minnesota Birds Continued



Silvicultural Systems for Minnesota's Forests

Forestry for Minnesota Birds is designed to incorporate small tweaks to traditional forest management activities that meet landowner goals to promote habitat structure, forest health, climate change adaptation, and species and structural diversity. Choosing which silvicultural treatment is appropriate will largely depend on the site characteristics, the quality of the stand, and landowner objectives.

Below are descriptions of the management techniques that enhance habitat features for FMNB's priority species followed by additional considerations for each forest habitat association. Where appropriate, incorporate these techniques into forest management plans or recommendations. Include the landowner in decision making to increase their understanding and promotion of bird-friendly techniques.

Log forwarder. © Eli Sagor

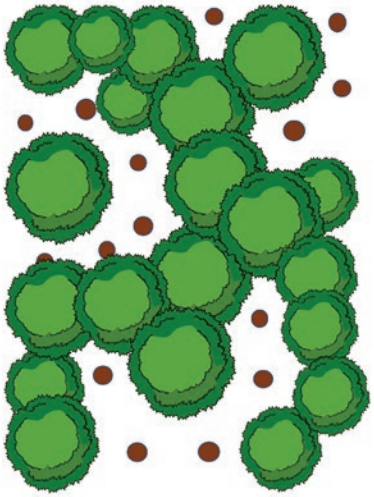
INTERMEDIATE TREATMENTS

Intermediate treatments are forest stand improvements that may not produce marketable products or generate revenue. Intermediate treatments are intended to improve the stand structure, composition, health, and quality (this could be tree quality, wildlife quality, or another consideration). Using silvicultural practices such as thinning or weeding will remove poor-quality stock and release trees (i.e., give more growing space and resources to remaining trees) with ecological or economic value. Create or maintain variable tree density by creating gaps to provide a mosaic of bird- friendly habitat features. These treatments can help stands become more resilient to climate change impacts by improving forest health, diversifying species present, and increasing structural diversity to provide a variety of conditions for tree growth and regeneration. Regional timber markets are highly variable; some intermediate treatments may produce income if local markets allow.

- Non-timber intermediate treatments include controlling invasive species and planting native trees and shrubs to improve species and structural diversity. Invasive species can reduce the success of silvicultural prescriptions by changing the natural patterns of forest succession. Planting native trees and shrubs will improve species diversity and provide additional habitat elements such as nesting sites or food. Consider plant competition and browse pressure when planting. Girdling trees (a shallow cut that encircles the tree and disrupts the flow of water and nutrients) can create snags and eventually coarse woody debris.
- Intermediate treatments may be utilized to create single-tree or group-sized gaps. It is important that some downed trees remain on site to mimic canopy gaps created by wind events, disease, low-intensity fires, or insect infestations. These gaps promote species and structural diversity by increasing light availability and creating woody debris, nurse logs (downed trees that provide a moist seedbed), tip-up mounds, and hollows that increase microsite heterogeneity (small-scale diversity).
- Prescribed fire is a management tool that mimics the disturbance created by low-intensity fires that were historically common across Minnesota due to lightning events and intentional ignition by Native Americans for vegetation management. Prescribed fire continues to be used to manage forest stand vegetation and can both positively and negatively impact bird habitat. For example, flycatching or canopy nesting species such as the Least Flycatcher respond positively to the open understory after prescribed burns. Ground nesting and foraging birds such as Ovenbirds respond negatively due to the lack of leaf litter. To minimize negative impacts, plan for burns to occur outside the nesting season and break up areas to burn so that only a portion of the habitat across the landscape is burned in any given year. If adjacent forest types are the same or similar and under different ownership, segmenting burns in the stand may not be necessary unless prescribed fire is also used in the neighboring stand. The Minnesota Prescribed Fire Council is a great statewide resource (see additional resources at the end of this guide for more information).

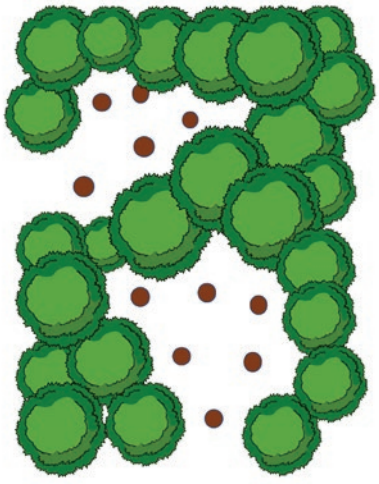
CROP TREE RELEASE

Crop Tree Release is a technique used to create more space for the crowns of desired trees, resulting in increased diameter growth. Crop trees (uncut trees) have ecological or economic value and may be chosen based on their ability to produce mast, timber, or wildlife habitat. In some cases, desired trees may be grouped for release. Once the desired tree or trees are identified, the directly adjacent crown competitors are marked for removal. Crop tree release can be an intermediate treatment and part of the strategy for the next several management steps, including group selection and/or shelterwood activities.



GROUP SELECTION STRATEGIES

Group selection harvesting is a technique where several trees in a group are removed together to create a canopy opening smaller than a typical clearcut but larger than a canopy opening resulting from single-tree selection harvesting. These canopy gaps create space for a mix of shade tolerant and intolerant species. This results in irregular mosaics (e.g., arrangements) of forest structure, age, and species composition. Size and location of group selection cuts are important to consider in a landscape context when diversifying bird habitat structure and meeting landowner goals. Incorporate desirable live and standing dead legacy trees into group selection gaps to mimic all types of gap-creating natural disturbances.



Group Selection Sizes

- Vary gap sizes and shapes to mimic natural disturbances.
- Small gaps are less than or equal to 0.25 (one quarter) acre.
- Medium gaps are between 0.5 (half) and 1 acre.
- Large gaps are greater than 1 acre and less than 2 acres.

Group Selection Placement

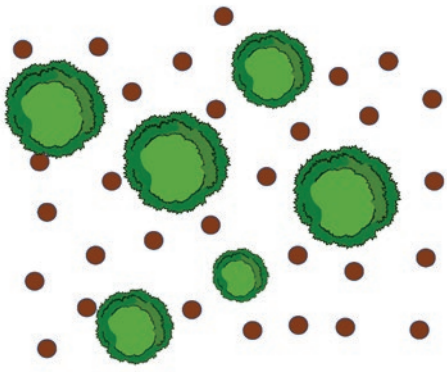
- Near mature seed and mast producing trees (oak, yellow birch, paper birch, etc.).
- Adjacent to overstory tree species that are mid- tolerant or intolerant of shade to encourage regeneration.
- Near conifer species to encourage conifer inclusions and thermal cover (especially spruce and fir).
- Where desired advanced regeneration (i.e., established seedlings and saplings) is already present.
- Create large gaps sparingly or group them together to minimize edge effect impacts on wildlife that depend on interior forest habitats.
- Feather gap edges by retaining pole- (<10 inches diameter at breast height) and seedling-sized trees and shrubs within the gap to create a transition into the forest interior.

Group Selection Return Interval

- Generally, a 15- to 20-year cycle; refer to basal area growth rate (how quickly the trees grow in diameter and number per acre) to determine the appropriate cutting year.
- Use single tree selection and/or crop tree release between canopy gaps in combination with group selection to control quality and recruit (i.e., allow for the establishment of) advanced regeneration.

SEED TREE MANAGEMENT STRATEGIES

Seed tree management is a technique where approximately 10 to 20 ft^2 of basal area is retained per acre (approximately 10 to 30 mature trees per acre). The retained trees should be widely dispersed to provide a seed source across the site. Canopy trees may be subsequently removed when regeneration is adequate, or they may be left onsite for species and structural diversity.



SHELTERWOOD MANAGEMENT STRATEGIES

Shelterwood systems retain greater basal area (i.e., preserve more trees per unit of area) than seed tree strategies for the purposes of moderating the microclimate for regeneration (typically leaving enough trees to provide shade, keeping the site cooler and/or less prone to drying out) in addition to providing a seed source. Shelterwood strategies can be varied

in the number of trees retained and/or the return interval for overstory removal. Both types of variations result in increased structural and age class diversity.

Shelterwood with reserves refers to lowering the basal area to release a new cohort (an existing population of established tree seedlings) while retaining the overstory over time to contribute to structural diversity, increase diameter growth for specialty products, or enhance the scenery. Use a first cut shelterwood harvest to reduce the residual basal area to approximately an average of 50 ft^2 per acre to enhance conditions for seed production and regeneration protection. Schedule the second cut when regeneration reaches an adequate level of stocking to release the established vegetation from overstory competition or retain the overstory indefinitely. If performing a second cut, leave a portion (5 to 15%) of the overstory trees (especially large- diameter trees) for more than 25% of the rotation time frame (or indefinitely), irregularly dispersed for habitat structure.

Oak Shelterwood. © Ryan Pennesi

IRREGULAR SHELTERWOOD MANAGEMENT STRATEGIES

The basic premise of two- or three-stage shelterwood strategies is that a new cohort of mid-tolerant (i.e., able to grow in partial shade) to tolerant tree species (i.e., able to grow in shade) is initiated with each activity and provides a longer regeneration period than a traditional shelterwood. Irregular shelterwood options should be tailored for site conditions and desired species regeneration.

Expanding Gap (Group) Shelterwood

- Establish group cuttings in select areas with advance regeneration. The harvest rotation is every 15 to 20 years; each harvest gradually enlarges the previous gaps until the whole stand has been regenerated. This type of shelterwood prevents advanced regeneration from being destroyed in subsequent harvests and provides forest gap habitat.

Extended Shelterwood

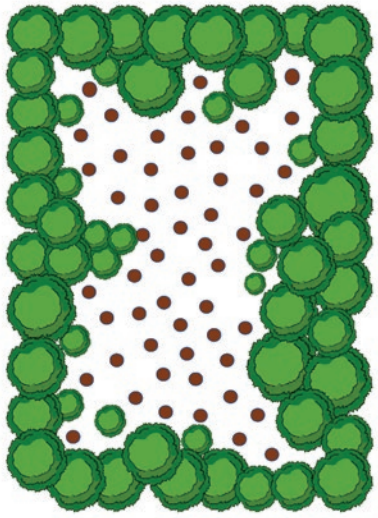
- Conduct a regeneration harvest as normal for traditional shelterwood but with subsequent harvests occurring later (20 to 30 years) or not at all. This provides canopy nesting sites for birds such as the Cerulean Warbler while releasing regeneration and providing habitat for understory and shrub nesting bird species, such as Chestnut- sided Warbler.

Continuous Cover Shelterwood

- This shelterwood type is intended to regenerate shade intolerant and mid-tolerant species while maintaining the forest in multiple age cohorts and creating high productivity. As appropriate, combine thinning, group selection, and traditional shelterwood to create habitat elements to benefit birds that prefer mixtures of gaps, dense understory layers, and large canopy trees.

CLEARCUT MANAGEMENT STRATEGIES

Clearcut strategies are used when the desired species for regeneration thrive in full sun. Ecologically, these types of timber harvests mimic large fires or severe wind blowdown events. Clearcuts are often used to regenerate aspen and paper birch and other shade intolerant species on upland sites. Small tweaks to the clearcut management strategy will maintain habitat on the site in the short term and enhance the habitat in the regenerating stand over time. Follow Minnesota's Voluntary Site-Level Guidelines and **consider the suggested guidelines as minimums rather than optimum goals** for elements such as leave trees, coarse woody debris, riparian management zone buffer areas, etc.



LEAVE LEGACY, CAVITY, AND SNAG TREES

- Retain or create 4-6+ snags and/or cavity trees per acre. Be mindful of windthrow especially on sandy or wet soils or with shallow rooted species. Leave more trees if excessive windthrow is anticipated.
- Leave over 5% of the area unharvested in a combination of groups or clumps of trees and scattered individuals across the site. Locate clumps adjacent to riparian areas or other important features.

