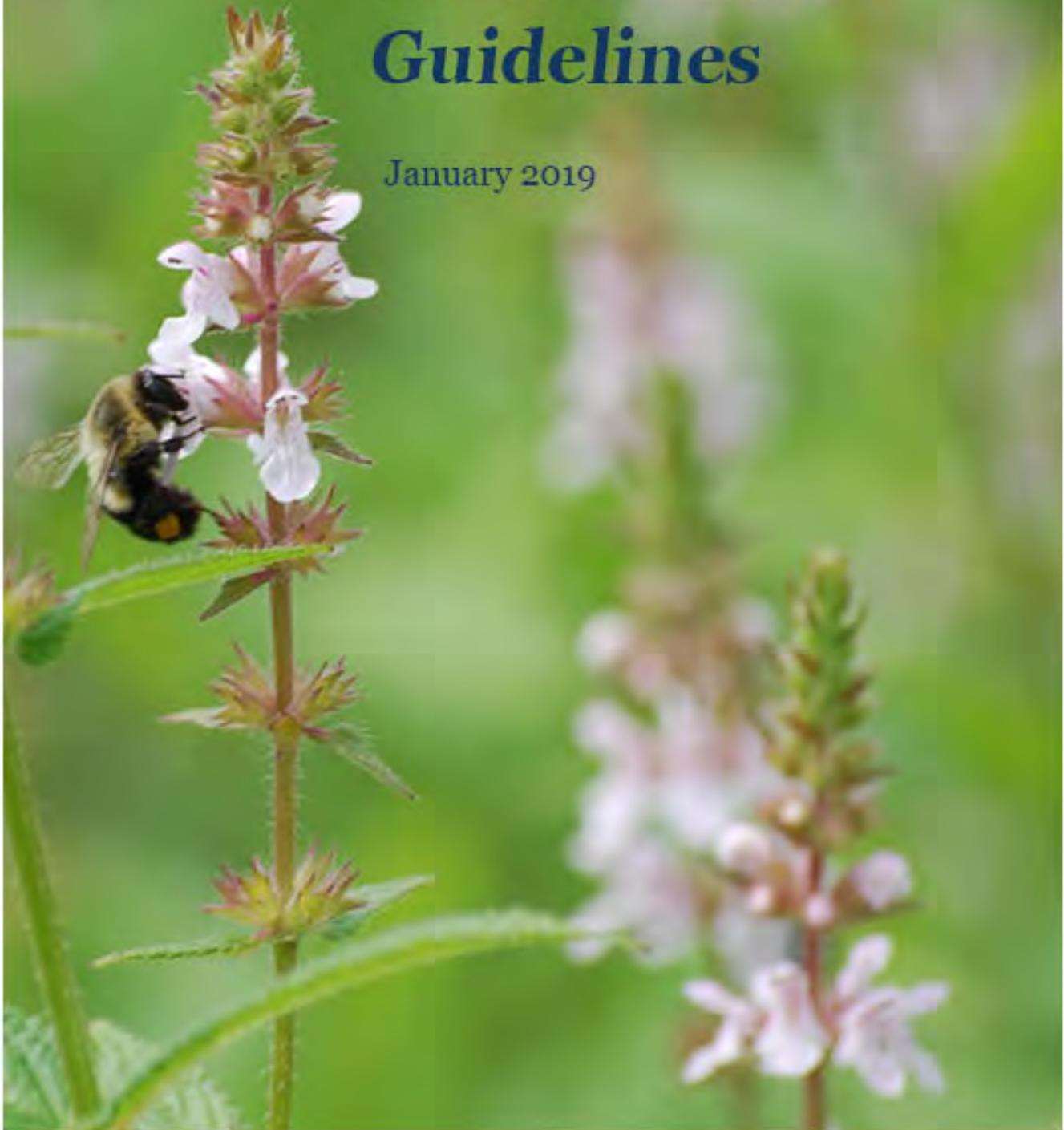




Native Vegetation Establishment and Enhancement Guidelines

January 2019



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Native Vegetation Establishment and Enhancement Guidelines

January 2019

Purposes: Native plants and plant communities play an essential role in sustaining environmental and human health, providing wildlife habitat, and adding resiliency to our landscapes. The purpose of these guidelines is to assist resource professionals and landowners across Minnesota in meeting state vegetation policies and standards and to guide the successful planting and management of restoration and other conservation projects. The guidelines are also designed to develop consistency among state programs; to avoid the use of [invasive species](#); and to ensure that plantings function at a high level and meet project goals. The guidelines will be updated periodically, as new research and field experience becomes available.



Contents: As listed below, the structure of the guidelines include an introduction summarizing their purpose, applicability and use; general considerations for the use of native vegetation; and specific guidance for a variety of project types.

General Considerations

Benefits of native vegetation; Strategies for restoring resilient, functional landscapes and maintaining ecological diversity; species diversity; Seed and plant sources; Native variety/cultivar use; Insecticides and chemical carryover; Seed mixes; Yellow tag seed; Invasive species, Prevention of palmer amaranth and other noxious weeds; Project bidding and specifications; Protecting natural communities; Riparian buffer planning and design, Restoring pollinator habitat, Climate change considerations

Project Site Preparation, Planting and Maintenance

Guidance by Project Type

Native Prairie Reconstruction; Pollinator Habitat; Wetland Restoration; Agricultural BMPs (including Agricultural Buffers); Stormwater Basins; Raingardens and Biofiltration Areas; Lakeshores, Forest/Woodlands; Native/Remnant Plant Community Restoration; Temporary Cover, Streambank Stabilization and Ravine Stabilization

Appendix A, Recommended Steps for Obtaining and Documenting Plant Materials

Appendix B, Definitions

Appendix C, Literature Cited

Applicability and Native Species Requirements

Requirements: These guidelines apply to all BWSR programs that have vegetation restoration components, as well as other state programs that have adopted the guidelines. These guidelines replace BWSR’s Invasive Non-Native Species Policy (Sept. 8, 2004). Environmentally suitable native annual, biennial and perennial plant species (following the source selection criteria included in the Guidelines) are required for projects to meet legislative requirements and provide multiple landscape benefits. See pages 9 and 10 for the seed and plant source sequence that must be followed for all BWSR-funded projects.

Flexibility: For BWSR funded projects, non-native species may be approved by BWSR’s Vegetation Specialist/Ecologist, Board Conservationists, RIM Technical Staff, Wetland Specialists, or Clean Water Specialists in cases where the species will provide increased ecological function, and not pose a risk to natural plant communities (an example would be urban stormwater plantings such as green roofs and tree trenches).

For BWSR funded projects, local conservation professionals can also make decisions about the use of non-native temporary covers/cover crops for soil health and soil stabilization, as well as for grass waterways, and projects to meet Minnesota’s Buffer Law (riparian buffers and alternative practices when applicable program requirements allow) that will be hayed, grazed, and/or exposed to pesticides. BWSR should be consulted for project-specific guidance, as needed.

Contact Information: Specific questions about these Guidelines can be directed to Dan Shaw, BWSR Vegetation Specialist/Senior Ecologist, Phone: 651-296-0644, e-mail: dan.shaw@state.mn.us



Bottle gentian in a wet meadow plant community

General Considerations

Benefits of Native Vegetation

Native annual, biennial, and perennial plants and the plant communities that they support provide a wide range of ecological and human services. The following information is a summary of key benefits of native vegetation.

1) Environmental Quality Benefits:

- Removal of nutrients and pollutants, providing protection for water resources
- Carbon sequestration by drawing carbon into root systems and soil
- Increased water infiltration and groundwater recharge through the creation of deep root channels
- Water interception and filtration by leaves, stems and roots
- Slope stability provided by extensive root systems
- Prevention of soil erosion and sedimentation caused by water and wind
- Soil health promoted by stabilizing soils, adding organic content through root decomposition, and by supporting healthy microorganism populations
- Evapotranspiration (releasing excess stormwater through leaves)
- Cooling and temperature moderation of soil and water
- Flood attenuation by slowing flood waters
- Healthy nutrient cycling and food chain support
- Preservation of biodiversity

2) Wildlife Habitat Benefits:

- Pollinator habitat and food sources, supporting hummingbirds, bees, moths, butterflies, and other insects
- Host plants for a wide variety of insects
- Food sources for insects and other animals
- Source of fruit and seed used by insects, birds, and other animals
- Shelter and nesting habitat for birds and other animals
- Aquatic habitat for insects, fish, birds and other animals

3) Landscape Resiliency Benefits

- Suitability to local conditions
- Providing connectivity between essential habitat
- Ability to adapt through genetic adaptation, succession and natural colonization
- Providing competition for invasive species

4) Other Human Services

- Regional character and identity
- Urban cooling from tree and shrub canopies
- Landscape aesthetics
- Human health benefits from healthy ecosystems
- Low maintenance once established
- Educational opportunities



Vegetation providing water quality and wildlife habitat benefits



Raingarden designed to infiltrate and filter stormwater



Monarch butterfly on meadow blazing star



Shorebirds using a restored wetland

Strategies for Restoring Resilient, Functional Landscapes and Maintaining Ecological Diversity

The following information summarizes strategies for restoring landscapes to be more resilient to climate change and other stressors, provide important landscape functions and services and maintain ecological diversity. These strategies are integrated from the disciplines of conservation, ecological restoration, landscape ecology, and sustainable farming and are key methods for developing landscapes that are resilient to changing land use practices and extreme weather conditions.



1) Strategic Site Selection - Work with project partners to identify the functions that are most beneficial for an individual landscape and where projects should be located to best provide those functions. In many cases, this involves restoring habitat complexes or buffering key water resources or plant communities to restore natural processes, nutrient cycling and plant and animal populations. Site projects in locations where ecological stressors such as un-natural water fluctuations, decreasing water tables, or invasive species will not significantly inhibit key functions into the future. See the Nature Conservancy's [Resilient and Connect Landscapes](#) tool as a resource.



2) Designing for Multiple Functions - Be strategic in the selection of primary and secondary goals but remember that multiple functions including wildlife habitat, plant diversity, food production, stormwater treatment, soil quality, carbon sequestration, and nutrient cycling can often be accomplished together.



3) Making Landscape Connections - Establish strong connections through landscapes. Create habitat and genetic dispersal corridors and decrease landscape fragmentation. Or, create a network of conservation practices in agricultural areas. Linking small parts plays a key role in restoring landscape resiliency and providing refugia for pollinators and other at-risk species.



4) Matching Plant Communities to the Site - Match your targeted vegetation to the native plant community that best fits the topography, soils, hydrology, and climate conditions (including the potential future climate) of your site. Restore natural hydrologic regimes to aquatic and wetland systems as applicable. Historic plant community information can be used as a guide for decision making. Determine the kinds of native wildlife that live in the area or migrate through, and include native plants natural to the site that will provide food and shelter for target species.

5) Restoring and Maintaining Diversity - Plant diversity (and structural diversity of plant communities) supports wildlife species and increases resiliency by helping plant communities and agricultural systems to continue functioning as intact systems during climate variation and other disturbances. Filling niches with native species also prevents the establishment of invasive species. Restoring natural disturbances such as prescribed fire, grazing and water fluctuations plays a key role in maintaining diversity. In addition to plant species diversity, protect genetic diversity of individual plant species by using site appropriate sources that can adapt to future conditions.



6) Working with Ecological Adaptation - Natural plant communities have the ability to adapt. They develop a natural dynamic through genetic adaptation, succession and natural colonization. Incorporate these processes into projects to complement restoration efforts, provide desired ecological functions, and buffer the community during future changes in climate and associated disturbance. Assisted migration may be needed in some ecosystems to help maintain plant community integrity.