- Retained trees should represent a diversity of species, ages, sizes (>6 inches diameter), and conditions, with special consideration for under- represented species on the site or landscape such as long-lived conifers or mast-producing species such as oak and yellow birch.
- Some leave trees should be relatively young and healthy to assure they are still standing and providing benefit long after older or dead trees have fallen.
- Small groups of conifers can provide important shelter immediately after harvest and well after the site has regenerated with sapling or larger-sized trees.
- Leave trees can be used to feather/soften hard harvest edge boundaries.
- Refer to the leave tree preference table in Appendix A for guidance.

Tip-up mounds can be created by using equipment to uproot trees. The exposed tangle of roots can be important habitat, and exposed soil can serve as a seed bed for different plants and trees.

When feasible, break up large clearcuts into 10- to 20-acre blocks to create structural diversity across the landscape. Consider irregular shapes that more closely mimic the erratic nature of wildfire burns.

Avoid clearcuts in or immediately adjacent to lowland areas where the harvesting would alter the hydrology such that the resultant habitat is dominated by wetland vegetation rather than regenerating forest cover. This is a phenomenon known as "swamping."

Summer harvests often will scarify (expose) the soil, benefiting light-seeded species such as paper birch and reducing the density of aspen. Risks include soil compaction, negative impacts to advanced regeneration if present, disruption to nesting birds, and increased vulnerability to spreading invasive species. Winter harvests can minimize impacts to soil, understory plants, and advanced regeneration while maximizing aspen stem density and growth.

Log landings will likely serve as openings or gaps in the future forest. Landings can be seeded with desirable plant species or trees to enhance site diversity.

Use the native plant community to help inform reforestation strategies and tree species options most suitable to the site and future climatic conditions.

STRIP OR PATCH CLEARCUTTING

- A potential management treatment for species with short-distance seed dispersal, like spruce.
- Width of strips should take windthrow and other effects into consideration.
- Generally, strips should be no wider than 150 feet in areas with mild winds and 50 feet in areas prone to windthrow, especially near the Great Lakes shorelines.
- Uncut areas are typically at least 100 feet wide.

Strip cutting and group selection experiment. © Google Maps

INVASIVE SPECIES MANAGEMENT

Invasive species can quickly colonize areas opened up by management activities. Climate change will exacerbate the issue, as increased tree stress from pests, disease, and drought cause pockets of mortality and create opportunities for invasive species colonization. Be proactive and reduce the opportunity for invasive species to establish or spread by removing them from in and around the forested area prior to management activities. Work with loggers to clear equipment of mud and brush debris that can import invasive species to the site. Early-detection and response is more effective that treating widespread infestations. These simple measures increase the chances of successful desired regeneration and long-term habitat management.

BROWSE IMPACT MANAGEMENT

Regeneration could be negatively impacted by browse from white-tailed deer, moose, voles, snowshoe hares, beaver, and other wildlife that are capable of browsing regeneration. In areas with high browse pressure, consider the following measures.

- Increase the harvest area and the resulting regeneration area to overwhelm ungulate browse; lack of cover in large harvest areas is a deterrent. Use only when necessary, as this results in reduced shelter and food for birds.
- Leave large top-wood and large woody debris in piles or rows to protect seedlings.

Installing tree protection tubes. © Eli Sagor

  - Large tops keep branches off the ground and allow space for regenerating seedlings.
  - Large woody debris also provides partial shade and protection to tree seedlings, reduces runoff, increases nutrient cycling, and provides habitat for birds, invertebrates, reptiles, and amphibians.

- When regenerating species particularly appealing as browse (oak, cedar, pine, yellow birch), plan for additional post-harvest labor investment and use protective measures listed below. Nursery stock is often preferentially browsed compared to natural regeneration.
  - Use fenced exclosures, tree tubes, bud caps, or other measures to protect seedlings.
  - Fencing for exclosures should be a minimum height of eight feet, which is ideal for small areas of regeneration. Shorter fence heights may be possible for smaller exclosure areas.
  - Individual tree tubes should be a minimum height of five feet and should be capped with a mesh-like cover to prevent birds from falling into the tubes where they can't escape.
  - Not every susceptible tree needs to be protected from browse. Protect enough seedlings to ensure the site is adequately stocked according to the forest management goals while accounting for some natural mortality.

CLIMATE CHANGE MANAGEMENT

When developing forest management plans, be sure to account for risk factors that could affect regeneration and forest health as the climate continues to change. For more specific information related to each forest type, refer to the climate vulnerability and adaptation information presented in the "Forest Habitat Associations" section in Appendix B.

- Assess the site for drought risk factors such as dry soils, south-facing slopes, or high stocking (i.e., high tree density).
  - Summer drought will become increasingly common as more precipitation occurs in concentrated heavy events and snow comes later in the winter and melts earlier in the spring. Mitigate drought stress by decreasing the level of stocking to reduce competition and favor drought-resistant tree species on dry soils and on south-facing slopes.
- Assess and mitigate threats from non-native, invasive pests and diseases.
  - Trees experiencing climate change-related stress will become more vulnerable.
  - Decrease the pressure from non-native, invasive forest pests and diseases by treating known infestations or infections.
  - Diversify tree species for increased forest resiliency.

Silvicultural "Tweaks" for Minnesota Birds

Below are slight modifications, or tweaks, to the silvicultural systems described previously that are designed to maximize bird habitat element creation in each forest habitat association. As the forester or land manager, tailor the following tweaks to the site characteristics, surrounding landscape, and landowner goals before recommending or including these in a forest management plan.

UPLAND CONIFER: PINE

- Create gaps in the canopy and plant site-appropriate, non-pine species to enhance horizontal and structural diversity as well as species diversity;
- Retain mature, seed-bearing conifers to ensure a seed source for regeneration;
- Consider variable retention harvesting and other strategies to move away from uniform rows with little horizontal and vertical structural variation;
- Use prescribed fire, when possible, to replicate natural disturbance patterns;
- Use natural disturbance return intervals to guide rotation periods;
- Mimic landscape disturbance patterns with timber harvest (e.g., more large patches);
- Manage stands to retain biological legacies;
- Increase the proportion of forest dominated by conifers. Minnesota has less than 2% of its old growth pine stands remaining compared to pre- European settlement.

UPLAND DECIDUOUS AND MIXED CONIFER: ASPEN-BIRCH

- Reserve or plant trees to increase diversity; factor in climate change when making species selection decisions (see Appendix B for more information);
- If regenerating the site using clear-cutting, retain coarse woody debris on site by leaving a few large-diameter log segments greater than six feet long scattered throughout each acre.
- Protect or create a conifer component, typically balsam fir and/or white spruce, in small islands throughout the stand (refer to Appendix B for information on conifers and wildlife);
- Retain large living trees (refer to the wind firmness chart in the appendices), both in grouped islands and as scattered individuals across the stand, to serve as future cavity trees and snags, as well as perching and feeding trees, and a source of seed and mast. Retain sapwell trees (i.e., trees drilled by Yellow-bellied Sapsuckers).
- Winter harvesting will lead to the highest aspen growth rate and density, summer harvesting will typically result in more species diversity, and fall harvesting encourages paper birch;
- Consider the age and species mix on the landscape around the forest stand when planning;
- Use natural disturbance return intervals to guide rotation periods;
- Maintain and create large patches of upland forest;
- Manage stands to retain biological legacies;
- Collaborate management across ownerships to increase patch size or to create travel corridors.

UPLAND DECIDUOUS AND MIXED CONIFER: OAK

- Avoid harvesting, pruning, or otherwise wounding oaks from April 1 to July 15 to reduce the risk of oak wilt infection.
- Retain large, acorn-producing oaks. Consider crop- tree release strategies to produce large, healthy crowns. Acorn crops can be assessed in late summer.
- Remember, oak is dependent on disturbance, historically fire, to maintain itself. Oak stands tend to transition into northern hardwoods or other upland types without intentional management.
- Prescribed burning can be used to control non-oak regeneration (seedlings and saplings) that may inhibit oak regeneration. Red maple and shrub species can be especially problematic.
- Late-summer harvesting can scarify (expose) soil and provide a good seedbed for germinating acorns while inhibiting non-oak advanced regeneration.
- Maintaining and especially regenerating oak is a long-term project. Landowners should be made aware of the big change to a mature forest regenerating oak necessarily involves.
- Use natural disturbance return intervals to guide rotation periods.

Oak Shelterwood. © Ryan Pennesi

UPLAND DECIDUOUS AND MIXED CONIFER: NORTHERN HARDWOODS

Northern hardwood. © nicholas_t, flickr

- Use natural disturbance return intervals to guide rotation periods;
- Retain or plant scattered conifers on the southern portion of the stand that can help provide shade in spring when sugar maples are prone to sunscald or frost cracking;
- Use single-tree or group selection to create a mosaic of canopy gaps/openings. Ecologically, this can simulate summer thunderstorms with high winds;
- Thin stands in a way that promotes or retains tree species diversity;
- Manage to maintain or create large patches of upland forest;
- Manage stands to create and retain snags, cavity trees, and coarse woody debris;
- Manage invasive plants and animals; prevent earthworm introduction;

LOWLAND CONIFER: BLACK SPRUCE, NORTHERN WHITE CEDAR, TAMARACK

- Be mindful of hydrology when harvesting wet sites. Over-harvesting can raise water tables and "swamp" the site, making it too wet for healthy tree growth.
- Thick moss and wet soils can delay or prevent proper freezing, making the site susceptible to rutting or compaction, which can take many decades to recover.
- Use natural disturbance return intervals to guide rotation periods;
- Mimic landscape disturbance patterns with timber harvest (for example, small patches, strip cuts);
- Regulate and monitor harvest of nontimber forest products such as spruce tops to avoid rutting and damage to sensitive peat substrates.
- Manage stands to retain biological legacies such as large snags and stumps.

Lowland conifer. © Eli Sagor

LOWLAND HARDWOOD: BLACK ASH

- In consideration of the emerald ash borer (EAB), plant non-ash trees; there is ongoing research to find viable species; experiment if needed;
- Retain enough trees to maintain hydrology and avoid "swamping out" the site, which can convert a forested ash wetland site into a non-forested wetland, greatly changing its value for bird species dependent on these unique sites.
- Maintaining the water table such that it remains suitable for trees will keep the site viable for ash in the event EAB-resistant ash trees or highly effective EAB control techniques are developed;
- Harvested ash should be utilized in a way and within a timeframe that minimizes the spread of emerald ash borer, especially into new areas;
- Employ management techniques to promote uneven-aged stands with mature trees;
- Manage stands to retain biological legacies such as large trees with cavities;
- Utilize best management practices for the management of reed canary grass.

LOWLAND HARDWOOD: BOTTOMLANDS

- Natural regeneration is often lacking in these stands and can be supplemented by planting trees;
- Retain and create cavity trees and snags, which are often used by many riparian (water's edge) species;
- Be mindful of spring snowmelt and ice floes that can flood or damage seedlings, saplings, and tree protection cages or other infrastructure;
- Employ management techniques to promote uneven-aged stands with mature trees;
- Manage stands to retain biological legacies such as large trees with cavities;
- Utilize best management practices for the management of reed canary grass.

Landscape-level Considerations

How forest types and habitat structure are arranged, connected, or isolated across the landscape, both within an ownership and across property boundaries, is critically important for birds. Each bird species has specific needs for various life stages including breeding, nesting, fledgling, and migrating. Managing bird-friendly forests should evaluate habitat features at multiple spatial scales, including within the larger landscape surrounding any given area.

SIZE AND SHAPE

The size and shape of a forest influences how much of the habitat is considered edge (areas less than 250 feet from the forest edge) and interior (area more than 250 feet from the forest edge). A larger forest has a higher interior-to-edge ratio than a small forest of the same shape. Birds relate differently to interior and edge habitat based on species, season, and other factors. Interior habitat is desirable for many forest birds and offers protection and necessary habitat elements for healthy bird populations. Edge effects can be softened with the recruitment or addition of young trees and shrubs outside the forested edge, creating a vegetative structure that gradually thins out, rather than one that abruptly stops. This is called feathering.