7) Providing Habitat for Pollinators and other Beneficial Insects - Pollinators and other insects play an essential role in supporting ecosystems by pollinating around 70% of flowering plants and providing food sources for a wide range of wildlife species. Support insect populations by minimizing pesticide use, buffering natural areas and diverse plantings from pesticide exposure, restoring habitat complexes and wide natural corridors, increasing plant diversity, managing invasive plants, providing nesting sites and shelter, and restoring clean water sources.



8) Effective Water Management, Treatment and Use - A variety of practices including perennial crops, conservation tillage, conservation drainage, cover crops, buffer strips, infiltration basins, raingardens and wetland restoration help manage water resources. Incorporate these practices in urban and rural landscapes to reduce runoff, erosion and sedimentation, recharge groundwater, maintain agricultural productivity, improve water quality, and reduce flooding. Promote the wise use of water resources and the use of catchment systems to help ensure adequate supplies into the future.



9) Preserving and Restoring Soil Health - Soils that have good soil structure, organic content and microorganism populations translate into healthy and productive ecological and cultural landscapes and play a key role in sequestering carbon. Soil health can be restored through planting cover crops, no-till farming, and establishing perennial vegetation.



10) Managing Invasive Species Across Boundaries - Invasive species are effective at dispersal, giving them an advantage in adapting to climate change. Plan to work in partnerships, prioritize species and manage invasive plants across ownership boundaries to restore resilient landscapes.

NRCS



11) Practicing Adaptive Management - Adjust management practices based on monitoring efforts and experience with successes and failures to improve the long-term effectiveness of management practices and resiliency of plant communities. Practices such as prescribed burning, water level management and prescribed grazing may replicate natural disturbances and promote diversity and resiliency.



12) Learning from Project Experience - Information about project successes and innovative practices is valuable. What practices provide the most benefits in our landscapes? What common activities are not worth the cost, or make a problem worse? BWSR's "[What's Working](#)" web page collects and shares practitioner experience about real-world outcomes.

Species Diversity

In most cases, high species diversity is recommended for projects to increase ecological function. Many studies (Knops et al 1999, Tilman, 1997, 1999, Biondini 2007, Piper 1996) have shown benefits from having high diversity, including resistance to invasive species, rapid establishment, improved plant community structure, increased biomass, decreased spread of fungal diseases, and increased richness and structure of insect populations.



There are many considerations when determining target diversity levels for a project, including target plant communities, site conditions, functional goals, and budget. As a general rule, natural regeneration, including establishment from the seedbank, should be maximized at restoration sites to promote local plant establishment, and contribute to diversity levels.

There are certain situations (particularly in urban areas) where projects may be planted in phases with lower diversity planted initially to aid weed control and more diversity added in subsequent years. There have been many efforts in Minnesota to increase diversity levels in existing projects. BWSR has developed inter-seeding guidelines for grasslands to provide information about techniques that can be used to increase diversity levels (www.bwsr.state.mn.us/native_vegetation).

The following table is a general guide to native diversity levels for a range of project conditions and functional goals. Target diversity levels for a particular project also depend on the size of the site, its natural regeneration potential, and the type of plant community being restored. A smaller number of species may be appropriate for smaller lakeshore projects, raingardens, and other projects less than half an acre in size to create a sense of order and simplify maintenance. It is important that species abundance is also considered along with the number of species present, to ensure that individual species provide sufficient cover to meet vegetation goals. In some cases, high diversity pollinator plots/zones of a few acres in size may be planted in restoration sites to provide enhanced habitat for pollinators.

| Current Site Conditions | Project Function/Goals | | | | | |
|--|------------------------|---------------|------------------------|--------------------------------------|---|---|
| | Soil Stabilization | Water Quality | Grassland Bird Nesting | Habitat for Multiple Wildlife Groups | Native Plant Community Restoration (marsh and sedge meadow) | Native Plant Community Restoration (prairie, savanna, forest) |
| Natural Areas with High Species Diversity | 15 | 20 | 30 | 30 | 30 | 40 |
| Some Intact Ecological Characteristics | 10 | 20 | 25 | 25 | 25 | 35 |
| Agricultural Field Conversion | 10 | 15 | 15 | 20 | 20 | 25 |
| Disturbed Site (Urban Soils, Compaction etc.) | 5 | 10 | 15 | 20 | 20 | 25 |
| Disturbed Site with High Invasive Species Risk | 5 | 5 | 15 | 20 | 20 | 20 |

Seed and Plant Source

There has been a transition in Minnesota over the last few decades from the use of non-native species for conservation projects to “native” species. Much of the discussion about appropriate seed and plant sources is now focused on “how close is close enough” for native plants. The following discussion is intended to give resource professionals an overview of source considerations for native plants.



Methods and distances of seed and pollen dispersal vary significantly among species. For example, seed of some wetland species may be distributed widely by waterfowl or flowing water, while seed from some forest and prairie species that is spread by insects or falling seed may be dispersed relatively short distances. Available research (Appendix D) suggests that some species that have seed (or pollen) that is not dispersed widely by wind, water, animals or other factors could be negatively impacted if seed of that species is introduced from far distances (Keller et al. 2000, Edmonds & Timmerman 2003, Hufford & Mazer 2003, Heiser & Shaw 2006). Unfortunately, information is available for only a small percent of species used in restoration, so more research is needed on this topic.

The following are some **primary concerns regarding origin distance** for seed and plants, they include:

- 1) Whether plants will produce viable seed, particularly if they are brought to areas with significantly different climatic conditions
- 2) Whether populations adapted to local site conditions will be affected by the introduction of new genes or genotypes, causing local populations to be “swamped” by non-local sources that are not locally adapted, decreasing the long-term fitness of the population.
- 3) Whether plants introduced from a different region will become aggressive and compete with other species.

There are also cases where isolated populations of species can benefit from the introduction of new genetic material (such as populations with inbreeding depression). This is most often a concern for small, isolated remnant plant communities. Unfortunately, we still need more information about what species used in restoration are most at risk from inbreeding depression. If this is a concern for a species, it is most common that seed is introduced from populations within the same ecological subsection to improve the plants’ vigor, and to act as genetic stepping stones to link the isolated population to a wider genetic diversity.

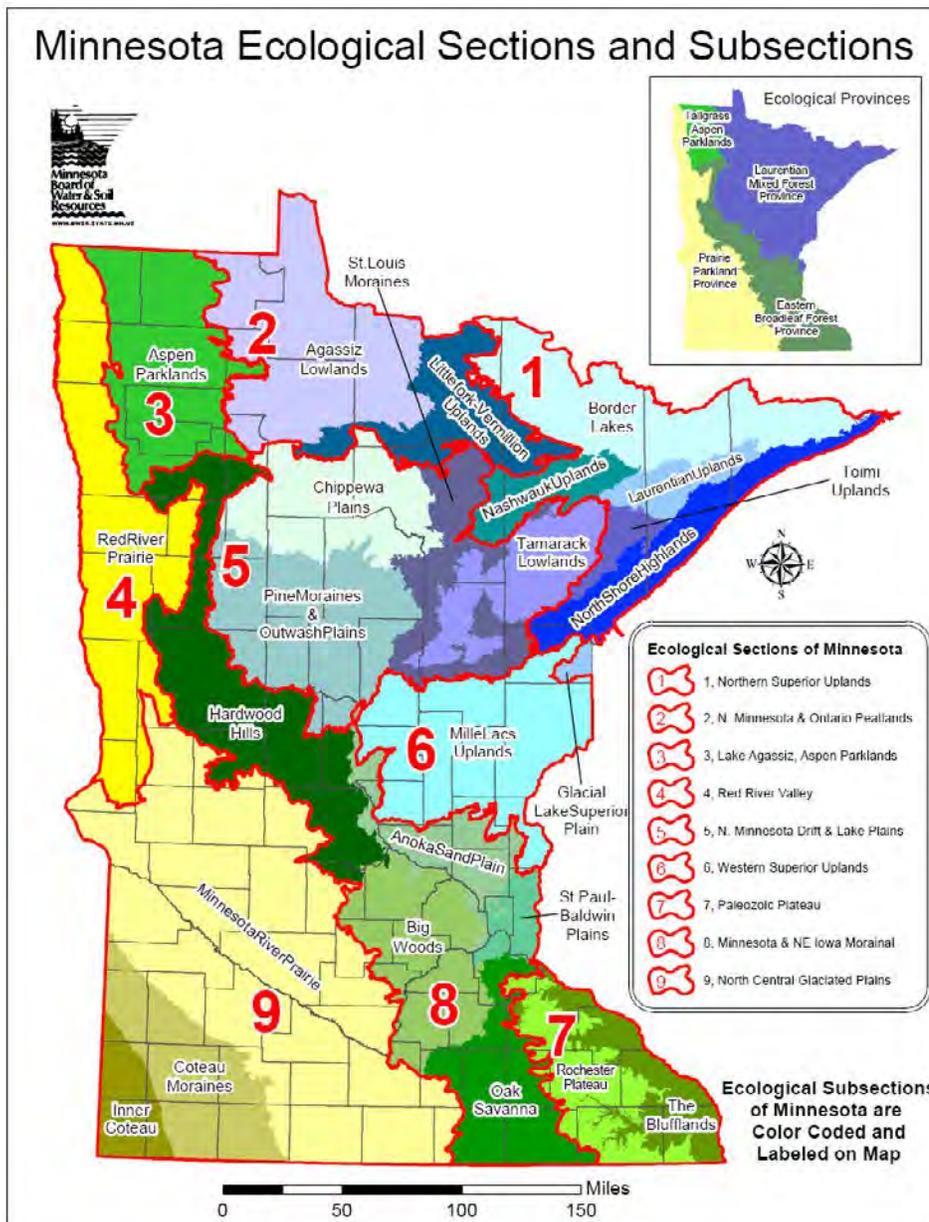
As a general rule, it is recommended that seed and plants be selected that match site conditions (soils, hydrology, precipitation, elevation, drainage, aspect, sun/shade and climate) and to have original harvest locations (original remnant populations, sometimes defined as seed “provenance”) from as close to the project site as possible to protect local ecotypes from genetic contamination. It may also be beneficial to collect seed from multiple sites to promote genetic variation, particularly for disturbed sites. Collection sites to the south of projects should be utilized when possible due to climate change concerns (see “Climate Change Considerations” on page 21.) The map and selection sequence on the following page is recommended when obtaining seed



for restoring native plant communities. The first step in the sequence recommends looking for seed in areas with **similar site conditions, and from areas located as close to the project site as possible** (including native seedbank and site collected seed); followed by seeking seed from **Ecological Subsections** (areas of similar ecological condition); then by looking in **Ecological Sections** (including extensions of Minnesota ecological sections into adjoining states); followed by seeking seed within **increasing distances from the project site, with 175 miles as the maximum recommended distance** (including seed and plants from an adjoining state or province). This maximum distance should only apply to

species that have wide seed and pollen dispersal. It is important to work with local resource staff and seed/plant vendors through the process of seed and plant selection, and seek outside advice when needed.

If a project encounters seed or plant availability issues, potential solutions are to use species substitutions or to change the project schedule/sequence to accommodate the availability of appropriate seed or plants.



Recommended sequence for obtaining seed/plants:

- A. Areas with similar site conditions, located as close to the project site as possible (including seedbank and site-collected seed)
- B. Ecological Sub-sections (colored areas on map)
- C. Ecological Sections (red boundaries on map)
- D. Working outward from the site with 175 miles as the recommended maximum range. Moving plant material from south of the site is preferred.



Native Variety/Cultivar Use

As stated under “Seed and Plant Source”, the first preference is typically for seed and plants that come from similar site conditions, and as close to the project site as possible. Named germplasms/varieties (also called “ecovars”) are plants that have multiple harvest locations of varying geographic range, and have been tested for performance across hardiness zones. Examples of these varieties include Red River Germplasm Prairie Cordgrass, Itasca Little Bluestem, and Bad River Blue Grama. These varieties have not been selected for specific traits. They may be appropriate for projects if they meet the origin requirements (based on the recommended sequence). Information about NRCS varieties can be found at the following website: (http://plant-materials.nrcs.usda.gov/ndpmc/pubs/publications_available.pdf). Similar to “ecovars”, Iowa Ecotype Project “variants” are species that have pooled genetic sources from across provenance zones (three zones arranged north to south in the state). “Variants” should be considered like “ecovars” when considering seed sources for southern Minnesota.

Water quality projects such as raingardens, biofiltration areas, and filter strips may have unique functional needs where a variety of a native species may be appropriate. Decisions about the use of native varieties can be made by local staff when the variety will increase the function of a project, and will not cause ecological harm due to their landscape setting, or lack of dispersal mechanisms. An example may be an urban raingarden where a variety may increase ecological function or have an aesthetic value that will increase public perception of the project; and the project is not near or connected to a native plant community.

Insecticides and Chemical Carry-over

To protect pollinator populations, any native seed and plants supplied for projects must not be treated (seed coatings or foliar application) with insecticides including but not limited to neonicotinoid insecticides (such as imidacloprid, clothianidin, thiamethoxam, dinotefuran and acetamiprid) that can harm pollinators. Also, to the extent possible, place pollinator habitat enhancement plantings on soils free of persistent pesticides such as insecticides. Systemic insecticides, like neonicotinoids, can persist in the soil and be absorbed by new plantings and transferred to pollinators that forage on them (Hopwood et al. 2012). Use temporary cover crops such as oats or winter wheat in areas where insecticides may be a problem to allow time for the chemicals to break down.

Diverse pollinator plantings (“pollinator plots”) should not be located adjacent to agriculture where insecticides will be used as seed treatments or through foliar application. A minimum buffer of 200 feet is recommended. [Minnesota pesticide laws and rules](#) define landowner responsibilities to minimize pesticide drift. The Minnesota Department of Agriculture oversees the state’s [Pesticide Applicator Licensing](#). NRCS Agronomy Technical Note 9 “[Preventing or Mitigating Potential Negative Impacts of Pesticide on Pollinators Using Integrated Pest Management and Other Conservation Practices](#)” as well as a BWSR fact sheet on [Protecting Conservation Lands from Pesticides](#) provide detailed information about methods to minimize impacts to pollinators.

Several chemicals being used for weed control along with Glyphosate in Glyphosate resistant crops act as pre-emergents or post-emergents (designed to inhibit germination) and can be a problem for native vegetation establishment from seed. Temporary cover crops planted for one or two seasons can also allow time for these chemicals to break down in the soil if they have been used. Investigate prior chemical use and labels to help define probability of having chemical carryover that could/should be addressed by using temporary cover crops. If in doubt seek consultation from others with applicable experience such staff at University of Minnesota Extension.

Seed Mixes

It is important that seed mixes are selected or designed to meet project goals. The following are some key principles for seed mix design:

- 1) Determine the target plant communities for a project and develop mixes based on these communities.
- 2) Add all functional groups ((warm season grasses, cool-season grasses, legumes, sedges, rushes, milkweeds, other forbs, etc.) into seed mixes that would be found in a natural plant community.
- 3) Make sure that mixes are an appropriate fit for soils and hydrology conditions.
- 4) Include early, mid, and late successional species into mixes.
- 5) Develop seed mixes based on seeds per square foot.
- 6) Develop diverse seed mixes but ensure that individual species are included at a high enough rate to show up in the planting.
- 7) Add at least three spring, summer, and fall blooming species in mixes to benefit pollinators.
- 8) Consider using temporary cover crops prior to seeding that are suppressed before planting instead of high rates of cover crops in mixes as they can compete with native species.
- 9) Seed specifications should be used for all projects when ordering seed (see sample specification on page 19).

Seed harvested from local remnant populations is often the most desirable source. If seed from remnant populations, or plants grown from the local seed are not available, or if locally harvested seed needs to be supplemented with additional species, custom seed mixes can be developed. For many conservation projects NRCS job sheets with seed calculators that define mix specifications are used to develop mixes. A guide to developing site specific seed mixes has also been developed and is available at: <http://www.lrrb.org/PDF/201020.pdf>. A focus of the guide is on developing mixes that are appropriate for site conditions and incorporating plant guilds (warm season grasses, cool-season grasses, legumes, asters, etc.) that are important for weed competition and ecological function.

State seed mixes have also been developed for many project types (wetland mitigation, conservation, stormwater projects, etc.) and are available at the following website: (www.bwsr.state.mn.us/native_vegetation). Around forty new “pilot” mixes are also being refined for a wide range of unique conservation practices. The state seed mixes are designed based on seeds per square feet for individual species to help us understand how they will interact with other species in the mix. The mixes contain combinations of early and later successional species, warm and cool season grasses, forbs, sedges and rushes to meet the needs of specific projects/programs. Substitutions/site specific changes or site specific mixes that follow similar design criteria are acceptable for projects if they meet the intended goals of a project/program and are approved by local resource staff. Additional species, such as tree and shrub seed can also be added to mixes. Mixes that are particularly beneficial for pollinator habitat (at least 15 species of forbs and at least 30% forbs by seed count) are noted with a * in the table below.

| Summary of State Seed Mixes | | |
|---|----------------------------|------------------------------------|
| Seed Mixes | Name/Description | Mixes Replaced by New Mixes |
| Cover Crop for Restoration and Roadsides | | |
| 21-111 | Oats Cover Crop | MNDOT110, BWSR UT1 |
| 21-112 | Winter Wheat Cover Crop | MNDOT 100 |
| 21-113 | Soil Building Cover Crop | MNDOT 130 |
| Mid-term Stabilization Native | | |
| 32-241 | Native Construction | BWSR U12, BWSR U11 |
| Stormwater Facilities | | |
| 33-261 | Stormwater South and West | MNDOT 310, MNDOT 328 |
| 33-262 | Dry Swale/Pond | BWSR W4 |
| 33-361 | Stormwater Northeast | BWSR W7 |
| Wetland | | |
| 34-171 | Wetland Rehabilitation | BWSR WT3 |
| 34-181 | Emergent Wetland | BWSR W1 |
| 34-261 | Riparian South and West | BWSR R1 |
| 34-262* | Wet Prairie | BWSR W3, MNDOT 325 |
| 34-271* | Wet Meadow South & West | BWSR W2 |
| 34-361 | Riparian Northeast | BWSR R1 |
| 34-371 | Wet Meadow Northeast | BWSR W2N |
| Native Grassland | | |
| 35-221* | Dry Prairie General | MNDOT 330 |
| 35-241* | Mesic Prairie General | MNDOT 350 |
| 35-421 | Dry Prairie Northeast | BWSSR U2 |
| 35-441* | Mesic Prairie Northwest | BWSR U1 |
| 35-521 | Dry Prairie Southwest | BWSR U4 |
| 35-541* | Mesic Prairie Southeast | BWSR U6 |
| 35-621 | Dry Prairie Southeast | BWSR U6 |
| 35-641* | Mesic Prairie Southeast | BWSR U5 |
| Woodland | | |
| 36-211* | Woodland Edge South & West | BWSR U7, |
| 36-311* | Woodland Edge Northeast | BWSR U13, BWSR U14 |
| 36-411* | Woodland Edge Northwest | |
| 36-711* | Woodland Edge Central | |

- * Seed mixes that are particularly beneficial for pollinator habitat
- * See sample seed specifications on page 19

Yellow Tag Seed

Yellow tag seed has a verifiable source that is certified by the Minnesota Crop Improvement Association (MCIA). Yellow tag seed should be used over non-source identified seed when it is available. See the following website for a survey of yellow tag seed availability: (www.mncia.org/). Flexibility regarding the use of yellow tag seed can be granted by local staff when seed from local remnant communities (generation 0 seed) will be used for a project, or the available yellow tag seed is not of a local source. Yellow tag seed may not be available for tree and shrub species.

Invasive Species

Invasive species are species that are not native to Minnesota and cause economic or environmental harm or harm to human health. BWSR uses the Minnesota DNR “Plant Checklist” ([Excel](#) or [pdf](#)) for these Native Vegetation Guidelines as well as for administration of the Wetland Conservation Act to list what species are non-native and cannot be planted with BWSR funding or on wetland replacement projects. The lists also designates which plant species are Minnesota designated Noxious Weeds.

The definition of Minnesota Noxious weeds is similar to the definition of invasive species but noxious weeds are associated with the Minnesota Noxious Weed Law. The Minnesota Noxious Weed Law ([MN Statutes 18.75-18.91](#)) defines a noxious weed as an annual, biennial, or perennial plant that the Commissioner of Agriculture designates to be injurious to public health, the environment, public roads, crops, livestock or other property. Prohibited noxious weeds must be controlled or eradicated as required in [Minnesota Statutes, section 18.78](#). Additionally, transportation, propagation, or sale of noxious weeds is prohibited except as allowed by Minnesota Statutes, Section 18.82. See the Minnesota Department of Agriculture’s [Noxious Weed List](#) website for description of categories including prohibited noxious weed: eradicate list, prohibited noxious weed: control list, and specially regulated plant.

In some cases, the list of species on the [DNR invasive plant webpage](#) (both terrestrial and aquatic pages) is used to help with decision making about what non-native species (that may be found on DNR “checklist” of native vs. non-native species) should be prioritized for management on conservation projects and wetland replacement projects.

Prevention of Palmer Amaranth and other Noxious Weeds in Conservation Projects

Guidance for Project Managers and Vendors

The introduction of *Palmer Amaranth* and other noxious weeds through seed and seed mixes is a major concern in Minnesota. It is important that [MN and federal seed laws](#) are followed for all projects and that other steps are taken to prevent introduction of noxious weeds. The following diagrams summarize stakeholder roles in noxious weed prevention (Diagram 1) and specific steps for prevention of noxious weeds in conservation plantings (Diagram 2). The diagrams are followed by detailed information about methods for addressing *Palmer Amaranth and other noxious weeds in conservation plantings*. The information summarizes the role of project managers, local governments, vendors, landowners and agencies. Figures 1-3 provide examples of a label, seed testing results, and DNA tests all needed to properly label native forb seed mixtures for sale and figure 4 is a seed specification that can be included as part of project bids to address noxious weed issues.