Southeastern Minnesota. © Michael Lynch

DISTRIBUTION OF AGE CLASSES

Various age classes across a forested landscape create important habitat elements that provide forest birds with diverse areas for feeding, nesting, and roosting. Age class diversity is created as trees regenerate after natural disturbances or forest management activities. Disturbance activities can occur within each forest stand, affecting a small number of trees through selective harvest, tree fall, or insect and disease outbreaks. Disturbance events can also occur across the landscape through larger stand-replacing events such as clear cuts, windstorms, and severe wildfires. Groups of trees in the early stages of regeneration usually offer dense growth of small trees and shrubs, while older forests have multiple layers of cover and more established elements, like down woody debris and leaf litter. Work to diversify age classes across the landscape when developing forest management plans.

Pine Warbler. © Bill Keim, iNaturalist

ROLE OF STAND IN RELATION TO LANDSCAPE

In addition to size and shape of the forest, the spatial arrangement of land uses across broad areas often determines the role the forest stand plays in providing habitat. In agriculturally dominated areas, a forest stand may act as a travel corridor or stopover habitat that can facilitate wildlife movement from one forest to another. It may be the only forested area in the landscape or have important features such as a wetland, stream, or pond. In a forest-dominated landscape, the forest type may be unique in relation to surrounding forests. A thorough understanding of the forest stand's role in the landscape is crucial to creating a management plan that will diversify, enhance, or preserve habitat across the landscape.

Habitat Feature Descriptions

VERTICAL STRUCTURE DIVERSITY / CANOPY COVER

Vertical structure diversity is the density and arrangement of understory plants, shrubs, saplings, and large trees, including twigs, branches, tree trunks, and cavities from the forest floor to the tops of the trees. Vertical structure is often measured as the percent of canopy cover in each of the overstory, midstory, and understory layers. To enhance or maintain vertical structure diversity, use forest management techniques that result in an uneven-aged forest stand where appropriate to the forest type or the use of gaps, group selection, and selective thinning, or reserve (no harvest) areas. Retaining long-lived tree species or implementing management practices that avoid damaging diverse ecological features or advance regeneration can promote ecological diversity over time.

HORIZONTAL STRUCTURE DIVERSITY

Horizontal structure diversity is the density and arrangement of understory plants, shrubs, saplings, and large trees, including tree trunks and branches that occur in a flat plane across the forest stand. The horizontal structure of tree trunks may be measured as basal area (a forestry term roughly meaning tree density) or stems per acre (which reflects large and small trunks without distinction). Canopy cover is also a measurement that can be used to assess the percentage of stand acres covered by the overstory, midstory, or understory. To enhance or maintain horizontal structure, use forest management techniques, including small gaps and group-selection and reserve areas.

GAPS / CANOPY GAPS

Canopy gaps of various sizes are areas in the forest where sunlight can easily penetrate the canopy to stimulate the growth and regeneration of trees and the seed and fruit production of woody shrubs and herbaceous plants at ground level. Gaps provide areas for birds (and bats!) to fly freely to feed on insects on the wing, a tactic called "hawking." Increased seed and fruit production means increased foraging opportunity. The resulting regeneration increases structural diversity over time for both insect and seed and fruit-eating foragers. When appropriate, plan for gap creation in forest management plans. In this guidebook, a small gap is under 0.25 (one quarter) acres, a medium gap is between 0.25 and 0.5 (half) an acre, and a large gap is larger than 1 acre but less than 2 acres.

Canopy gap. © Michael Lynch

NATIVE BIODIVERSITY / INVASIVE SPECIES

Maintaining the integrity of native ecological and biological communities by promoting management techniques that safeguard or enhance biodiversity is essential to retaining ecological functionality of our forest systems and supporting robust populations of resident and migratory bird species. Invasive plants, insects, or pathogens negatively affect bird habitat by interfering with native plant communities, such as outcompeting native tree regeneration or changing soil conditions, which in turn puts wildlife communities at risk. Invasive plants are often very prolific, quickly dominating a site and becoming hard to control. Eradicate invasive species in and around the forest prior to conducting forest management activities. Ensure equipment entering the site has been cleared of mud and debris, which can transport invasive species into or out of a site. Forest management activities implemented in the winter months often decrease the risk of spreading invasive species.

LARGE-DIAMETER TREES

Large-diameter trees contribute to stand structural diversity and provide nest sites, perches, and places to forage for a number of forest birds. Conduct management activities to preserve large-diameter hardwood and softwood trees (conifers) throughout the forest (this may mean throughout the stand, within reserve areas in the stand, or within the larger landscape). If none are present, use management activities like crop tree release on small-diameter trees with growth potential to create large-diameter wildlife trees in the future.

CONIFER/SOFTWOOD INCLUSIONS

Softwood trees (i.e., "conifers") provide year-round shelter for birds and other wildlife. The needles, twigs, and cones are utilized by a variety of wildlife for nest-building material and food; the duff (partially decomposed leaf/ needles and other plant

material) supports invertebrate populations. They also provide shelter from snow, rain, heat, and cold. Use management activities to retain or recruit softwood inclusions (clusters) or create softwood inclusions by planting conifers, keeping climate change appropriate trees in mind. See Appendix B for detailed examples of how conifers are used by Minnesota wildlife.

SNAGS, CAVITY TREES, LEAVE TREES, AND LEGACY TREES

Snags are free-standing dead trees. Cavity trees are living trees that have holes that can be used as nesting sites by birds or denning sites for mammals. The holes could be created by woodpeckers, fungus, mechanical damage, or from other causes. Leave trees are trees with commercial timber value that have been intentionally left unharvested to provide some benefit including wildlife habitat, a seed source, or for aesthetic considerations.

Male, female Black-backed Woodpecker. © Ryan Pennesi

Legacy trees are similar to leave trees except they are generally near their maximum size and age for their species. All of these trees can provide essential structural elements for nesting, roosting, and perching in addition to harboring insects, which are a food source for birds. In Minnesota, over 40 bird species, 29 mammalian species, and several species of reptiles and amphibians use snags during at least part of their life cycle. Retain or create 4–6 snags per acre by girdling — a shallow cut made around the perimeter of a tree, slowing killing it while leaving it standing — during management activities. Snags should be greater than 12 inches in diameter when possible. Additionally, retaining a minimum of 5% non-harvested living canopy trees in clumps and/or six to twelve leave or legacy trees per acre is recommended. These trees should be at least 6 inches in diameter and be representative of the dominant or codominant tree species in the forest canopy. At least one to two leave trees should be greater than 18 inches in diameter per acre if possible, and about 50% of remaining leave trees should be greater than 12 inches in diameter. Snag and cavity trees left in clumps with other trees often remain standing longer than trees left in the open, which are more prone to windthrow. It is important to not only leave existing standing dead trees intact during and after forest management activities but also to create or retain living cavity and future snag trees. Snags will eventually rot and fall, providing benefit to species needing downed wood but no longer providing cavity nesting opportunities. By ensuring living cavity trees are preserved, the timeline for which the forest stand provides snags is extended. These forest management practices replicate natural ecological disturbances, such as wind, fire, or insect outbreaks, that leave a variety of different types of trees, living and dead, across a site. See the Minnesota Forest Resource Council's Voluntary Site-Level Guidelines for more information (link in Appendix C).

ROADS AND TRAILS

Skid-trails, log decking (stacking) areas, and occasionally roads are created as part of a timber sale. Skid-trails are paths used by logging equipment to transport logs to an area where they can be stacked before being loaded on trucks and hauled to saw or pulp mills. Careful planning should be taken when laying out this infrastructure and many of these should be closed, reshaped to local contours, and re-vegetated as soon as possible following harvest while others can be maintained to serve landowner goals such as walking trails, burn breaks for prescribed fire, or for subsequent forest management work.

Forest roads can provide travel corridors for bird predators and nest parasites (cowbirds) and cause the proliferation of invasive plant species that can alter habitat condition and function. These new roads also can increase motorized recreation use, which exacerbates disturbance either directly or indirectly. Careful planning should be taken when laying out these features and many of these should be closed, reshaped to local contours, and re-vegetated as soon as possible following harvest. Pay extra attention to sensitive areas, such as stream or wetland crossings, easily damaged by traffic when not frozen. Some infrastructure can be maintained to serve landowner goals such as walking trails, burn breaks for prescribed fire, or for subsequent forest management work.

Skid trail. © Michael Lynch

LEAVE TREE PREFERENCES FOR LONGEVITY, WIND FIRMNESS, AND CAVITY POTENTIAL

EXCELLENT	GOOD	FAIR
White pine	Red pine*	Paper birch
Oaks	Tamarack	Balsam fir*
Elms	Northern white cedar	Jack pine*
Ashes	Red maple	Black spruce*
Sugar maple	White spruce*	Balsam poplar
Yellow birch	Black cherry	
Basswood	Hickories	
Aspens	Box elder	
	Cottonwood	
	Black walnut	
	Hackberry	

*Leaving these species in the overstory poses some risk of insect and disease infestation to understory regeneration of that same species.

DOWN WOODY MATERIAL ("FINE AND COARSE WOODY DEBRIS")

Down woody material, or debris, provides important habitat structure for birds and other wildlife for the material it provides for nesting and for the development of invertebrate food sources. Down woody debris is classified as either large (greater than six inches in diameter and over four feet long, also referred to as "coarse woody debris") or small (less than six inches in diameter and less than four feet long, referred to as "fine woody debris"). Ruffed Grouse, for example, will utilize large logs lying on the forest floor for "drumming," an important activity during mating season. Retain existing down woody debris, leaving it in place if possible. If necessary, create a mix of both large and small woody debris during management activities. Approximately two thirds of important soil nutrients found in a tree are contained within the leaves and small branches and therefore leaves and fine woody debris play an important role in forest soil nutrient cycles.

Small brush piles are another type of down woody debris and can be created during forest management activities by piling small twigs and branches. They are used by a variety of birds seeking food or temporary shelter, as well as small mammals and other wildlife.

Prescribed burn. © Michael Lynch

LEAF LITTER AND DUFF

Leaf litter is created as the leaves and needles from trees and dead herbaceous vegetation build up on the forest floor. Duff is created as leaf litter breaks down and becomes part of the soil. Deciduous leaf litter and duff are important for bird habitat and invertebrate food sources and can be beneficial to some tree species' seed germination. The ideal depth is greater than 1.5 inches. Conversely, too much leaf litter in an oak forest type can inhibit the growth of understory flora and oak acorns, which, like the seeds of birch trees, prefer to germinate in areas of bare mineral soil. Non-native earthworms can reduce leaf litter and duff layers significantly, which may result in drier soils, extreme soil temperature fluctuation, soil erosion, and vastly reduced seedbed quality, which in turn inhibits successful tree seedling establishment and alters herbaceous plant species diversity. Heavy browsing by white-tailed deer can greatly exacerbate this problem by eating understory plants, shrubs, and trees and reducing their abundance and diversity.

RIPARIAN AND WETLAND FORESTS

Water features, such as streams, ponds, wetlands, and the surrounding vegetation, provide beneficial habitat elements favored by certain bird species. These near-water areas are called riparian zones. Forested wetlands and vernal pools (seasonal ponds often wet in the spring and dry in the summer) are essential breeding grounds for amphibians and a host of aquatic invertebrates while also being critical habitat features for a number of bird species. While structural diversity of vegetation near water can be beneficial to birds, special care should be taken when managing these sensitive areas. Retaining tree root mass to protect soil from erosion and retaining shade through the incorporation of buffer zones (areas with limited tree harvest) is also important for keeping water temperatures cool for some species of fish and other wildlife. If management is necessary, ensure leaf litter, coarse woody de-

bris, and duff remain intact and avoid the creation of deep ruts, which interfere with amphibian migration or compacting the soil. Leaving some tall canopy trees and other long-lived species is also recommended. When planning for management around water features, refer to Minnesota's voluntary site-level forest management guidelines "Incorporating Riparian Guidelines into Plan Design" section.