Palmer amaranth

Diagram 1

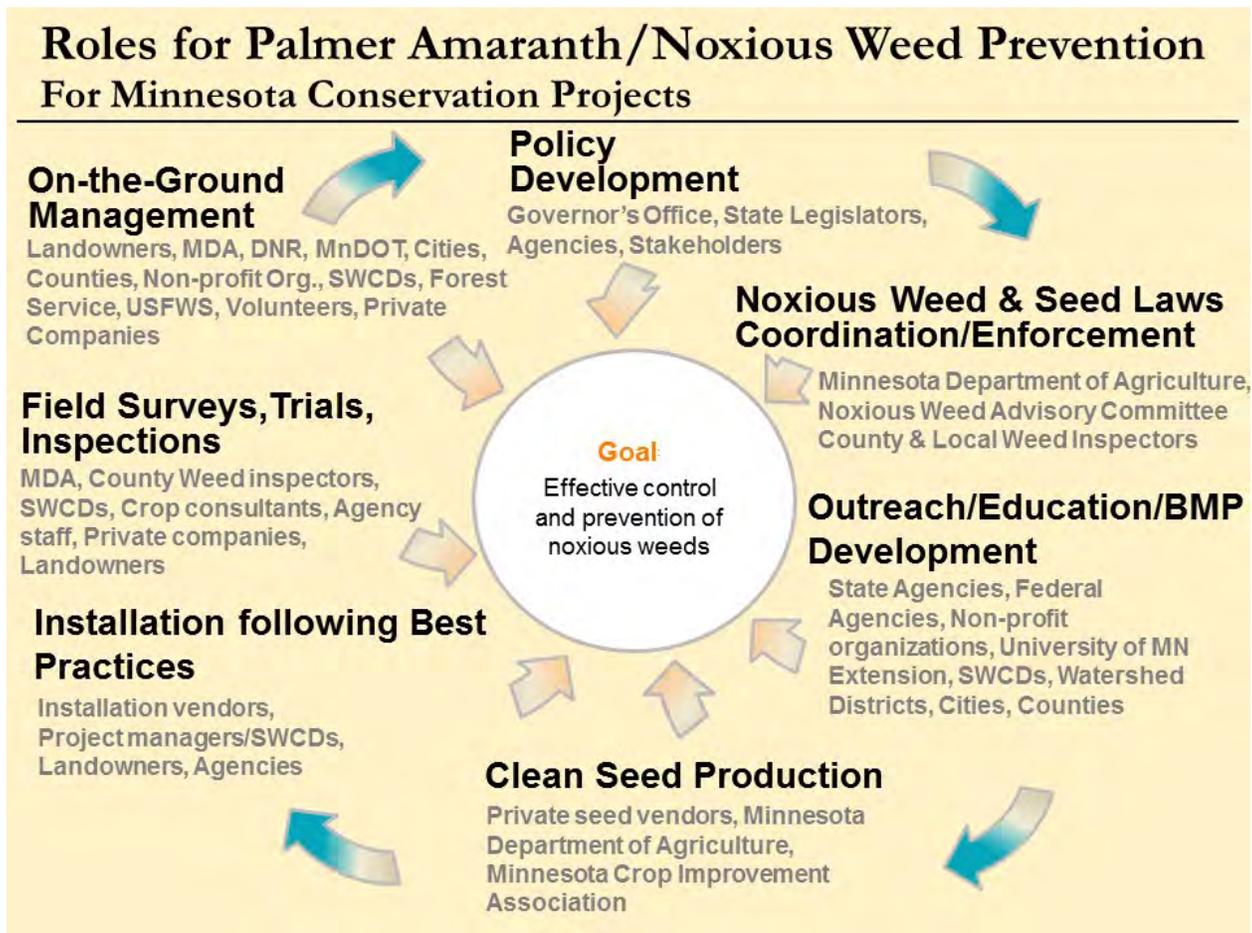
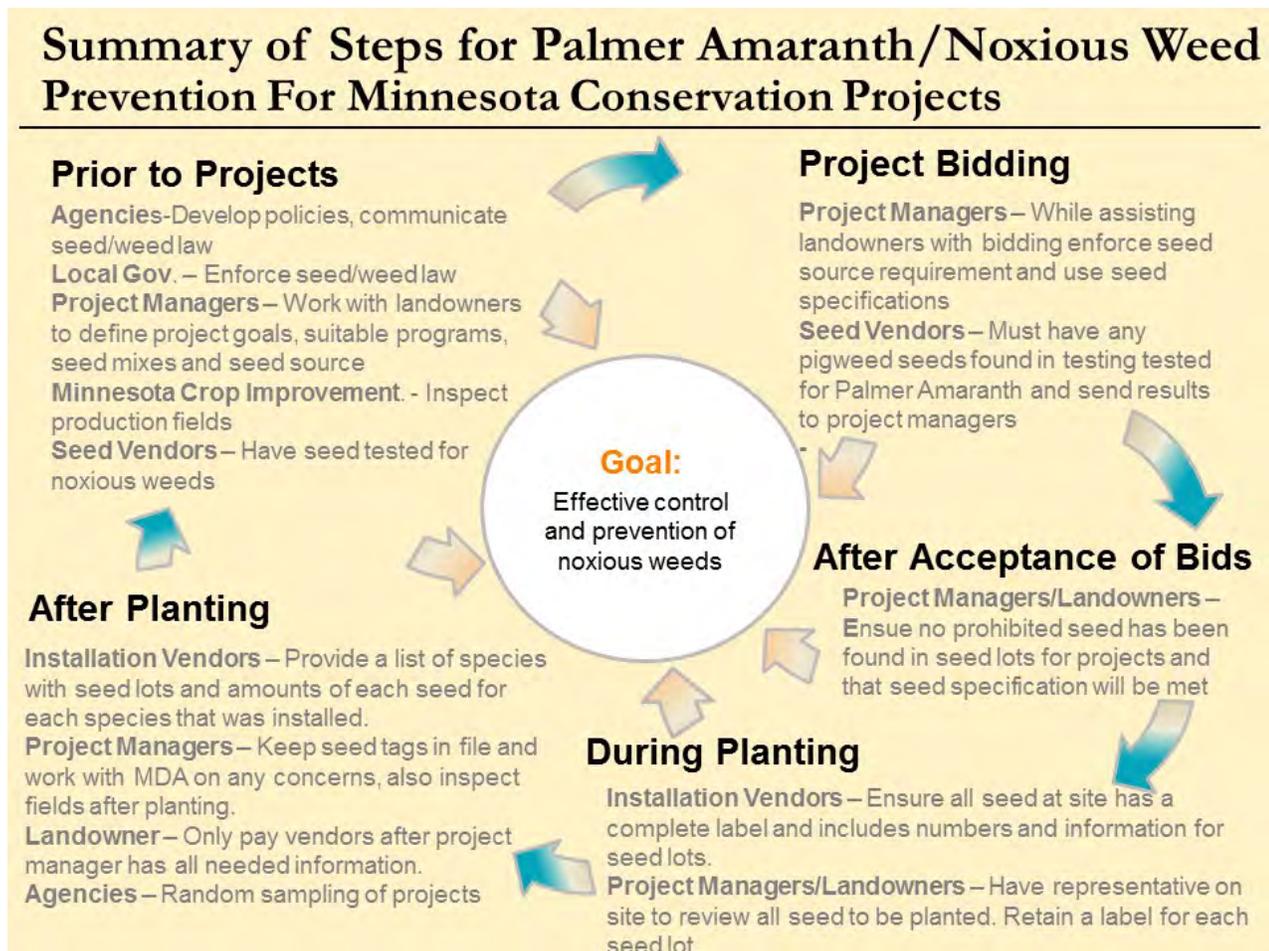


Diagram 2



Methods for Addressing Palmer Amaranth and Other Noxious Weeds

1) Prior to Projects

Agencies: Minnesota Department of Agriculture (MDA) is working with seed vendors to ensure that they know state requirements for meeting state and federal seed law requirements and are taking steps to prevent the introduction of noxious weeds. All vendors with a permit to label seed for sale in Minnesota are listed on the MDA website.

Local Governments: County, city and township officials inspect land and ask owners to control and eradicate noxious weeds that are present in order to keep them from spreading and harming neighboring lands.

Seed Production Vendors: To be in compliance with the state seed law, any seed being sold must be tested for weed seeds including restricted and prohibited noxious weed seeds. Seed that is harvested from the wild must also be tested for noxious weeds and labeled appropriately.

2) Project Bidding

Project Managers: Seed source requirements defined for projects must be followed and seed can only be purchased from vendors that provide the documentation listed in this guidance and meet other seed specifications for the projects. See the seed specifications below (figure 4).

Seed Production Vendors: If Amaranth species were found in the purity or noxious weed seed test, MDA requires that the vendor conduct a genetic test to determine if the Amaranth species are Palmer Amaranth. Genetic test results must be made available to MDA during inspections.

3) After Acceptance of Seed Bids

Project Managers: For acceptance of seed bids, project managers must ensure that vendors can meet all seed specifications.

Project Managers: Soon after the acceptance of a seed bid and any final changes to mixes, it is recommended that project managers have seed vendors provide a preliminary seed label/tag for the proposed seed mix(s). The manager should review the noxious weed seed section of the label (Fig. 1C). If any restricted noxious weed seeds are listed, the manager should confirm that in total there are less than 25 restricted noxious weed seeds per pound of the seed mix. A seed mix that contains any prohibited noxious weed seeds is not legal for sale in the state. If seed testing results are available for review (Fig. 2) the manager should review both the weed seed percentage, common weed seed found, and noxious weed seed sections of the Report of Analysis. Some labs provide a comprehensive list of all weed seeds found in the noxious exam. If Palmer amaranth or any Amaranth species is listed in the noxious weed seed section of the report (Fig.2C), the report should indicate whether genetic testing has been conducted. Most seed mixes are blended after each single species component has been tested, so a project manager may also receive seed testing results for each single component in the mixture. This review step is intended to allow project managers to verify the mix prior to seeding and the seed label/tag can be used to verify that the correct seed has been delivered to the targeted project site.

4) During Planting

Seed Installation Vendors: All seed delivered to sites must have a complete label and mixes must include information for individual seed components and their lot numbers. Installers must allow MDA staff to take seed samples when they arrive for a random planting inspection.

Project Managers: Have a representative on site at planting to review labels and other paperwork for all of the seed to be planted. All seed must be appropriately labeled and mixes must include information for individual seed components and their lot numbers. Reject any seed that does not have a label or does not correspond to the preliminary seed label/tag that was provided after acceptance of the seed bid. If seed substitutions are necessary, all required information must be provided in advance for the project manager's review. Reject any seed that does not have a label, is improperly labeled and/or does not correspond to the preliminary seed label/tag that was provided after acceptance of the seed bid.

Project Managers: Count the number of bags of each seed lot and retain a label for each lot indicating the number of bags at the site on the back of the label. Review the label(s) and contact MDA for a label review if there are any concerns.

5) After Planting

Seed Installation Vendors: Must provide a final list of species (with seed lots) and amounts of seed for each species planted for the project.

Project Managers: Keep the seed tags and a copy of the final list of species planted in the project file. Project managers should work with the MDA if they have any concerns about seed mixes. MDA can assist with taking official seed samples at planting, as needed. MDA also has an official [complaint process](#) for cases where there is reason to believe that a violation of state seed law has occurred.

Landowners: Project payments should not be made to seed installers until coordinating project managers feel confident that they have received all of the appropriate seed information for the project. Landowners should periodically inspect fields and report back to the project manager or MDA any observations of excessive weeds or plants of concern.

Project Managers: Project inspections by local staff with plant identification expertise will play an important role as a final assurance that Palmer Amaranth and other noxious weeds are not introduced into plantings.

Agencies: MDA will conduct a noxious weed seed exam on a random sample of native seed mixes collected in each county. They will work with each SWCD to establish a sampling plan for their district that defines a specific number of plantings to be sampled. MDA is also conducting field inspections for Palmer Amaranth and other noxious weeds through grant funding.

Figure 1. Example of a label for a native forb mixture. The lettered sections A, B, and C are related to the Report of Analysis for seed testing in Fig. 2. This seed would not be legal for sale in Minnesota because it contains Palmer Amaranth.

| Native Forb Mixture | | | | | | | | | | |
|--|-----------|------------|----------------|------------|---------------|------------------|---------------|-------|--|--|
| Lot BPSIMN1802 | | | | | | | | | | |
| Kind | Variety | Source Lot | Genetic Origin | Pure Seed% | Germination % | Hard or Dormant% | Total Viable% | PLS% | | |
| Partridge Pea | VNS | IA1010 | IA | 20.71 | 41 | 54 | 95 | 19.67 | | |
| Canada Tick Trefoil | VNS | MN2020 | MN | 20.18 | 36 | 61 | 97 | 19.57 | | |
| Wild Bergamot | VNS | MN2021 | MN | 10.05 | 78 | 10 | 88 | 8.84 | | |
| Black-eyed Susan | VNS | MN2023 | MN | 25.23 | 85 | 8 | 93 | 23.46 | | |
| Hoary Vervain | VNS | MN2024 | MN | 21.78 | 45 | 35 | 80 | 17.42 | | |
| Purity | 97.95 | A | | | | | | | | |
| Other Crop | 1.87 | | | | | | | | | |
| Weed Seed | 0.17 | | | | | | | | | |
| Inert Matter | 0.01 | | | | | | | | | |
| Noxious Weeds | #/lb | C | | | | | | | | |
| Giant Foxtail | 21 /lb | | | | | | | | | |
| Palmer amaranth | 11/lb | | | | | | | | | |
| Test Date | 12/1/2017 | | | | | | | | | |
| Best Prairie Seed In Minnesota 100 Prairie Way Green, MN 11111 | | | | | | | | | | |

Figure 2. Example of Report of Analysis for seed testing results from a native forb mixture. The purity analysis in section A, the viability analysis in section B, and the noxious weed seed exam in section C, all correspond to the same sections on the seed label in Fig. 1. This report shows a seed lot that is positive for Palmer Amaranth and indicates that genetic testing has been conducted. If this report were for a single species only one pure seed component would be listed on the purity analysis.

| Name and Address of Testing Lab | | | | | | | | | |
|--|------------|--|---|-----------|--------|-----------------------------------|--------------|-------------|----------------|
| Sample number: 1539087 Date Received 11/2/2017 Report Date: 12/19/2017 | | | Sender's Information Kind: Native Forb Mixture Varieties: Not Stated Lot Number: BPSIM1802 Origin: MN, IA Bag Weight: Not Stated Size of Lot: Not Stated Labeler's Name: Best Prairie Seed in Minnesota. Product Name: Native Forb Mixture Date Sampled: 10/2/17 Note: the information listed here is that of the send and not the laboratory | | | | | | |
| Tests Requested: Purity/Noxious All-States, Germination Tests | | | | | | | | | |
| Purity analysis A | | | Laboratory Test Results B | | | | | | |
| Viability analysis | | | %normal | %dormant | %hard | %total viable | Seeds tested | Days tested | Date Completed |
| 4.488 g analyzed | %Pure Seed | | | | | | | | |
| Pure seed components | | | | | | | | | |
| Partridge Pea <i>Cassia fasciculata</i> | 20.71 | | 41 | x | 54 | 95 | 400 | 12 | 12/17/2017 |
| Canada Tick Trefoil <i>Desmodium canadense</i> | 20.18 | | 36 | x | 61 | 97 | 400 | 12 | 12/17/2017 |
| Wild Bergamot <i>Monarda fistulosa</i> | 10.05 | | 78 | 10 | x | 88 | 400 | 10 | 12/17/2017 |
| Black-eyed Susan <i>Rudbeckia hirtai</i> | 25.23 | | 85 | 8 | x | 93 | 400 | 12 | 12/17/2017 |
| Hoary Vervain <i>Verbena stricta</i> | 21.78 | | 45 | 35 | x | 80 | 400 | 12 | 12/17/2017 |
| Other Crop Seed | 1.87 | | Comments: Palmer amaranth identification confirmed by PCR testing on single seeds. | | | | | | |
| Inert Matter | 0.01 | | | | | | | | |
| Weed Seed | 0.17 | | | | | | | | |
| Other Crop Seed | | | All-States Noxious | | | Noxious weed seeds in 40.47 grams | | | |
| Kind: | No. found | | Kind: | No. found | No./lb | | | | |
| Illinois Bundleflower | 4 | | Palmer Amaranth <i>Amaranthus palmeri</i> | 6 | 11.1 | C | | | |
| Purple Prairie Clover | 2 | | Giant foxtail <i>Setaria faberii</i> | 10 | 21.2 | | | | |
| New England Aster | 1 | | | | | | | | |
| Inert matter | | | Other determinations: | | | | | | |
| Broken seed pieces, plant material, soil | | | Also found in 40.47 grams: 1 common lamb's quarters, 2 common chickweed | | | | | | |
| Common Weed Seed | | | Rules Followed: AOSA | | | | | | |
| Kind: | No. found | | | | | | | | |
| Lamb's Quarters <i>Chenopodium album</i> | 2 | | | | | | | | |

Figure 3. Sample of Palmer Amaranth Test Report

| Palmer Amaranth Report | | | | | | | |
|---|--------------------|-------------|-----------|------------------------|-------|---------------|----------------------------|
| Customer Name: Best Prairie Seed in Minnesota | | | | Date Received: | | | |
| Address: | | | | Date Completed: | | | |
| Phone: | | | | Date Reported: | | | |
| Sample Number | Customer Sample ID | Seed Number | Lot | Number of Seeds Tested | Plate | Well Location | Results Palmer Amaranth |
| 217236321 | 1539087 | 1 | BPSIM1802 | 1 | A4211 | A1 | Negative |
| 217236321 | 1539087 | 2 | BPSIM1802 | 1 | A4211 | A2 | Negative |
| 217236321 | 1539087 | 3 | BPSIM1802 | 1 | A4211 | A3 | Negative |
| 217236321 | 1539087 | 4 | BPSIM1802 | 1 | A4211 | A4 | Negative |
| 217236321 | 1539087 | 5 | BPSIM1802 | 1 | A4211 | A5 | Negative |
| 217236321 | 1539087 | 6 | BPSIM1802 | 1 | A4211 | A6 | Negative |

Figure 4. Seed Specifications

Note: The following specifications are included in this bid package to help ensure the quality and success of the restoration or BMP project and to protect the integrity of local plant communities.

- •Substitution of species in the specified seed mixes/species lists must be approved by the project manager.
- Yellow tag seed must be used if it is available, unless otherwise directed by the project manager.
- All seed that is supplied for projects must be labeled according to the requirements of the Minnesota Seed Law, section 21.82, including limits on noxious weed seed.
- The origin of seed is required to be listed on the seed tag for all species in a mix to provide verification of original (generation 0) seed source. The smallest known geographic area (township, county, ecotype region, etc.) shall be listed.
 - Information pertaining to pure seed, germination, and hard (dormant) seed of individual components in a mix is required on seed tags.
 - When submitting seed bids, seed vendors must list any *Amaranth* seeds that were found in official seed tests. If *Amaranth* species are found in the test results, the Minnesota Department of Agriculture (MDA) requires that the vendor pay for genetic testing to determine if the *Amaranth* seeds present are *Palmer amaranth*.
- Soon after the acceptance of a seed bid, seed vendors must provide a preliminary seed label/tag for the proposed seed mix that lists any regulated weed seeds (Restricted and Prohibited Noxious Weed seeds and other plant seeds not intended to be part of the mix) that were identified through official seed lot tests.
- Seed must be cleaned to an extent sufficient to allow its passage through appropriate seeding equipment.
- All wild harvest mixes must be tested. Germination, hard seed and Pure Live Seed information is required on seed tags for the number of species that are required through a program or project diversity standard. Any *Amaranth* species in wild harvest mixes must be identified and have the same genetic testing required for seed that is produced. There should also be categories for inert matter and weed seeds. Unless otherwise requested, small, large, and cover crop seeds should be packaged separately.
- Seed source standards for conservation programs must be followed for seed mixes. For Minnesota Board of Water and Soil Resources (BWSR) funded project the seed zone map and source sequence on page 10 of BWSR's Native Vegetation Establishment and Enhancement Guidelines must be followed for obtaining seed.
- All seed delivered to sites must have a complete label and include information about individual component seed lots. Installers must allow MDA staff to take seed samples when they arrive for a random inspection.
- A final list of species (with seed lot information) and amounts of each species seed planted for the project must be sent to project managers following the installation.
- Project contracts provided to landowners must state that if it can be determined that seed installers were responsible for introducing regulated state noxious weeds into plantings, seed installers will be responsible for controlling or eradicating noxious weeds on those properties for a time that is sufficient to be effective.

Note: When using these specifications for bidding, it is also recommended to include a seed zone map. Upon project installation retain and file all seed information.

Protecting Natural Communities

Intact native plant communities such as remnant prairies, savanna and calcareous fens are now uncommon in the Minnesota landscape and are losing plant diversity from fragmentation, invasive species, and negative impacts from surrounding land uses. These plant communities should be buffered with conservation plantings and connected to habitat corridors and larger habitat complexes when possible to minimize edge effect and other consequences of fragmentation; and to promote plant and animal dispersal.



Remnant prairie in Goodhue County

It is also important that these areas are protected from non-local sources of seed that may cause outbreeding depression.

Experienced resource professionals should be involved in seed collection and management planning when working in, or near, remnant communities. Varieties/cultivars (selected germplasms) of native species cannot be used adjacent to these areas (within a one-quarter mile buffer) to limit genetic influences. Seed must come from local sources when planting buffers adjacent to medium and high quality remnant communities. Whenever possible, seed should be collected directly from local remnants (generation 0) or from the first generation of production (generation 1), or from the ecological subsection when a further distance is needed (such as when species are being re-introduced). The DNR County Biological Survey Program can provide more information about remnant communities in the state. Data about mapped remnant prairie communities can be found at <https://gisdata.mn.gov/dataset/biota-dnr-native-plant-comm>.

Riparian Buffer Planning and Design

Riparian buffers play an important role in landscapes by filtering pollutants, slowing and infiltrating stormwater, and providing habitat for a wide range of species. It is important that environmentally suitable annual, biennial, and perennial species are used for buffer areas that will maximize landscape benefits. Recommendations for buffer planning and design are included under sections of these Guidelines titled “Project Site Preparation, Planting and Maintenance” and “Guidance by Project Type”. Individual project types that are covered and relate to buffers include: Native Prairie Reconstruction; Pollinator Habitat; Wetland Restoration; “Agricultural BMPs” (including Agricultural Buffers); “Stormwater Basins”; “Raingardens and Biofiltration Areas”; “Lakeshores”, “Forest/Woodlands”; “Native/Remnant Plant Community Restoration”; “Temporary Cover”, “Streambank Stabilization and Ravine Stabilization”. More information about buffer planning and design can be found in the BWSR [Buffer Establishment and Management Toolbox](#).



Providing Pollinator Habitat

Insect pollinators including native and domesticated bees that play a key role in crop and native plant pollination have seen significant population declines in during recent years from habitat loss, disease and pesticide use. As a result, it is important to incorporate pollinator habitat into a wide range of project types.

Site selection is an important consideration when planning pollinator habitat to ensure that insects will not be impacted by pesticide drift. It is also important that bees have clean water sources nearby, sufficient nesting sites, and a diversity of flowers that provide pollen and nectar through the entire growing season. Even smaller project types such as raingardens or



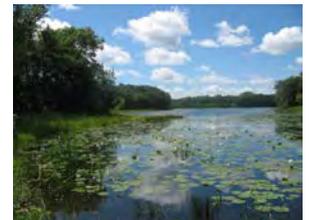
biofiltration areas can support many types of insects that play a key role in supporting healthy ecosystems. State legislation from 2013 states that **“prairie restorations conducted on state lands or with state funds must include an appropriate diversity of native species selected to provide habitat for pollinators throughout the growing season”**. The section of these guidelines titled “Guidance by Project Type” includes a section on restoring pollinator habitat. The list of state seed mixes (page 12) identifies mixes that are particularly beneficial for pollinator habitat with at least 15 species of forbs and at least 30% forbs by seed count. The Minnesota Board of Water and Soil Resources also has a [pollinator webpage](#) with a “pollinator toolbox”, peer to peer resources and links to other pollinator efforts.