GOLDEN-WINGED WARBLER RIPARIAN HABITAT MANAGEMENT

Golden-winged Warblers depend on young forest habitat, and will use regenerating brushy wetlands such as recently sheared tag alder stands with reserve trees. When managing these stands, minimize impacts to wetlands by operating in the winter on frozen ground to avoid creating ruts. In the absence of overstory reserve trees, it is important to leave "islands" of alder to provide structural diversity for nesting habitat. Regenerating alder also builds soil fertility as it fixes nitrogen, and allows for a flush of forbs, grasses, and sedges which are important for nesting cover and support insects as a food source.

Ecology, Forest Habitats, and Native Plant Communities

Native plant communities (NPCs), also referred to as natural communities or natural habitats, are classified and described by considering vegetation, hydrology, landforms (related to past glacial or other geological processes), soils, and natural disturbance regimes. NPCs can be identified in the field by taking note of the plants, shrubs, and trees growing in a given area and some information about the soils underfoot. Field guides developed by the Minnesota Department of Natural Resources can provide additional information about the forest such as the ecological processes that helped develop and sustain the forest, the likely plant and tree species composition of the forest through history, and what it may look like in the future under different management (or no management) activities. Knowing the NPC in an area can help with decisions about what tree species may grow well, including in future climate change scenarios. It can also indicate when a forest may be lacking potential biodiversity from past events such as high-grade logging, tree diseases, heavy browsing, or invasive species. This can help inform short- and long-term forest management activities such as forest thinning activities, planting trees, regeneration cuts, and more, in ways that can maximize the ecological benefit the forest is capable of providing as well as its resilience in the face of forces such as climate change, wildfire, and invasive species. By knowing the ecological processes that helped shape a given stand through time, ecologically-based silvicultural practices (i.e., forest management) can be utilized to closely mimic natural processes.

Detailed information can also be found on the Minnesota DNR's website: https://www.dnr.state.mn.us/npc/index.html

Golden-winged Warbler. © Matt Felperin, iNaturalist

FOREST HABITAT TYPES

FOREST HABITAT ASSOCIATION	FOREST HABITAT SUBTYPE	NATIVE PLANT COMMUNITY FOREST SYSTEM
Upland Conifer	Pine	Fire-dependent Forest System
Upland Deciduous and Mixed-Conifer	Aspen-birch	Mesic Hardwood Forest System or Fire-dependent Forest System
	Oak	Mesic Hardwood Forest System or Fire-dependent Forest System
	Northern Hardwoods	Mesic Hardwood Forest System
Lowland Conifer	Black Spruce, Northern White Cedar, Tamarack	Forested Rich Peatland System, Acid Peatland System
Lowland Hardwood	Black Ash	Wet Forest System
	Bottomlands	Floodplain Forest System

UPLAND CONIFER FORESTS

Primary and Associated Tree Species

- Pine – Jack pine, red pine, white pine; found both in plantations and natural sites;
- Spruce – White spruce; pure stands of white spruce are seldom found outside of plantations;
- Balsam fir and white cedar.

Identification

Upland, dry conifer stands make up around 6%, or just over one million acres of the forested area in Minnesota. Historically, pine-dominated sites were much more abundant than today due to a combination of factors including intensive late 19th- and early 20th-century logging, fire suppression, and deer browsing. Natural conifer- dominated sites generally increase northward, being very rare in the southern portion of the state where conifers, especially red pine, are almost exclusively found in plantations. Many forest types have at least some conifer trees, such as pines, spruces, fir, cedar, and tamarack. For the purposes of this guide, a site is considered conifer-dominated if at least 50% of the timber volume of the stand consists of conifer species.

Ecology/Natural History

Minnesota's coniferous forest exists primarily in the north, north-central, east-central, and northeast portions of the state. The area was completely glaciated 10,000 years ago and is primarily composed of shallow and nutrient-poor soils over bedrock or well-drained sandy or gravelly soils. The climate is cold, with a frost-free growing season often under 100 days. In this harsh environment, pine, spruce, and fir have an advantage over less well-adapted deciduous trees. Fire, both from lightning and from indigenous inhabitants occupying the area on the heels of the retreating ice sheets, helped to shape this landscape, occasionally opening up the canopy by killing large overstory trees when the fires were large enough

Red Pine Plantation. © USDA Forest Service photo by Ryan Pennesi

to carry through the tree crowns, and more often clearing away underbrush and smaller seedlings when the fires were smaller and restricted to the ground. Small variations in soil moisture and terrain and existing vegetation lead to uneven fire impacts and therefore create a mosaic of different ages, species composition, and vertical and horizontal structure across the broader landscape. Today's coniferous forests tend to be more homogenous and have been reduced in area by about two thirds since European settlers arrived in the state.[12] Aspen-dominated forests occupy many of these formerly upland conifer sites.

Wildlife

Upland coniferous forests provide critical feeding, roosting, and perching habitat for migrating birds. The native shrubs found in these forests often produce fleshy fruits, an important source of nutrients for migratory birds, especially as they need energy to fly south to their wintering areas. The conifer cover can moderate summer warmth and winter cold for white-tailed deer and moose and provide habitat for the American pine marten.

Moose preference for balsam fir affects the tree's height and abundance, ultimately affecting species composition, community structure, and successional patterns. These forest types support a variety of wildlife species listed as threatened or of special concern like the gray wolf (timber wolf) and the Canada lynx.

General trend of forest type

Upland coniferous forests could experience significant community changes due to a variety of climate-related factors. Drought and changes to the water table are predicted to increase stress, making trees more susceptible to pressure from native and invasive pests. Mortality from these pests and drought conditions could increase the frequency of stand-replacing fires. In addition to these competitive challenges, upland coniferous forests could experience herbivory by white-tailed deer and moose in some far north areas. This could result in altered forest structure and succession patterns due to their consistent browsing of seedlings, thus hindering their growth and ultimately their reproduction.

The majority of the trees in this forest habitat type are predicted to decrease, and a few may increase as climate change progresses. Species predicted to decline include balsam fir, black spruce, jack pine, northern white cedar, tamarack (significantly with mortality caused by Eastern larch beetle), and white spruce. Species that may increase include red and white pine.

FMNB PRIORITY SPECIES	KEY HABITAT FEATURES
Blackburnian Warbler	Mature conifer and mixed forests, large white pine and white spruce
Magnolia Warbler	Dense, mid-aged conifers
Pine Warbler	Dense conifers, low shrub cover
ADDITIONAL WILDLIFE SPECIES	**KEY HABITAT FEATURES**
American Marten	Mature and cavity trees, large downed woody debris
Moose	Mature conifer and mixed forests with shrub understory; forested wetlands
Snowshoe Hare	Dense, early to mid-aged conifers with areas of high shrub cover
Canada Lynx	Dense, early to mature-aged conifers with thick understory
Blue-headed Vireo	Mature conifer and mixed forests, spruce or balsam fir understory

UPLAND DECIDUOUS AND MIXED-CONIFER HABITAT ASSOCIATION

Common Forest Types and Associated Tree Species

- Aspen-paper birch – Quaking aspen, paper birch, red maple, balsam fir;
- Oak – Bur, red, and white oak;
- Northern hardwoods – Sugar maple, American basswood, yellow birch.

Identification

Upland deciduous and mixed conifer forests can be subdivided into several subcategories: **aspen-birch** located primarily in the north and northeast part of the state, **oak** found in the central and southeastern part of the state, and **northern hardwoods,** found mainly in the central and northern part of the state. Many aspen-birch stands in the state have limited conifer components whereas others, especially older stands or stands with a less intensive management history, tend to have balsam fir, white spruce, and red or white pines present. Aspen-birch forests compose the single largest forest type in the state, nearly 4.7 million acres, representing approximately 30% of the forests in Minnesota[13] and also making aspen the most important tree species to the forest products industry in the state. The most common tree species that make up the aspen-birch type are quaking aspen, paper birch, red maple, and balsam fir. The tree species found in the **oak type** include bur oak, red oak, and white oak. About 9%, or 1.5 million acres, of Minnesota's forests are oak. **Northern hardwoods** describe

a collection of tree species that primarily include sugar maple, American basswood, and yellow birch, and, similar to the oak type, comprise approximately 9%, or nearly 1.5 million acres, of Minnesota's forests. It is important to know which sub-category you are working with, as forest management techniques can be quite different between the sub-types.

Upland Mixed Forest. © Eli Sagor

Ecology/Natural History

Aspen-paper birch forests are early successional forests that thrive in more frequent and wide-scale disturbance regimes. Three natural disturbance regimes can result in these "pioneer" forests: large wildfires that kill both small understory trees as well as larger canopy trees, wide-spread insect or disease outbreaks, or wind blowdown events that often affect the largest trees in the stand and leave the smaller trees largely intact. Today, forest management is the primary disturbance regime maintaining this forest type. Many formerly conifer-dominated stands across the state have transitioned into aspen-birch dominated stands through a combination of turn-of-the-century logging, wildfires, and deer browsing. **Oak forests** were historically maintained through a combination of periodic small wildfires that kill shade-tolerant tree species establishing themselves in the understory (such as sugar maple), and larger wildfires that kill canopy trees, opening up the area beneath to increased sunlight. In the absence of fire or deliberate forest management, many oak stands are converting into northern hardwood stands. **Northern hardwood** forests are often closed canopy mature systems where natural disturbances, primarily thunderstorm-derived winds, create small gaps in the canopy by blowing down individual or small groups of large, older, overstory trees, but leave the understory intact. These gaps provide sunlight to existing but suppressed seedlings and saplings in the understory.

Wildlife

Mature stands of mixed hardwoods, including yellow birch, oaks, and maples, produce hard mast and seeds, which are staple food sources for wildlife. Vernal pools, or ephemeral wetlands (areas often wet after spring snowmelt but dryer at the end of summer), are common and serve as breeding habitat for frogs, salamanders, and a host of macro-invertebrates. They also provide ideal stopover sites for migrating birds. Mature hardwood forests are relatively stable and can look largely the same for many decades, perhaps even hundreds of years. Habitat is maximized when mature forest is interspersed with younger forests at various stages of succession in the nearby landscape.

Young aspen forests provide dense escape and brood-rearing cover for a suite of species that includes Ruffed Grouse, American Woodcock, Golden-winged Warbler, Mourning Warbler, and Chestnut-sided Warbler. The suckering nature of aspen regeneration makes it the single-easiest species to create dense deciduous forests. The trees themselves are also the preferred food of moose and white-tailed deer. The density of stems means that browsing by these animals does not prevent the stand from regenerating. Aspen self-thin throughout their lifecycle, leading to a lot of coarse woody debris and escape cover on the forest floor, providing habitat for small mammals. Aspen is plagued by heart rot as it ages, making it ideal for cavity-nesting species to carve out a home. Pileated Woodpeckers, Wood Ducks, chickadees, pine marten, and fisher often den in hollow aspen.

Additionally, their open canopy makes excellent nesting spots for stick nest builders like Broad-winged Hawks, American Goshawks, ravens, crows, and owls that reuse old nests built by other species.

General trend of forest type

As the climate continues to change, forests and accompanying bird habitats may be moderately to significantly vulnerable to increased threats from pests, diseases, and drought (and associated wildfire). The adaptive capacity of diversified upland deciduous/mixed-conifer forests ranges from low for the more boreal aspen-birch type to high for oak and northern hardwoods. Overall temperatures are expected to rise, particularly in the winter, resulting in fewer days with frozen ground. The growing season will become longer, with increased chances of summer droughts.