Climate Change Considerations

The effects of a changing climate such as extreme storm events and temperature variation can cause stress to aquatic and terrestrial ecosystems. Rare plant and animal species are often most at risk from these changing conditions and may need additional adaptation strategies to ensure the health of populations. The “Strategies for Restoring Resilient, Functional Landscapes and Maintaining Ecological Diversity” on page 6 of these guidelines outline key strategies for increasing the resilience of our remnant and reconstructed plant communities to disturbance and adapting to climate change, while Climate Change Considerations for Plant Selection are listed below.

Conditions in Minnesota have changed rapidly over the last few decades and an overwhelming base of scientific evidence projects that Minnesota’s climate will see additional significant changes through the end of the 21st century. Over the last several decades, the state has experienced substantial warming during winter and at night, with increased precipitation throughout the year, often from larger and more frequent heavy rainfall events. These changes alone have damaged buildings and infrastructure, limited recreational opportunities, altered our growing seasons, impacted natural resources, and affected the conditions of lakes, rivers, wetlands, and our groundwater aquifers that provide water for drinking and irrigation. The years and decades ahead in Minnesota will bring even warmer winters and nights, and even larger rainfalls, in addition to other climatic changes not yet experienced in the state (2017 Interagency Climate Adaptation Report (<https://www.pca.state.mn.us/sites/default/files/p-gen4-07c.pdf>))

It is challenging to predict the effects of climate change on remnant and restored native plant communities and they will have varying impacts across different regions of the state. It is likely that extended and moister spring and fall seasons are already favoring cool season invasive species such as smooth brome grass and reed canary grass, as well as woody invasive species such as buckthorn. These type of changes require management actions for existing plant communities in addition to site preparation and seed and plant selection considerations when planning restorations. Maintaining and restoring native plant diversity across landscapes will play an important role in maintaining resilience of ecosystems.



Moving plants and seed for climate change (assisted migration) is a topic of significant debate amongst ecologists. One concern about moving plants and seed relatively long distances is that there can be risks to the genetic fitness of existing populations if plants are introduced from too far away. A positive trait of most herbaceous native plants is that they have high genetic diversity, often giving them the ability to adapt to changing conditions, if the conditions are not too extreme, and if their populations are of a sustainable size. As a result, these guidelines are focused on the use of locally adapted sources. However, it is recommended to favor seed and plants from sources located just to the south of projects due to the risk of climate change. Plant species that are at the southern edge of their range and at risk of population declines with a warming climate may need special consideration by conservation professional to determine strategies to support their populations.

Climate Change Mitigation and Adaptation Considerations for Plant Selection

1. A partnership approach between conservation partners with knowledge about plant ecology and native plant communities should be used to select restoration strategies as well as species and sources adapted to climate change.

2. Plant selection should take into consideration current and projected site conditions, potential plant stressors (extreme weather, diseases, invasive species, pollutants, etc.), unique natural features, and sensitive plant and animal species. Ecological assessments should be conducted that take into consideration the strategies that will be needed to maintain and increase plant community resilience.
3. Diversity levels and seed mix components should be selected for restoration projects that will increase the overall resiliency to stressors. High diversity levels, as well as early, mid and late successional species, should be provided in seed mixes.
4. As extreme precipitation events have been increasing statewide, select plant species for stormwater projects and shorelines that are adapted to challenging conditions (see [Plants for Stormwater Design](#)).
5. Assisted migrations of trees and shrub species has become more commonplace in response to expected forest changes, as it may take woody vegetation many years to produce seed. Generally, gradual shifts of common species should be implemented (Hunter 2007). In most cases, forests should also be managed for diversity and multi-aged stands to increase their resiliency and forest management plans should be developed to guide management activities based on site ecological and production goals. Assisted migration efforts for trees and shrubs should involve input from teams of foresters and ecologists knowledgeable about forest ecosystems to select species that meet project goals and won't have negative consequences.
6. When selecting herbaceous native plants and seed sources it is important to focus on matching environmental conditions (using ecological subsections and sections) to help ensure that plantings will thrive within the restoration site. It may be beneficial to mix seed sources (of local origin) of species for individual restoration projects, particularly for highly disturbed sites (Lesica 1999) where successful establishment may be less predictable and aided by increased genetic diversity. If seed cannot be found locally, then sources to the south of projects should be the first preference to aid adaptation to warming temperatures.
7. Conservation plantings can have a key role in climate mitigation as well as adaptation. Plantings can be designed to maximize their carbon sequestration benefits. Some key methods include 1) ensuring all key functional groups are represented in prairie and wetland plantings; 2) designing seed mixes and selecting other plant materials that are well suited to soil types; 3) focusing on deep rooted herbaceous plants; and 4) when appropriate, focusing on a combination of fast growing and later successional tree and shrub species.
8. In agricultural landscapes, cover crops, perennial vegetation, and strip tilling play important roles in sequestering carbon in the soil while also protecting water quality.
9. Our remnant and reconstructed native plant communities are under increasing pressure from invasive species, and require prioritization to determine the greatest regional threats. Local organizations such as Cooperative Weed Management Areas play a key role in setting priorities, developing plans and sharing resources to accomplish control.
10. Monitoring is needed to track the response of plant communities and individual species over time. Monitoring can help us understand if the abundance of certain species is changing and if new species are appearing. As part of monitoring efforts it will be important to separate potential explanatory factors such as current land use, past land use, exotic species invasions and climate change.
11. The need for adapted management of restored and native plant communities is increasing due to invasive species, herbivores, extreme precipitation and other stressors. This management should be based on monitoring information and will vary for plant communities but may involve prescribed fire, conservation grazing, conservation haying, water level management, biocontrol and other methods.

Project Site Preparation, Planting and Maintenance

The following information provides an overview of site preparation, planting and maintenance strategies that are commonly used for restoration and conservation practices. More detailed information about site preparation, planting and maintenance can be found in the Minnesota Wetland Restoration Guide at www.bwsr.state.mn.us/publications/restoration_guide.html . A summary of practitioner “What’s Working” information can be found at <http://www.bwsr.state.mn.us/grants/WhatsWorking.html>.

Site Preparation Methods

Transitioning from Other Uses

Effective site preparation is essential to getting a conservation practice or restoration project off to a good start as well as for long term success. Primary goals of site preparation are to control weed species and to provide ideal growing conditions for the seed or plants to be installed. Site preparation methods vary depending on past uses of the site and the weed species that are present. The protection of microorganism populations and native seedbanks, preventing soil erosion, and managing weed establishment are all considerations during the site preparation process. In most cases, non-herbicide methods are preferred over herbicide intensive methods to protect aquatic organisms and soil microfauna, but herbicides may be the most efficient method of controlling some invasive perennial species.



Field prepared for broadcast seeding

It is common for many conservation plantings to transition from corn or soybean production. Fields that are in agriculture often have control of most weeds, though additional control of species such as Canada thistle is sometimes needed in the fall after harvest. Another consideration is that several chemicals being used for weed control, along with Glyphosate in Glyphosate-resistant crops act as pre-emergents or post-emergents (designed to inhibit germination) and can be a problem for native vegetation establishment from seed. Temporary cover crops planted for one or two seasons can also allow time for these chemicals to break down in the soil if they have been used. Investigate prior chemical use and labels to help define probability of having chemical carryover that could/should be addressed by using temporary cover crops. If in doubt seek consultation from others with applicable experience.

If a site is in perennial weeds such as smooth brome, quack grass or bluegrass and cannot be put into agricultural production for one or two seasons intensive site preparation may be needed for the control of perennial invasive species with extensive rhizomes. Herbicide application is often recommended, as tilling alone may re-suspend the rhizomes, allowing them to continue growing. For species such as reed canary grass and giant reed grass, combinations of mowing, herbicide application, prescribed burning, and tilling (or possibly additional herbicide application) may be needed. The [Minnesota Wetland Restoration Guide](#) provides detailed management recommendations for a wide range of species.

For small lakeshore or stormwater projects perennial weeds can often be dug with shovels or garden forks, making sure to remove all of the rhizomes. Heavy mulches or clear plastic (solarization) have also been used as part of site preparation for small areas. When removing sod for lakeshores or raingardens, sod kickers, sod cutters or other mechanical equipment can be used to remove roots and weed seeds.

Scraping with backhoes and bulldozers is sometimes conducted to remove species such as reed canary grass and giant reed grass, or to remove fill materials or sediment that has deposited in wetlands or along shorelines. Sediment removal can be expensive and there must be a plan for the disposal of scraped material. An advantage of sediment removal is that it can remove accumulated nutrients and expose remnant native seedbank. Shallow scraping, mechanical raking or brushing, or other means to remove the duff layer from a site can also aid the control of species such as cattails, giant reed grass and reed canary grass.



The removal of fill as part of a shoreline restoration project

Photo: Ramsey-Washington Metro Watershed District

Inundation can also be used for the control of perennial weeds such as cattails, giant reed grass and reed canary grass. This technique requires the ability to retain water. Inundation should be initiated early in the season when the target species is short and snowmelt is contributing to water levels. Mowing to decrease vegetation height is recommended if inundation is started during other times of year. It may take a full growing season at a depth of one to two feet to accomplish full removal, making sure that sufficient hydrology is necessary. Reed canary grass on the edges of the inundated areas will likely require herbicide treatment. A plan should be in place to control seedlings following inundation.

Seedbed Preparation

Methods that are used to prepare a seedbed can vary depending on the type of seeding equipment to be used. If a traditional native seed drill will be used, a smooth, firm seedbed is required. Soybean fields generally are sufficiently prepared for a native seed drill, but sites that were recently tilled will require additional soil treatment such as harrowing and rolling to prepare an adequate seedbed and prevent seed from being buried too deep. Broadcast seeding can be conducted on soybean or corn fields, or fields that have been disked, as long as the soil is allowed to settle before seeding. Some practitioners have found that broadcast seeding on a smooth surface (not tilled or disked) leads to the establishment of higher diversity. It is important that the soil surface is not too hard packed, so cultipacking or light harrowing of crop fields before broadcast seeding may be needed. Seed can be lost on smooth surfaces, so it is recommended to seed into temporary cover crops or to roll sites after seeding.



Harrowing to prepare for seeding

For sites where containerized plants will be installed, a firm, weed free surface is desirable to aid planting efforts and to ensure that soil will not bury seedlings after rainfall. For raingardens, shredded hardwood mulch is often applied before planting containerized plants to prevent compaction of the soil during planting, and so seedlings are not buried by mulch when it is installed. Shoreland plantings commonly use wood mulch or erosion control blanket to suppress weeds, retain moisture, and stabilize soils. Shoreland plantings may also use bio-logs and/or wattles or wave break structures to decrease wave energy and to hold upland soils in place while plants establish. On flat or moderately sloped sites a light layer of prairie straw (available from some native plant companies) or weed free straw can be used as mulch to help retain moisture and suppress weeds. On some shoreline and upland sites, fencing, repellents, and/or tree/shrub protectants may be needed to prevent animal herbivory until plants are established.



Raingarden where mulch has been applied before planting to prevent compaction
Photo: Metro Blooms



Shoreline restoration using wood mulch, coconut fiber bio-logs, wattles and fencing

Planting Considerations

Seed Mixes

Seed mixes for projects can include seed collected from the project site, or nearby natural areas, State seed mixes, private vendor mixes, or custom mixes developed for site conditions. State seed mixes have been developed for a variety of project types including wetlands, prairies, forest edges, roadsides, riparian areas, and stormwater treatment systems. These mixes have been designed to increase diversity, create competition for invasive species, and promote plant community resiliency. Single-species cover crops are not recommended in addition to permanent state seed mixes, as they already contain oats or winter wheat (depending on the season of planting). The State seed mixes are available at www.bwsr.state.mn.us/native_vegetation

The following website lists native seed vendors in Minnesota:
<http://www.dnr.state.mn.us/gardens/nativeplants/suppliers.html>.

Temporary Cover Crops and Mulch

The use of short lived temporary cover crops help stabilize project sites and minimize the need for additional mulch in preparation of planting native seed mixes. They can also provide time to observe weed problems, and to allow for proper weed control before fall seeding. If cover crops are seeded at the same time as the native species, they can act as a germination indicator as they grow faster than the native species and show that the seeding was successful. Temporary cover crops such as oats or winter wheat (the two species most commonly used) should be mowed to 10-12 inches before seeds mature (or harvested upon maturity) to prevent re-seeding. Slough grass is a common cover crop for wet areas. Annual rye grass was commonly used but is generally avoided now due to its ability to inhibit germination of native species. Perennial species are discouraged as temporary cover crops, as they require herbicide application before conducting seedbed preparation and seeding. Other cover crops typically used in agricultural fields, such as buckwheat, pennycress, and radishes, can help stabilize soil, build soil quality, or provide weed competition as part of restoration projects. See NRCS Agronomy Technical Note 31.



Wetland grass, forb, sedge and rush seeds



Slough grass established as a temporary cover crop

Planting Dates

Spring seeding is generally favored for native grass establishment, while fall seeding is often favored for planting forb, sedge, and rush seed to allow winter conditions to naturally break seed coats. Fall dormant seeding should be conducted after October 15th in the northern half of the state and after November 1st in the southern half of the state, and before the soil freezes. Dormant seeding or frost seeding (seeding into a few inches of snow) can also aid the establishment of forbs and sedges in uplands where grasses can become more dominant with spring plantings. Dormant seeding is also beneficial for pollinator projects with a high percentage of forbs and if hydrology will be restored in the fall, as it may be difficult to access the site after spring snowmelt. It is common to conduct dormant seeding shortly before snowmelt to ensure that seed is not lost from wind, birds or rodents.



If a wetland project will be constructed in the spring/early summer, or will have flowing or fluctuating water levels it may be better to seed later in the spring after water levels stabilize. Spring seeding of wetland and upland areas should be conducted before June 30th, as summer temperatures can lead to the loss of seedlings.

Containerized plants, vegetated mats, and bare root plants are most often planted in the spring when there is adequate rainfall and soil moisture, but fall plantings can also be successful. Containerized trees and shrubs can also be planted in late fall, before the ground freezes, but frost heave is sometimes a problem in high moisture areas. The installation of woody plant cuttings is typically conducted from early spring until leaves start to develop.

The table below summarizes preferred seeding and planting dates for different types of seed and plants.

Planting Date Guidance for Restoration & BMP Projects

Seeding - Recommended Dates/Vegetation Type

| Seed Type | Spring/Early Summer | Mid-Summer | Early Fall | Mid-Fall | Late Fall (Dormant Seeding) | Frost Seeding |
|-------------------------------|---------------------|----------------|----------------|-----------------|---|------------------|
| | (see date below) | Jun 30 - Aug 1 | Aug 1 - Sep 10 | Sep 10 - Oct 15 | Nov 1 - Frozen Soil (see note about soil temp.) | Feb 15 - April 7 |
| Cool-season Prairie Grasses | Apr 1 - Jun 15 | ** | | * | | |
| Warm-season Prairie Grasses | May 15 - Jun 30 | | * | * | | |
| Prairie Sedges and Forbs | May 15 - Jun 30 | | * | * | | |
| Wetland Grasses | Apr 1 - Jun 30 | ** | | * | | |
| Wetland Sedges and Forbs | Apr 1 - Jun 30 | ** | | * | | |
| State Native Construction Mix | Apr 1 - Jun 15 | | * | * | | |
| Oats Temp. Cover | Apr 1 - Jun 15 | | | * | * | * |
| Winter Wheat Temp. Cover | ** | * | | | * | * |

Plant Installation - Recommended Dates/Vegetation Type

| Plant Type | Early Spring | Late Spring | Mid-Summer | Early Fall | Mid-Fall | Late Fall (Dormant Planting) |
|----------------------------|---------------------|------------------------|-------------------|----------------------|--------------------|---|
| | Green-up- May 15 | May 15 - June 30 | Jun 30 - Aug 1 | Aug 1 - Sep 10 | Sep 10 - Oct 15 | Nov 1 - Frozen Soil (see note about soil temp.) |
| Bare-root Herbaceous | | | * | ** | ** | |
| Bare Root Woody | | | * | ** | ** | |
| Containerized Prairie | | | | * | * | * |
| Containerized Wet Meadow | | | | * | * | * |
| Containerized Marsh | | | | * | * | * |
| Containerized Woody | | | | | * | |
| Submergent Plant Fragments | | | | * | * | ** |
| Vegetated Mats | | | | * | ** | ** |
| Woody Cuttings | | | ** | ** | * | |

Expected Success Rates:

| |
|--|
| High Success |
| Medium Success |
| Not Recommended Without Watering or Favorable Weather Conditions |
| *Low Success |
| ** Not Recommended |

Note: Late fall dormant planting can be conducted earlier if National Weather Service soil temperature data is showing a consistent soil temperature below 40 degrees F for cool-season grasses and legumes or below 50 degrees F for Native warm season grasses, forbs and legumes.

Seeding Considerations

Spring/Summer Seeding: Spring and summer tends to be the best season for grass establishment and forbs such as pasque flower, prairie smoke, phlox, shooting star, golden alexanders, gentian, meadow rue, and many violets that do not require stratification. Forbs and sedges that require a winter for stratification tend to do better with fall planting but when planted in the spring they can sit dormant for a season until they are ready to germinate.

Fall Dormant Seeding: It is common to wait until around November 1st when dormant seeding. It is important that conditions will be cold enough to prevent germination right before winter. It is also common to wait until shortly before snowfall to prevent the loss of seed from wind, birds and rodents. Fall dormant seeding is commonly done when forbs, cool-season grasses and sedges are a primary goal for a project. Fall dormant seeding and winter seeding typically should not be conducted in areas where there will be flowing or standing water in the spring as seed may be lost.

Snow Seeding: Snow seeding is conducted during early or late winter when there is less than a foot of snow, and on sunny days when seed can move to the soil surface. This technique has been successful for a wide variety of species types. Refer to the Minnesota Wetland Restoration Guide for more information about snow seeding.

Cover/Companion Crop Use: Cover crop species are included in state seed mixes. Oats (*Avena sativa*) should be used in spring or summer, and winter wheat (*Triticum aestivum*) in fall. If a project is focused on stabilization and slopes are between 5-10%, cover species should be increased by 35 pounds per acre. If slopes are more than 10% cover species should be increased to 56 pounds per acre.

Plant Installation Considerations

Plant Condition: the planting dates listed in the table assume that containerized plants are fully rooted into containers, that pre-vegetated mats have established vegetation, and that herbaceous, and woody bare root plants (and cuttings) are stored in optimal conditions prior to planting.

Weather Conditions: Weather conditions (including rainfall and temperatures) during a season can have a big influence on the ideal planting dates for vegetation. Planting dates may need to be adjusted based on past and projected conditions.

Seeding Wetlands and Retention Basins

State wet meadow and wet prairie seed mixes are designed to be used from the planned edge of open water (pool elevation) to around 1-1.5 feet in elevation depending on soil texture and capillary action of soil. Other considerations for the use of wetland seed mixes include the extent of hydric soils, and swales coming into a wetland. Upland mixes are used approximately 1-1.5 feet above pool elevation and can be broadcast or drill seeded. The state “emergent seed mix” is commonly used in a 6 to 10-foot band that straddles the edge of open water. This strip of emergent seed is hand broadcast after water levels have stabilized within the wetland. It is not recommended to seed in areas that will have open water, as most wetland seed will float.



Broadcast seeder being used to seed a wet meadow restoration

In most cases, wetland seed is broadcast-seeded followed by rolling or packing, as most wetland seed needs light to germinate. Wetland grasses can be drill-seeded followed by broadcasting forbs and sedges. If a seed drill will be used for installation of wetland seed the drill must be calibrated carefully to ensure that small seed is placed correctly, at the surface.

Prairie, Savanna and Woodland Edge Seeding

Upland prairies, savannas and woodland edges are most often restored through the installation of seed. A variety of seeding equipment is used for upland seeding including broadcast seeders, traditional native seed drills, no-till drills, Brillion seeders and Trillion seeders. Specialized no-till grass drills have depth bands designed to handle a wide variety of seed (fluffy, smooth, large and small) and low seeding rates. Since no-till drilling can plant directly into a light stubble layer, this method reduces erosion on the newly seeded site. Conventional grain drills are not capable of handling diverse seed sizes and are unlikely to provide satisfactory results. While no-till native seed drills can plant through light stubble, success is still likely to be greatest when most excess residue is removed.



Native seed drill

Seed mixes should be chosen that will be suited to the soils and hydrology of the site. State seed mixes are available for prairies and woodland edges in different regions of the state. Mixes are also available from native seed vendors and site specific seed mixes can also be developed. It is important to consider project goals when selecting species for projects, and determining the percentage of individual species in a mix. It can be helpful to overlap upland and wetland mixes a few feet to ensure successful establishment in areas where hydrology levels are unpredictable.

Mulching

Care should be taken to ensure that upland soils do not erode into wetland areas and cover wetland seedlings. As much as one centimeter of sediment can prevent germination of many wetland species. If temporary cover crops are not used as mulch and if sufficient crop stubble is not present additional mulch is recommended at one-ton per acre in wetland areas, and two-tons per acre in upland areas. It is essential that a weed-free mulch be used; MClA Certified Weed Free

mulch (MnDOT Type 3) is recommended. The mulch should be disk-anchored to prevent movement. If the mulch windrows along the edge of open water, it should be removed or re-spread.

Use of Native Seedbank

Maximizing the use of native seedbank is encouraged for wetland projects as a means to promote the establishment of local seed/species. Seedbanks often contain annual species such as fleabane, beggarticks, smartweeds and jewelweed that provide important environmental benefits and often are not included in seed mixes. If native seedbank is planned as a method to establish vegetation, a seedbank test or survey of existing vegetation will assist in determining the need for supplemental seeding. A method for testing seedbank viability can be found in *Section 5, Appendix D* of the “Minnesota Wetland Restoration Guide”: www.bwsr.state.mn.us/publications/restoration_guide.html. If a survey of existing vegetation has been conducted or will be conducted as an alternative to a seedbank test the overall percent cover of individual species should be recorded to gain an understanding of additional species that may be needed. The composition of state wetland seed mixes can be used as a reference to see if additional grass, sedge or forbs species should be seeded. Survey information from nearby remnant communities can also be used as a guide for developing a diversity standard and determining what additional species may be beneficial.



Tree Planting

Planting 200 to 400 seedling trees or shrubs per acre is recommended for upland and wetland forested communities and shrub wetlands. Spacing should depend on the size of plant material, seedbank of woody species, potential for colonization, expected aftercare, and potential losses. It is not uncommon to lose between 25-50% of seedling trees and shrubs or cuttings. Nursery grown plants may not do well when planted in saturated soils, so planting on mounds or berms (1-2 feet tall) can be helpful. The seeding of trees and shrubs has become a more common practice to plant large areas. Thorough site preparation and weed control is needed for seeding trees and shrubs, similar to methods used to prepare and maintain prairie plantings.