Across the whole state of Minnesota, habitat suitability is projected to decline substantially for quaking aspen, a species already on the southern edge of its habitat range in Minnesota, with some models predicting 50–75% reductions in suitable habitat across the state over the next century. Closely associ-

ated species like paper birch and balsam fir may have similar trajectories. Conversely, both northern hardwood forests and oak forests may gain suitable habitat in the state but may be challenged by invasive species, insects, or disease and may be slow to naturally fill the gaps left by a loss of aspen-birch without intentional planting efforts.

Within this broad forest habitat type, about half the tree species present may increase and half may decrease as the climate warms. Species likely to increase include red maple, bur oak, white oak, sugar maple, and American basswood. Tree species likely to decrease include quaking aspen, paper birch, balsam fir, and yellow birch. Red oak may be stable in the future relative to today.

FMNB PRIORITY SPECIES	KEY HABITAT FEATURES
American Woodcock	Males need open areas for breeding displays; females use variety of mixed forests
Canada Warbler	Closed canopy, dense understory, structurally complex forest floor
Golden-winged Warbler	Young forests, scattered large trees
Pileated Woodpecker	Large-diameter trees for nesting, roosting, and feeding
Red-headed Woodpecker	Open oak and pine savanna, clear understories, many snags for feedings/ nesting
Ruffed Grouse	Hardwood and aspen stands with dense overstories, mix of young and old stands
Scarlet Tanager	Large, undisturbed mature mixed forests
Wood Thrush	Mature deciduous forests with few conifers
Yellow-bellied Sapsucker	Snags, aspen with variety of age classes and trees with sapwells
ADDITIONAL WILDLIFE SPECIES	**KEY HABITAT FEATURES**
Moose	Large regenerating forested areas of mixed deciduous and coniferous forest with mature reserve patches scattered throughout
Black Bear	Large forested areas, hard mast, downed woody debris
Flying Squirrel	Forested areas with cavity trees
Fisher	Mature deciduous and mixed forest with large cavity trees, large, downed woody material
Blue-spotted Salamander	Mature mesic forest with ephemeral ponds, downed woody material, leaf litter

LOWLAND CONIFER FORESTS

Common Forest Types

- Black spruce
- Northern white cedar
- Tamarack

Identification

Lowland conifers, primarily composed of black spruce, tamarack, and northern white cedar, are found on nearly 3.5 million acres, or about 21% of Minnesota's forested lands.[13] Lowland conifers occupy wet sites often classified as bogs or swamps. Depending on site characteristics, all three lowland conifer tree species can be found growing together, or, more often, one species will make up the majority of the trees present — for example, a black spruce bog or a cedar swamp. One of the largest peatland areas found in the state is north of Red Lake, an area nearly 50 miles long and 9 miles wide dominated by largely intact and undisturbed peatlands.[14]

Lowland Conifer Forest. © Ryan Pennesi

Ecology/Natural History

Lowland conifers are found predominantly on low, wet peatlands, which are areas of partially decayed plant matter. Saturated soils, a short and cold growing season, and a low oxygen environment combine to create very slow decomposition and gradual buildup of peat over hundreds of years. Sphagnum moss, sometimes very thick and forming a dense floating mat, can be found on many of these sites. Peatlands contain a vast amount of stored carbon in the form of partially decomposed plant material.

Wildlife

Lowland conifer sites are home to Great Gray Owls, Spruce Grouse, and snowshoe hare, and can provide important deer

wintering areas by offering thermal protection. The dark green and dense tree cover helps absorb heat, decrease snow depths, and moderate cold winter winds.

General trend of forest type

Most of Minnesota's lowland conifers exist in the northern part of the state. Black spruce and tamarack in the state exist on the southern edge of their range and as such are particularly vulnerable to the impacts of climate change. Variable precipitation and warmer temperatures make these forest types vulnerable.

The lowland conifer forest habitat type is particularly susceptible to a warming climate. All of the major species are predicted to decline. These include black spruce, northern white cedar, and tamarack.

One particular concern with tamarack is the increasing damage being done to stands throughout the state by the native Eastern larch beetle, which has decimated hundreds of thousands of acres over the past 20 years. Since the beginning of the outbreak in 2001, over a million acres, or 75% of mature tamarack forest in Minnesota, have been impacted to some degree.[15] The beetle appears to be surviving winters in increasingly high numbers. Northern white cedar trees are very susceptible to herbivory by snowshoe hare and white-tailed deer, which are surviving in increasingly higher numbers farther north in the state, browsing seedlings faster than they can grow to replace older, mature, overstory trees. Most cedar stands are failing to successfully replace older trees succumbing to age. Adding to these stressors is the increasing average age of most lowland coniferous forests.

FMNB PRIORITY SPECIES	KEY HABITAT FEATURES
Connecticut Warbler	Mature lowland conifer forests, park-like understory, sphagnum moss
Golden-crowned Kinglet	Dense conifer forests with large trees, esp. lowland conifers
ADDITIONAL WILDLIFE SPECIES	**KEY HABITAT FEATURES**
Bog Lemming (Northern and Southern)	Mature tamarack/spruce with open sphagnum areas and ericaceous shrubs, such as blueberries
Snowshoe Hare	Mature lowland conifer forest with dense understory
Great Gray Owl	Mature lowland forest adjacent open bog, riparian area or forested wetlands
Swainson's Thrush	Mature lowland conifer forest with areas of dense conifer understory
Palm Warbler	Open areas with scattered stunted spruce, sphagnum moss and scattered deciduous shrubs
Spruce Grouse	Mature lowland conifer forest with open understory, sphagnum moss and ericaceous shrubs, scattered pockets of dense conifer saplings

LOWLAND HARDWOOD HABITAT ASSOCIATION

Common Forest Types and Associated Tree Species

- Black Ash – Black ash, yellow birch, red maple, quaking aspen, balsam poplar;
- Bottomlands – Silver maple, american elm, black and green ash, Eastern cottonwood, balsam poplar, black willow.

Identification

Lowland hardwood forest habitats can be found primarily in two types of areas: **black ash-dominated** low depressional wetlands that may be wet for most of the year or seasonally, especially in the spring, or along riparian areas such as lakeshores and the banks of rivers and streams. Lowland hardwood areas can also be found along artificial embankments that act as dams and can pool water, such as along railroad tracks, roadways, or pipeline corridors. Minnesota is home to more black ash — about one billion trees, or 8% of all the trees in the state — than any other state.[16] Where the water tends to be more stagnant or pooled, black ash generally predominates. On other sites, such as along rivers and streams, **bottomland hardwood** species such as American elm, silver maple, green ash, or Eastern cottonwood may predominate. In addition to being uniquely adapted to wet environments, black ash also has unique wood characteristics that make it well-suited for making snowshoes and ash baskets.

Ecology/Natural History

The habitat structure of lowland hardwood forest types is driven by windthrow and fire disturbances and changes to sur-

Black Ash Forest. © Eli Sagor

face (e.g., flooding) and groundwater. Windthrow, often aided by ice and snow accumulation, creates small gaps. Regeneration is dependent on gap size and is influenced by the surrounding seed source and hydrological conditions. Seedlings in these wet environments often germinate on hummocks and on decaying logs and stumps ("nurse logs"), where they can get above the saturated soils.

Bottomland Forest. © Eli Sagor

Wildlife

Black ash stands support a wide variety of breeding birds. Research is ongoing to study the impacts emerald ash borer may have beyond the trees themselves — for example, if certain birds, or insects important to birds, are fully dependent on ash trees or if other tree species can meet their needs. Birds commonly associated with black ash stands include the black-capped chickadee, common yellowthroat, northern parula, northern waterthrush, and especially the brown creeper, great crested flycatcher, and winter wren, which are listed as species of greatest conservation need (SGCN) in Minnesota. Bottomland forests provide habitat for woodpeckers, wood ducks and other tree cavity nesting ducks, Barred Owls, hawks (including Broad Wing and Red-shouldered Hawks), Great Blue Heron rookeries, and raccoons, as well as beavers that can create ponds that provide habitat critical to several species like turtles, salamanders, and frogs.

General trend of forest type

Lowland black ash and bottomland forests are under pressure from a variety of threats that may dramatically impact their health into the future. Bottomland forests are currently declining in extent in the Minnesota and Mississippi River Valleys as mature trees die during extended flood seasons and they are not being replaced due to poor tree regeneration caused by the prevalence of dense reed canary grass. Droughty summer conditions can also negatively affect tree species that grow shallow roots to avoid saturated soils. Stands that are fed primarily with groundwater or are in low-lying areas are better able to withstand droughts and water fluctuations. Bottomland forests tend to feature species with more southerly ranges, which may increase their ability to adapt to a changing climate.

About half of the species found in the lowland forest type may decrease and half increase under a warming climate or other environmental factors. Species predicted to decline include black ash (especially with emerald ash borer), balsam poplar, quaking aspen, and yellow birch. Species that may increase in abundance include American elm (Dutch elm disease may negate the more favorable environment), Eastern cottonwood, green ash (emerald ash borer will likely prevent actual gains), red maple, and silver maple.

Due to the non-native invasive insect, the emerald ash borer, black and green ash is predicted to continue to be substantially reduced or decimated across Minnesota. As ash, especially black ash, is virtually eliminated from a site, the water table can rise due to decreased water use (i.e., transpiration), which may lead to the site "swamping out" (i.e., becoming too wet) for any ash or other species remaining on the site. This can, in turn, lead to the entire forested wetland area converting into a non-forest type, such as a cattail swamp, alder swamp, or pond. If this happens, potentially hundreds of thousands of acres of forested wetland sites could be lost along with the habitat it provides for birds dependent on it.

FMNB PRIORITY SPECIES	KEY HABITAT FEATURES
Cerulean Warbler	Tall, mature deciduous trees, scattered openings, adjacent to streams and rivers
Prothonotary Warbler	Large lowland deciduous forests with 50%+ canopy cover, open understory
Winter Wren	Wet-mesic conditions with coarse woody debris and upturned trees with exposed roots
Yellow-billed Cuckoo	Dense shrubby vegetation, alder and willow thickets
ADDITIONAL WILDLIFE SPECIES	**KEY HABITAT FEATURES**
American Beaver	Forested riparian areas and wetlands
Boreal Chorus Frog	Forest openings and wetlands
Barred Owl	Dense mature forest riparian areas, large-diameter cavity trees
Northern Waterthrush	Mature forest riparian areas, tip-up mounds
Wood Turtle	Small to medium sized fast-moving water with sand or gravel substrate with adjacent alder thickets, forests, or grasslands.

Climate Change Vulnerability/Adaptability Tables

The following tables show how the habitat for a given tree species will either increase or decrease in suitability by the year 2100 based on Tree Atlas[17] models under a continued high carbon emissions scenario (i.e., if CO2 emissions aren't greatly reduced from today's levels). If a species' adaptability is high, they may do better than models currently suggest due to variables not included in the models, and if low, they may do worse.

UPLAND CONIFER FOREST HABITAT ASSOCIATION - Climate Change and Tree Species

SPECIES	INCREASE / DECREASE	ADAPTABILITY
Balsam fir	Decrease	Low
Black spruce	Decrease	Medium
Jack pine	Decrease	Medium
Northern white cedar	Decrease	Medium
Red pine	Increase	Medium
Tamarack	Decrease*	Low
*Tamarack with ELB	Large Decrease	Low
White pine	Increase	Medium
White spruce	Decrease	Medium
*ELB = Eastern Larch Beetle, a native insect increasingly problematic		

UPLAND DECIDUOUS AND MIXED-CONIFER HABITAT ASSOCIATION – Climate Change and Tree Species

SPECIES	INCREASE / DECREASE	ADAPTABILITY
Quaking aspen	Decrease	Medium
Paper birch	Decrease	Medium
Red maple	Increase	High
Balsam fir	Decrease	Low
Red oak	No change	High
Bur oak	Increase	High
White oak	Increase	High
Sugar maple	Increase	High
American basswood	Increase	Medium
Yellow birch	Decrease	Medium

LOWLAND CONIFER FORESTS – Climate Change and Tree Species

SPECIES	INCREASE / DECREASE	ADAPTABILITY
Black spruce	Decrease	Medium
Tamarack	Decrease*	Low
*Tamarack with ELB	Large Decrease	Low
Northern white cedar	Decrease	Medium
*ELB = Eastern Larch Beetle, a native insect increasingly problematic		

LOWLAND HARDWOOD FOREST HABITAT TYPE – Climate Change and Tree Species

SPECIES	INCREASE / DECREASE	ADAPTABILITY
Black ash	Decrease*	Low
*Black ash with EAB	Large Decrease	Low
American elm	Increase	Medium
Balsam poplar	Decrease	Medium
Eastern cottonwood	Increase	Medium
Green ash	Increase*	Medium
*Green ash with EAB	Large Decrease	Low
Quaking aspen	Decrease	Medium
Red maple	Increase	High
Silver maple	Increase	High
Yellow birch	Decrease	Medium
*EAB = Emerald Ash Borer, a non-native, invasive insect		

The Importance of Conifer Trees to Wildlife

CONIFER SPECIES	EXAMPLES OF USE BY WILDLIFE
Balsam fir	Important winter and summer cover for deer, moose, and many species of birds. Birds eat seeds and use trees for nesting. Winter browse for moose.
Black spruce	Important escape and severe winter cover. Birds eat seeds and use trees for nesting. Buds and needles are important spruce grouse food.
Eastern red cedar	Important winter cover. Berry-like cones are used by birds for food.
Hemlock	Mature trees provide important owl roosting sites. Limited range in Minnesota. Hemlock is particularly important for Blackburnian warblers.
Jack pine	Very good cover when trees are young. Used as browse. Buds and needles are important spruce grouse food. Seeds eaten by red squirrels. Persistent cones provide a year-round food source.
Red pine	Mature trees may be used by raptors for perches or nest trees. Seeds are important mast for winter birds and red squirrels.
Tamarack	Mature stands provide excellent habitat for owls. Snags are used as hunting and singing perches.
Northern white cedar	Mast is an important food source. Cedar provides winter cover for deer. It is important for browse (food) during severe winters. Provides cover and cooling effect near water.
White pine	When young, provides good escape and severe weather cover for many species. High calorie, large seeds eaten by many small mammals and winter birds. Mature trees are important for cavity- dependent wildlife, preferred bald eagle nest trees, and escape trees from bears. Roosting trees for wild turkeys.
White spruce	Important seed source for winter finches. Summer nest cover for birds. Black-backed woodpeckers forage under bark for insects.

Source: Minnesota Forest Resources Council [18]

Native Plant Community Descriptions

Acid Peatland System – These low, wet areas are characterized by conifers, low-growing shrubs, or grass-like species. They tend to be water-saturated, highly acidic, and very low in available nutrients, which limits both what species are able to grow on these sites and the rate at which they can grow. They are often stocked with dense, small, very old black spruce trees or, if particularly wet, can be very open with scattered small, old trees. Associated forest habitat type: lowland conifer forests.

Fire-dependent System – Very common in the northern part of the state but present throughout, these areas, as the name suggests, have historically been shaped by fire (sometimes small and frequent surface fires, sometimes large and infrequent crown fires), which creates conditions suitable for certain fire-adapted tree species such as jack pine, paper birch, aspen, and oaks. Jack pine cones have resins that melt from the heat of fire and allow the cones to open and drop seeds onto freshly burned ground. Paper birch and aspen have small seeds, easily carried long distances by the wind, that grow well on the bare soils present after a fire moves through an area. Aspen also sprout prolifically from the roots (a process called suckering) when overstory trees are burned, windthrown, or felled. Oaks have thick bark that allows them to survive all but the largest fires. Newly germinated acorns grow best on bare soil with a partially open canopy, providing enough sun for them to grow but enough shade to allow them to stay moist during dry periods. Associated forest habitat type: upland conifer, upland deciduous and mixed-conifer, lowland conifer forests.

Floodplain Forest System – Generally found just over the banks of river and stream systems where water can pool after

annual seasonal flooding such as after snowmelt or occasionally after particularly heavy or sustained rains. Deciduous trees such as cottonwoods, elms, silver maples, black and green ash, and willows dominate these sites that are prone to water-saturated soils and frequent erosion, or deposition of sediment carried in by floodwaters. Often the understory can be open, almost park-like. Associated forest habitat type: lowland hardwood forests.

Forested Rich Peatland System – Dominated by conifer species such as black spruce in the northern part of the state, red maple in the south, and shrubs in the northwest, these wet sites exist on the accumulation of hundreds or thousands of years of peat (partially decomposed plant matter), which helps differentiate them from other wet systems like wet forests or floodplain forests. Associated forest habitat type: lowland conifer forests.

Mesic Hardwood System – These sites often have the highest tree species diversity of any of the other systems. They have nutrient-rich soils capable of retaining soil moisture, which favors steady and reliable plant and tree growth. The moisture and the shade created by a tall, well-developed tree layer keeps these areas cool and moist and less prone to wildfire except during the worst droughts. Sugar maple, basswood, paper birch, and oaks are characteristic of these sites, along with a rich shrub layer and understory plant layer. Wind, especially from summer thunderstorms, can take down single or small groups of large, overstory trees, opening the canopy so smaller seedlings and saplings can grow. Associated forest habitat types: upland deciduous and mixed-conifer forests.

Wet Forest System – Commonly occurs in narrow zones along the margins of lakes, rivers, and peatlands, or inland in shallow depressional areas ("low spots") surrounded by more upland forests. They can also occur adjacent to roads, railroads, and pipeline corridors when those features act as dams. The water table is typically very high, with standing water present after spring snowmelt and then just below the surface except during exceptionally dry drought-like conditions. Black ash, white cedar, and red maple are commonly found in the overstory, and a shrub layer of alder or mountain maple may or may not be present. Associated forest habitat type: lowland hardwood forests.

Pileated Woodpecker. © Jordan Feeg, Shutterstock

Glossary

Acre: An area of land approximately 209 feet by 209 feet, or 43,560 square feet. A square-shaped 40-acre parcel is ¼ mile by ¼ mile. A section is 640 acres or 1 mile by 1 mile.

Advanced regeneration: Tree seedlings or saplings established and growing underneath an existing overstory canopy of trees. Assess the quality to assure viability if relying on advanced regeneration to populate a site after timber management activities.

Basal area: A forestry term literally meaning the total cross-sectional surface area, measured in square feet, of all the trees in the stand at approximately 4.5 feet above the ground. In practice, it refers to how many trees per acre are in a stand. For reference, a city park may have approximately 10–50 square feet of basal area, a mature aspen, northern hardwood, or oak stand may have 70-120 square feet, and a dense pine plantation may exceed 150 square feet.

Biodiversity: The variety of life forms and relative complexity of species and ecosystems.

Biogeography: The study of the distribution of species and ecosystems in geographic space and through geological time.

Biological legacies: Organisms, structures, or patterns present in a stand due to past forest management, ecological disturbance, or other factors and potentially at risk without intentional consideration.

Biome: A distinct geographical region with specific climatic conditions, vegetation, and animal life. Minnesota has four distinct biomes.

Canopy gap (gap): Opening in the forest canopy that allows light to reach the mid- and understory layers as well as the ground. Gaps, or openings, also provide areas for birds and bats to catch insects in-flight (i.e., "hawking").

Cavity tree: A living tree with a hole or holes suitable in size for nesting by birds or denning by mammals. Sometimes referred to as a den tree or wildlife tree. Compare with snag.

Climate vulnerability: An assessment of the risk to a given species from the impacts of climate change in regard to exposure, sensitivity to projected habitat change, and adaptability.

Cohort: An aggregation of trees approximately the same age in a stand that starts as a result of a single disturbance, such as wildfire or forest management.

Coarse woody debris (CWD): See down woody material.

Crop tree: A particular tree chosen for long-term growth and health through forest management activities.

Down woody material: Logs and limbs on the forest floor often subdivided into fine (small) and coarse (large) down woody material.

Duff: The partially decomposed organic material of the forest floor beneath the litter of freshly fallen needles, leaves, and twigs. Duff retains soil moisture and moderates temperature while providing habitat for insects, fungus, and, in turn, birds.

Feathered edge: A gradual or soft transition between two habitat types, often one forested and the other non- forested, accomplished by gradually decreasing tree density as the non-forest edge is approached.

Forest age class: A distinct grouping of trees originating from a single natural event or regeneration activity.

Forest habitat association: Broad grouping of forest types that provide similar habitat features.

Forest management: The practical application of biological, physical, quantitative, managerial, economic, social, and policy principles to the regeneration, management, utilization and conservation of forests to meet specified goals and objectives.

Forest stand: A contiguous group of trees sufficiently uniform in age-class distribution, composition and structure, and growing on a site of sufficiently uniform quality to be a distinguishable and manageable unit. Generally, a stand must be three or more acres or it is considered an inclusion within a surrounding, larger stand.

Forest structure: Arrangement of woody vegetation in the forest; may be classified horizontal arrangement (i.e., across the land) or as the following vertical layers:

- **Overstory:** Uppermost layer of forest vegetation including twigs, branches, cavities and trunks in the tallest trees
- **Midstory:** Intermediate layer of forest vegetation including young trees and shrubs
- **Understory:** Lower layer of forest vegetation including small shrubs, grasses and herbaceous vegetation

Gap (canopy gap): Opening in the forest canopy that allows light to reach the mid- and understory layers as well as the ground. Gaps, or openings, also provide areas for birds and bats to catch insects in-flight (i.e., "hawking").

Habitat fragmentation: The process by which a landscape is broken into small islands of forest within a mosaic of other forms of land use or ownership, negatively affecting the movement and dispersal of animals.

Hardwoods: Broadleaved deciduous trees that lose leaves in autumn.

Hawking: The act of catching flying insects in the air. Many species of birds, as well as bats, feed this way.

Inclusion: A small group of trees (typically <3 acres) within and unlike the surrounding forest stand but too small to be considered a separate stand. Example: a 1-acre group of aspen within a northern hardwood stand.

Invasive species: A non-native species (i.e., a species not present before European settlement) that causes ecological or economic harm and generally spreads readily.

Landscape: A broad area surrounding a given forest stand. In this guide, generally the area encompassing an area approximately one mile around the forest stand of interest.

Leaf litter: The surface layer of the forest floor that is not in an advanced stage of decomposition, usually consisting of freshly fallen leaves, needles, twigs, stems, bark and fruits. See also duff.

Leave tree: A tree usually with commercial timber value intentionally left uncut after forest management activities for the purpose of providing wildlife habitat, a seed source, shade, or for aesthetic reasons.

Legacy tree: A tree, generally near its maximum size and age, intentionally left uncut after forest management activities.

Migration: Where a given bird species lives throughout the year.

- **Resident:** Year-round resident of Minnesota
- **Short-distance migrant:** Breeds in Minnesota and winters in the Southern U.S.
- **Medium-distance migrant:** Breeds in Minnesota and winters in the Caribbean, Central America, and Mexico
- **Long-distance migrant:** Breeds in Minnesota and winters in South America

Native plant community: A collection of plants indicative of underlying soil characteristics, local climate, and ecological processes. Often abbreviated as "NPC".

Pesticides: A chemical preparation used to control individual or populations of injurious organisms such as invasive or undesired plants, insects, or fungus.

Population status: An indication of the relative health and population trends of a species locally and across its entire range. Like, and often used interchangeably with, conservation status.

Riparian: An area adjacent to a water source such as a stream, pond, lake, or wetland.

Rotation: The age of a tree, based on biological or economic factors, when forest management activities are considered. For example, aspen is often cut at age 40 when rotation age is based on economic factors, or 60 year or older if based on biological factors.

Sapwell tree: A tree with rows of shallow holes drilled by Yellow-bellied Sapsuckers to increase sap flow, which can trap insects used as food.

Shade tolerance: The ability of a plant or tree to grow in shade, often divided into intolerant plants that need full sun (ex. aspen), mid-tolerant plants that can grow in partial shade (e.g., American basswood), and tolerant plants that can grow in full-shade (ex. Balsam fir or sugar maple).

Silviculture: The art and science of growing and tending trees.

Snags: Free-standing dead trees often used for feeding or perching. Compare with cavity tree.

Softwoods: Coniferous trees with needles (ex. balsam fir, cedar, spruce, pine, tamarack).

Stand: *See* forest stand.

Structure: *See* forest structure.

Succession: The change in forest composition, specifically to trees and other plants, over time. Early-succession generally refers to a forest soon after a major disturbance.

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Forestry for Minnesota Birds – Additional Resources

Bird Identification and Information Resources

All About Birds Online Guide by the Cornell Lab An online guide to birds and birdwatching. Includes information on: Bird ID Skills; Feeding Birds; FAQ's and Common Problems; Bird Friendly Homes and more. allaboutbirds.org

American Bird Conservancy (ABC) Bird identification information, threats and solutions, events, news, and more. https://abcbirds.org/

Audubon Minnesota Information about "Important Bird Areas" (IBA's) that provide essential habitat for breeding, wintering, and migrating bird species. https://mn.audubon.org/node/4281

Audubon Online Guide to North American Birds App Features a catalog of North American bird species information, songs, climate vulnerability and more. https://www.audubon.org/app

Audubon Upper Mississippi River Information and resources for the Upper Mississippi River chapter of the Audubon society. https://umr.audubon.org/

BirdCast When, where, and how far will birds migrate? How many birds passed last night? These tools help you explore the answers to these and many other questions about bird migration. https://birdcast.info/

Bird Watcher's Digest What bird is that? Consult our bird identification guide to ID mystery birds in the backyard and beyond. We have photos, song recordings, in-depth entries, and more to help bird watchers correctly identify the birds they spot. https://bwdmagazine.com/bird-identification/

iNaturalist A place to record and organize nature findings, meet other nature enthusiasts, and learn about the natural world.

Merlin Smartphone App by Cornell Lab Answer three simple questions about a bird you are trying to identify and Merlin will come up with a list of possible matches. It can also identify birds by sound. Merlin offers quick identification help for all levels of bird watchers to learn about the birds across the Americas, Europe, Asia, Africa and Oceania. This app is free to download. https://www.allaboutbirds.org/guide/merlin/

Minnesota Ornithologist' Union (MOU) Bird information, sightings, galleries, seasonal reports, events, and more. https://moumn.org/

The Minnesota Breeding Bird Atlas (MNBBA) documents the distribution and provides information for every species that currently breeds in Minnesota and provides a solid foundation for future conservation efforts. https://mnbirdatlas.org/

A 616 page hardcover book, a comprehensive, detailed, illustrated history of Minnesota's breeding birds—the first in nearly a century, is available from the University of Minnesota Press: https://www.upress.umn.edu/9781517906795/the-breeding-birds-of-minnesota/

Sibley Birds V2 Smartphone App The app based on the Sibley Guide to Birds includes all of the content in the printed guide as well as over 2,800 audio recordings, additional text, complete seasonal status data for every species in every state and province, hundreds of searchable criteria, and much more. There is a cost associated with this app. https://www.sibleyguides.com/product/sibley-birds-v2-app/

University of Minnesota (U of MN) Natural Resources Research Institute (NRRI) Avian Ecology Lab. https://nrri.umn.edu/research/avian-ecology-lab

Upper Mississippi / Great Lakes Joint Venture (UMGL JV): Information, news, and resources for partnerships from a diverse and large group of organizations working towards bird and bird habitat conservation. https://umgljv.org/

U.S. Forest Service (USFS) – Climate Change Bird Atlas The Climate Change Bird Atlas allows you to find information about both trees and birds and how they may fare under different climate change models. https://www.fs.usda.gov/nrs/atlas/bird/

Climate Change Resources

Great Lakes Indian Fish and Wildlife Commission – Aanji bimaadiziimagak o'ow aki (Climate Change Vulnerability Assessment) – Traditional and scientific ecological knowledge report on projected climate change impacts within the Ceded Territories (primarily forested areas of Northern Michigan, Minnesota, and Wisconsin). https://glifwc.org/ClimateChange/VulnerabilityAssessment.html

National Audubon Society's Climate Change Audubon scientists used more than 140 million observations, recorded by birders and scientists, to describe where 604 North American bird species live today—an area known as their "range." The latest climate models were then used to project how each species' range will shift as climate change and other human impacts advance across the continent. More than two thirds of North American bird species are at risk from climate change. https://www.audubon.org/climate/survivalbydegrees

Northern Institute of Applied Climate Science (NIACS) The United States Department of Agriculture (USDA) Northern Forests Climate Hub and the Northern Institute of Applied Climate Science provides information and practical advice for land managers to help forests adapt to changing climate conditions. https://forestadaptation.org/adapt

Climate Change Field Guide for Northern Minnesota Forests: Site-Level Considerations and Adaptation https://forestadaptation.org/learn/resource-finder/MN_field_guide

U.S. Forest Service (USFS) Climate Change Atlas for both Birds and Trees Examine distributions of current and modeled future habitat quality for many individual tree species within the eastern United States. Explore regional species summary tables to see how tree species habitat quality may change. https://www.fs.usda.gov/nrs/atlas/bird/

University of Minnesota Extension (U of MN) – Climate Ready Woodlands Strategies for adapting forests to a changing climate as well as a list of suitable plant and tree species for 11 different regions across the state. https://extension.umn.edu/managing-woodlands/climate-ready-woodlands

Cost Share Programs

Minnesota Department of Natural Resources (MNDNR) Cost-share programs provides financial assistance to private woodland owners for a wide variety of forestry-related practices. https://www.dnr.state.mn.us/woodlands/cost-share.html

Natural Resources Conservation Service (NRCS) Cost Share In addition to technical assistance, NRCS offers several financial assistance to landowners to help with the cost of conservation plan development as well as with implementation of planned activities. Programs including the Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP) can provide funding for Forest Management Plans, forest stand improvement, invasive species control practices, tree and shrub planting, wildfire mitigation practices, and much more. https://www.nrcs.usda.gov/conservation-basics/conservation-by-state/minnesota/forestry-minnesota

Partners for Fish and Wildlife Program (USFWS) The Partners for Fish and Wildlife program provides free technical and financial assistance to landowners, managers, tribes, corporations, schools, and nonprofits interested in improving wildlife habitat on their land. Find your national and regional contacts here: https://www.fws.gov/program/partners-fish-and-wildlife/contact-us

Finding a Forester

Minnesota Department of Natural Resources (MNDNR) – Forestry DNR foresters can answer questions about your woods and help you find the right programs to meet your woodland goals. Additional resources include tax incentive programs for forest landowners, a list of consulting foresters in your area, forest stewardship plan writing resources and more. https://www.dnr.state.mn.us/foreststewardship/index.html

Minnesota Logger Education Program (MLEP) The MLEP provides ongoing educational programming to loggers on the most current methods for sustainable forest management, transportation, safety, and business management. MLEP certified loggers are required to complete qualified trainings and workshops annually. A directory of MLEP certified loggers can be found at: https://www.mlep.org/mlep/Logger_Training_Directory.asp

Minnesota Soil and Water Conservation Districts (SWCD) Districts work in both urban and rural settings, with landowners and with other units of government, to carry out a program for the conservation, use, and development of soil, water, and related resources. A directory of local county districts can be found here: https://www.maswcd.org/

Natural Resources Conservation Service (NRCS) Your local Natural Resources Conservation Service (NRCS) office provides technical assistance to farmers, ranchers, and forest landowners. https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/land/forests

Biologists and American Bird Conservancy Foresters at these offices can help you evaluate your forest habitat elements and decide what steps to take next. NRCS staff can work with you to develop a conservation plan or may refer you to consulting foresters who are certified as Technical Service Providers for planning assistance. If your next steps include seeking financial assistance, development of a forest management plan may be necessary. Find your local NRCS Service Center here: https://offices.sc.egov.usda.gov/locator/app?agency=nrcs&state=mn

Forest Management and Ecological Information

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The Forest Stewards Guild – Foresters for the Birds Links to forestry for the birds publications, webinars, and events from other states across the U.S. https://foreststewardsguild.org/foresters-for-the-birds/

Minnesota Forest Resource Council (MFRC) Management Guidelines Minnesota's timber harvesting and forest management guidelines address the management, use, and protection of historic and cultural resources, riparian areas, soil productivity, water quality and wetlands, wildlife habitat, and visual quality. More information: https://mn.gov/frc/programs/forest/guidelines/

Minnesota Department of Natural Resources (MNDNR) – Ecological Classification System https://www.dnr.state.mn.us/ecs/index.html

Minnesota Department of Natural Resources (MNDNR) – Firewise Information about how to keep your house or community safe from wildfires, including landscaping considerations, construction and building materials, creating defensible space, and more. https://www.dnr.state.mn.us/firewise/index.html

Minnesota Department of Natural Resources (MNDNR) – Forester Assistance https://www.dnr.state.mn.us/woodlands/cfm-map.html

Minnesota Department of Natural Resources (MNDNR) – Native Plant Community Information https://www.dnr.state.mn.us/npc/index.html

Minnesota Prescribed Fire Council Information and resources related to the safe and effective use of prescribed fire for land and habitat management - https://www.mnprescribedfire.org/

Natural Resources Conservation Service (NRCS): Financial and technical assistance information for Minnesota private landowners and tribes. https://www.nrcs.usda.gov/conservation-basics/conservation-by-state/minnesota

North Shore Forest Collaborative Forest landowners along or near the North Shore of Lake Superior can find helpful information about restoring their forest by planting native species, controlling invasive plants and participating in landowner assistance programs and opportunities. https://northshoreforest.org/

Ruffed Grouse Society / American Woodcock Society Forest management information for Ruffed Grouse and American Woodcock. Click on the Western Great Lakes Regional page to find resources closest to you. Species specific forest management guides can be found in the Best Management Practices section below. https://ruffedgrousesociety.org/western-great-lakes-regional-page/

Sustainable Forestry Initiative - Minnesota Information for forest landowners about forest management, climate change, invasive species, threatened and endangered species, and more. https://www.mnsfi.org/landowner-manual

University of Minnesota (U of MN) Extension Extensive information for forest landowners related to forestry, wildlife, forest management planning, climate change, tree and shrub selection, planting, invasive species control, and more. More information: https://extension.umn.edu/natural-resources

U of MN – Sustainable Forests Education Cooperative Continuing education opportunities for foresters, natural resource managers, and the public. https://sfec.cfans.umn.edu/

Best Management Practices and Management Guides for Selected FMNBs Priority Bird Species

Below are links to more detailed forest management recommendations for selected birds, where available. Some of the guidelines were developed for areas outside of Minnesota but may still have useful information.

- American Woodcock: https://files.dnr.state.mn.us/assistance/backyard/privatelandhabitat/managing_for_woodcock.pdf
- Canada Warbler: https://naturecanada.ca/wp-content/uploads/2014/12/CAWA_BCR14_HabMgmt_en.pdf
- Cerulean Warbler: https://amjv.org/wp-content/uploads/2018/06/cerulean_guide_1-pg_layout.pdf
- Golden-winged Warbler: https://gwwa.org/wp-content/uploads/2020/06/GWWA-GLRegionalGuide_190711.pdf
- Golden-winged Warbler: additional resources for professionals: best-management practices, forest habitat specific guidelines, and much more: https://gwwa.org/for-resource-professionals/
- Ruffed Grouse – A 12-page document from MNDNR with forest management recommendations for several forest types: https://files.dnr.state.mn.us/recreation/hunting/grouse/managing_woodland_ruffed_grouse_flat.pdf
- Wood Thrush: https://com-bbimages.s3.amazonaws.com/bbimages/clo/pdf/thrushguide.pdf

Additional Threats to Birds

There are many additional human-caused threats to birds, driving overall declines in bird populations across North America. **The primary human-caused threats to birds include:**

- Cats outdoors (both feral and pets): Current research by the Smithsonian Migratory Bird Center and the U.S. Fish and Wildlife Service (UWFWS) estimate that free-roaming cats kill 1.3 to 4.0 billion birds and 6.3 to 22.3 billion mammals EVERY YEAR! More: https://www.allaboutbirds.org/news/faq-outdoor-cats-and-their-effects-on-birds/
- Glass collisions
- Communications tower collisions
- Wind turbines (collisions and habitat fragmentation)
- Vehicle collisions

Other threats that are harder to quantify, yet have direct impacts to birds include:

Pesticides

- Direct toxicity to birds ingesting coated seeds
- Indirectly impacts birds by reducing critical bird food supplies (insects)

Rodenticides

- Impact predatory birds who capture and eat a poisoned rodent

Heavy metal contaminants

- Lead shot or fishing sinkers are toxic to birds consuming fragments of lead in their prey (e.g., Bald Eagles and Common Loons consuming fish, or Turkey Vultures consuming carcasses)
- Mercury bioaccumulates through the food chain and harms breeding success of birds such as Tree Swallows, which may ingest mercury by eating insects that emerged as adults from wetlands, lakes, ponds, or rivers

Impacts of burning fossil fuels and other environmental pollution (e.g., water pollution)

- The number of birds harmed directly and indirectly by these sources of pollution are not yet well understood

Resources to better understand these additional threats, and how you can help protect birds:

- Bird-friendly Communities - Ideas to help transform your community into a healthier place for birds and people: https://saintpaulaudubon.org/conservation/bird-friendly-communities/
- Seven Simple Actions to Help Birds: https://www.birds.cornell.edu/home/seven-simple-actions-to-help-birds/
- Impacts of outdoor cats to birds: https://abcbirds.org/program/cats-indoors/cats-and-birds/

Preventing window collisions

- American Bird Conservancy's guide to window collision causes and solutions: https://abcbirds.org/glass-collisions/
- National Audubon Society's Lights Out program: https://www.audubon.org/our-work/cities-and-towns/lights-out

Contaminants

- Lead – MNDNR "Get the Lead Out project: https://www.dnr.state.mn.us/eco/nongame/projects/leadout.html

The Forestry for Minnesota Birds Forest Habitat Assessment Worksheet

Forestry for Minnesota Birds - Forest Habitat Assessment Worksheet

Date: **Property:**

Stand ID: **Stand Size (acres):**

Main Forest Type*:

*(upland conifer, aspen-birch, oak, northern hardwoods, lowland conifer, bottomland floodplain forest, bottomland ash)

Dominant overstory tree species (list one or two):

Average height of overstory trees (feet): **Average diameter (inches):**

Age of average overstory tree (years): **Native Plant Community System*:**

*(fire-dependent, mesic, floodplain, acid or rich peatland, wet forest)

Assess the number of canopy gaps you see, estimating the size, and record below:

Small Gap	Medium Gap	Large Gap
(<0.25 acres or <100 ft x 100 ft)	(up to 1/2 acre or 145 ft x 145 ft)	(up to 1 acre or 200 ft x 200 ft)

Average Canopy Cover in the Stand (see reference guide on back page):

	Species (trees, shrubs, plants)	Cover (Low, Med, High)
Overstory:		
Midstory:		
Understory:		
Ground plant layer:		

Softwood Inclusions - retain or promote at least some conifers (e.g., pine, spruce, or fir) in the stand.

Circle one:	Absent	Present	Notes/Species:

Snags - record the number of standing dead trees you see, measure diameter at chest height

Small/Medium	Large	High quality species?*	Notes:
>6-12 inches in diameter	>12 inches diameter	Percent of snags	

*Use the leave tree ranking guide on back page

Downed Wood on the Ground - assess logs on the ground

Course Woody Debris		Sparse	Abundant	Notes:
Large (12"+ diameter on big end)				
Small (<12" diameter on big end)				

Leaf litter depth (circle one):

N/A	Poor	Good	Notes:
Needles	<1.5"	>1.5"	

Notes:

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Forest Habitat Assessment Worksheet

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Water - ponds, streams, and wetlands

Water	Permanent	Seasonal	Notes:
(circle one)	Absent / Present	Absent / Present	

Invasive Species (note species and abundance, location)**:**

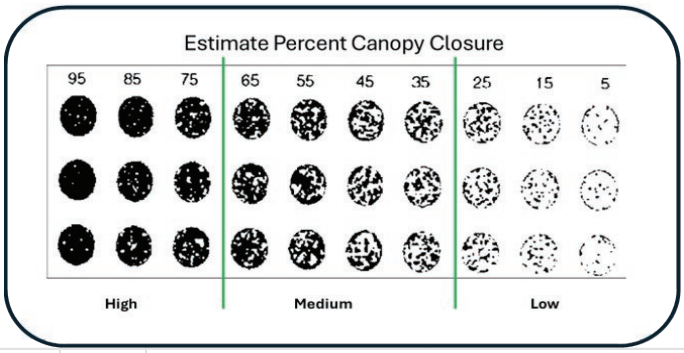
Birds Observed or Heard*:

*Consider using the Merlin app's sound ID feature and record the results here.

Wildlife Signs (observed, tracks, scat, etc.)**:**

Landscape-level notes (adjacent areas with noteable habitat considerations)**:**

Reference Material:



	Dimensions	
Acres	Sq. Ft	Square (feet x feet)	Circle - Radius (feet)
1	43,560	209	118
0.75	32,670	181	102
0.5	21,780	148	83
0.25	10,890	104	59
0.1	4,356	66	37

Example: 1 acre is a square 209 feet by 209 feet or a circle with a radius of 118 feet from the center to the outside.

Leave Tree Preferences for Longevity, Wind		
Excellent	**Good**	**Fair**
White pine	Red pine	Paper birch
Oaks	Tamarack	Balsam fir
Elms	Northern white cedar	Jack pine
Ashes	Red maple	Black spruce
Sugar maple	White spruce	Balsam poplar
Yellow birch	Black cherry	
Basswood	Hickories	
Aspens	Box elder	
	Cottonwood	
	Black walnut	
	Hackberry	

Important Habitat Elements - Canopy gaps, tree species diversity, cover in different vertical layers, tree size and age, conifer inclusions, snags, large and small downed-wood, leaf litter, water, invasive species, landscape (large scale) considerations.

The Forestry for Minnesota Birds
Forest Habitat Assessment Sample Worksheet

Forestry for Minnesota Birds - Forest Habitat Assessment Worksheet - Sample Sheet Filled Out

Date: June 1, 2025 **Property:** Sample Forest

Stand ID: 1 **Stand Size (acres):** 10

Main Forest Type: Upland Deciduous Mixed - Northern Hardwoods

*(upland conifer, aspen-birch, oak, northern hardwoods, lowland conifer, bottomland floodplain forest, bottomland ash)

Dominant overstory tree species (list one or two): Sugar maple, basswood

Average height of overstory trees (feet): 70 feet **Average diameter (inches):** 12 inches

Age, if known (years): 85 **Native Plant Community System*:** Mesic-hardwood

*(fire-dependent, mesic, floodplain, acid or rich peatland, wet forest)

Assess the number of canopy gaps you see, estimating the size, and record below:

Small Gap	Medium Gap	Large Gap
(<0.25 acres or <100 ft x 100 ft)	up to 1/2 acre or 145 ft x 145 ft	(up to 1 acre or 200 ft x 200 ft)
4	1	0

Average Canopy Cover in the Stand (check one for each vertical canopy layer)

	Species (trees, shrubs, plants)	Cover (Low, Med, High)
Overstory:	Sugar maple, basswood	High
Midstory:	Sugar maple, ironwood	Low
Understory:	Sugar maple	Low
Ground plant layer:	Sedges, trillium, jack in the pulpit	Med

this standmay benefit from a more developed midstory and understory

Softwood Inclusions - retain or promote at least some conifers (e.g., pine, spruce, or fir) in the stand.

Circle one:	Absent	Present	Notes/Species: no conifers observed in stand.

Snags - record the number of standing dead trees you see, measure diameter at chest height

Small/Medium	Large	High quality species?*
>6-12 inches in diameter	>12 inches diameter	Percent of snags
2	2	100%

Notes: create more

*Use the leave tree ranking guide on back page

Downed Wood on the Ground - assess logs on the ground

Course Woody Debris	Sparse	Abundant
Large (12"+ diameter on big end)	X	
Small (<12" diameter on big end)		X

Notes: create more large CWD

Leaf litter depth (circle one):

N/A	Poor	Good
Needles	<1.5"	>1.5"

Notes:

Notes:

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Forest Habitat Assessment Sample Worksheet

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Water - Ponds, Streams, and Wetlands

Water (circle one)	Permanent	Seasonal
	Absent / Present	Absent / Present

Notes:

Invasive Species (note species and abundance, location): **Buckthorn, NE corner, seed bearing trees and several dozen seedlings.**

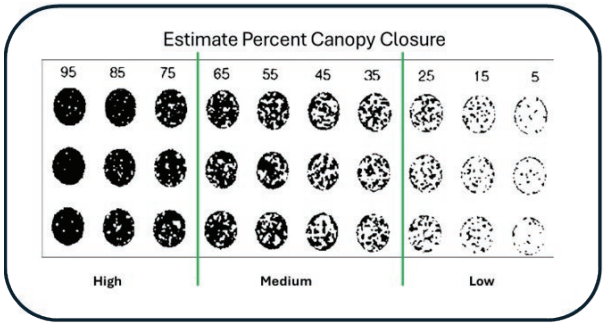
Birds Observed or Heard*: **Black-capped chickadee, hairy woodpecker, red-breasted nuthatch, blue jay, red-eyed vireo, wood thrush.**

*Consider using the Merlin app's sound ID feature and record the results here.

Wildlife Signs (observed, tracks, scat, etc.): **Gray squirrel nests, deer scat and browsed seedlings, black bear scat.**

Landscape-level notes (adjacent areas with noteable habitat considerations): **10-acre grass pasture to west, lowland conifer swamp to south, 5-year old aspen stand with no standing snags or older residual trees left on-site.**

Reference Material:



Use this chart to estimate canopy cover, low, med, or high

		Dimensions	
Acres	Sq. Ft	Square (feet x feet)	Circle - Radius (feet)
1	43,560	209	118
0.75	32,670	181	102
0.5	21,780	148	83
0.25	10,890	104	59
0.1	4,356	66	37

Example: 1 acre is a square 209 feet by 209 feet or a circle with a radius of 118 feet from the center to the outside.

Use this chart to estimate area.

Leave Tree Preferences for Longevity, Wind		
Excellent	**Good**	**Fair**
White pine	Red pine	Paper birch
Oaks	Tamarack	Balsam fir
Elms	Northern white cedar	Jack pine
Ashes	Red maple	Black spruce
Sugar maple	White spruce	Balsam poplar
Yellow birch	Black cherry	
Basswood	Hickories	
Aspens	Box elder	
	Cottonwood	
	Black walnut	
	Hackberry	

Important Habitat Elements - Canopy gaps, tree species diversity, cover in different vertical layers, tree size and age, conifer inclusions, snags, large and small downed-wood, leaf litter, water, invasive species, landscape (large scale) considerations.

Forestry for Minnesota Birds

Hermit Thrush eggs. © Ryan Pennesi