Planting seedling trees and shrubs

As tree and shrub seedlings are susceptible to deer and rodent browsing, protection (bud caps, tree tubes, wire exclosures, etc.) is often necessary to ensure their survival. An exception is when large numbers are planted through tree and shrub seeding, when some loss is expected. Repellents can be applied on and around seedlings until they are established. Watering is needed for trees and shrubs if rainfall is less than one inch per week.

Aquatic Plant Installation

For shallow marsh restorations, and the edge of retention ponds and lakeshores (without significant wave action), the establishment of emergent plants will help ensure sufficient establishment in open water areas. Species such as arrowhead, water plantain, giant burreed, bulrushes, sweet flag, wild iris, and pickerelweed can be planted near the edge of open water and allowed to spread into deeper water. Burreed and three-square bulrush are less desirable by muskrats, so they are beneficial where muskrats are a risk. Lakeshore restorations are often planted with a higher density of both wet meadow and emergent plants with a spacing of 1.5-4 feet between plants. The spacing of individual species is often based on how quickly the species can spread by underground rhizomes or other means.

It is recommended that aquatic plants be installed in May or June; recent research and project experience has shown this to be the best time for establishment. Late summer plantings seem to have lower survival rates. Install emergent plants at a depth where they will not be covered with standing water. Waves may also influence plantings, particularly on east shorelines, so it may be beneficial to plant some emergent species a little further up slope from the open water edge to aid establishment. Wave break structures, wattles, or coconut fiber logs can be used to minimize wave damage. Temporary fencing may be needed for projects where waterfowl or muskrats may graze young plants; in some cases this can be as simple as flagging tape attached to stakes to deter waterfowl. Watering may be needed in drought conditions.



Planting of emergent plants on the edge of open water

Submergent and floating leaved species such as wild celery, coontail, lotus, and sago pondweed can be used in deeper portions of a site. Plant vendors should be contacted for availability of species and propagule types, and to provide recommendations on how best to anchor/establish new plantings. All efforts should be taken to prevent the spread of Aquatic Invasive Species.

Upland Plant Installation

Similar to aquatic plants, prairie plants can be installed from containers. Containers are typically used for species that do not establish well, or quickly from seed (liatris, lilies, butterfly milkweed, etc.), and for species where little seed is available. The number of containerized plants used for projects often depends on project budget. For raingardens, biofiltration areas and many other BMPs it is common to use containerized plants instead of seed to ensure rapid establishment and a predictable spacing and distribution of species, adding to an ordered appearance. Containerized plants are commonly planted in late spring after plugs have a chance to mature. Some plantings are also conducted in the fall. It is important that plants will not have too much weed competition and are watered. In the summer months during the first year, new plantings require 1 inch of water per week, either by rainfall or by supplemental watering. If drought conditions occur during the second year, supplemental watering may also be required. Flags may be needed for large areas to mark the location of plants and aid watering efforts.

Inter-seeding

Inter-seeding is most effective in stands where grass is not overly dominant. It does not work well in monoculture stands of switchgrass, and reed canary grass or in Kentucky bluegrass sod. Forbs and grass species can be inter-seeded. Forbs are generally broadcast seeded while grasses are commonly drilled. Individual species and seeding rates should be selected based on existing vegetation, site needs and project goals.



Inter-seeding forbs into native grasses to increase diversity

Site preparation generally involves the removal of thatch through burning or haying to provide light for seedlings. Weed removal through herbicide treatment is sometimes needed to decrease competition and open areas for establishment. An alternative method is to cultivate nodes within larger areas for seeding. A year or longer may be needed for site preparation if perennial weeds are dominant.

Converting non-native grasslands may require cropping for a year or two, or combinations of tilling and herbicide application to prepare for seeding. In some cases, inter-seeding can be successful without tilling, particularly when existing vegetation is not vigorous due to sandy soils or other factors. When removing existing weeds such as smooth brome and goldenrod, fields are typically burned to remove thatch, and then treated with herbicide as vegetation reaches about six inches tall. Several herbicide applications, or combinations of herbicide and tilling may be conducted before seeding occurs. Repeated mowing to about six to eight inches during the first two years can be important to aid seedling establishment.

Inter-seeding should be timed to correspond to site-preparation methods. The installation of forb seed is commonly conducted in late fall or late winter. Seeding during these times of year provides time for forb seeds to be stratified (break dormancy). Inter-seeding can be conducted in spring or early summer, but some type of packing or dragging is beneficial. A potential strategy is to broadcast forb seed followed by seeding grasses with a seed drill that is equipped with a roller that can enhance establishment by promoting seed to soil contact.

During the first two years after inter-seeding, burning should be avoided to prevent damage to seedlings. Mowing is an important method to promote seedling establishment and growth after seeding. Frequent mowing (bi-weekly if possible) to a plant height of 6-8 inches is recommended for two seasons in non-native grasslands and restored/reconstructed native prairie.

Monitoring the success of inter-seeding efforts is important to better understand the effectiveness of methods and to guide future efforts.

Seeding Forb Diverse Mixes for Pollinator Habitat

Pollinator seed mixes typically include greater than 30% forbs by seed count for large areas and over 50% for smaller pollinator plots/zones of a few acres in size. As a result, it is important that weeds are thoroughly controlled before seeding through combinations of herbicide application and tilling or other methods that will decrease the weed seedbank. It is also important that pesticides that persist in the soil were not used prior to seeding. The persistence of individual pesticides need to be investigated if they were used. Seed should be dormant seeded in late fall to allow forb seed to stratify over winter and be ready to germinate in the spring. Forb species are sometimes planted in masses to make them easier for pollinators to find and to decrease travel distance. Broadcast seeding or seeding with a native seed drill should be conducted followed by rolling to improve seed to soil contact and prevent erosion. See page 38 for information about pollinator habitat.



Native bee on wild bergamot



Project Maintenance

Proper site maintenance is essential to ensure the success of a restoration project. A schedule summarizing planned maintenance activities each month is very helpful to guide contractors and project managers. It is also helpful to have information in vegetation management plans about problematic weed species that may establish at a site, as well as details about how they will be controlled. [Appendix B](#) of the “Minnesota Wetland Restoration Guide” provides information on invasive species control. It is common that the management methods listed below are used in combination for effective site maintenance. Indeed, Integrated Plant Management, or IPM, which is using multiple management methods over time, will yield the best results. Just as in agricultural settings, invasive plants can become resistant to certain herbicides after repeated applications. Some species may respond better to certain management methods, so using IPM, or “all the tools in the toolbox,” will be most effective over time. As a general rule, mechanical or bio-control options should be considered before herbicide methods to limit damage to aquatic organisms and pollinators that may be using the restoration project. However, there are cases where herbicide application will be the most efficient method of removing some perennial invasive species.

Mowing/Cutting

Mowing can be an important step in the establishment of upland prairie restoration sites. Mowing at least twice the first season and at least once the second season with a flail mower or stalk chopper (to prevent smothering plants) is often needed to decrease competition and to provide sufficient sunlight for seedlings. Weeds should be mowed to between five and eight inches before seed is allowed to set (usually as weeds reach 12-14 inches). Mowing height should be raised as native plants establish. The timing and frequency of mowing should be planned to allow sufficient light to reach native plant seedlings and preventing weed seed production. Sites with low weed competition due to sandy soils or other factors may not need mowing. Annual weeds can be controlled by mowing or cutting alone by cutting them before they produce seed.



ATV used to mow Canada thistle before flowering

Mowing of annual and biennial weeds is also beneficial in wetland transition areas for species such as giant ragweed, barnyard grass, and Canada thistle, but should only be conducted if rutting and soil compaction will not result. Pressure from annual and biennial weeds is generally less with increased soil saturation and water depth. For smaller projects, brush cutters, string trimmers, or hand equipment can be used to target weeds and work around native plants. See the Minnesota Wetland Restoration Guide appendix: <http://bwsr.state.mn.us/restoration/resources/documents/appendix-6a-3mowing.pdf>

Haying

Haying can be used as a management tool to remove weed growth and thatch to provide sunlight for establishing native species and to help control woody plants in prairies and wetlands. Haying can also be used to help maintain diversity levels. One study found that the total number of species and proportion of native species was similar between planted grassland plots that were hayed in the fall and plots where early season prescribed burns were conducted. Haying can be a good alternative to prescribed burning where burning is not feasible due to the presence of desirable woody plants, unfavorable weather or surrounding land uses. Another role of haying can be to remove tall growth of weeds or woody plants prior to burning, herbicide treatment or flooding. If allowed by conservation programs, and consistent with project goals, haying of uplands can also provide forage for cattle producers and biomass for energy production. When considering haying as a management strategy it is important to consider potential influences on pollinators, bird nesting, soil disturbance, soil nutrients, and long-term diversity levels. See the Minnesota Wetland Restoration Guide appendix: <http://bwsr.state.mn.us/restoration/resources/documents/appendix-6a-4haying.pdf>

Hand Weeding

Hand weeding can be an effective method of controlling small populations of weeds, or for weed management for BMP projects. For rain gardens, biofiltration areas, and lakeshores, hand weeding may be more effective (and more desirable in some cases) than using herbicides. Hand weeding should be done when soils are moist and care should be taken to avoid disturbing the root systems of desirable plants. Soil pulled up with the weed should be knocked off and placed back on the ground, covering the hole left by the pulled weed to prevent the introduction of more weeds. It is also

important that proper pulling technique is used to avoid injury. If weeds are not producing seeds they can sometimes be left in place to act as mulch. Tools such as weed wrenches and weed talons can be used for pulling woody plants such as buckthorn and non-native honeysuckles. Perennial invasive plants may need to be dug out with a shovel or other tool. An [Minnesota Department of Agriculture](#) website provides information about disposal of weeds.

Biological Control

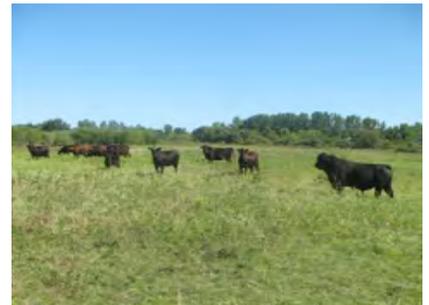
Biological control is an effective management tool for large infestations and environmentally sensitive areas. Biological control agents are currently being used for purple loosestrife, leafy spurge, Canada thistle, common tansy, and spotted knapweed and they are in development for several other species. State or federal agencies should be contacted for recommendations on obtaining bio-control agents. Other practices such as mowing, prescribed fire, grazing, and inundation can influence bio-control agents, so their use should be part of a comprehensive management plan.



Leafy spurge bio-control beetle

Conservation Grazing

Conservation grazing is conducted by a variety of species, including cattle, bison, horses, sheep, and goats, to target specific invasive plants and non-native species or to replicate natural grazing regimes and to promote nutrient cycling and species diversity. For example, early spring grazing by cattle has been used to control Kentucky bluegrass in prairies, while later spring grazing has been used to control smooth brome grass. Goats have also been used for the management of buckthorn and non-native honeysuckles, as they eat a variety of woody plants. Detailed grazing plans are an important component in the planning and implementation of prescribed grazing, defining objectives and factors such as timing, potential disturbance, herd size, fencing and water sources. See



Cattle grazing reed canary grass in a restored wetland

<http://bwsr.state.mn.us/restoration/resources/documents/appendix-6a-5conservationgrazing.pdf>

Water Level Control

If water level controls are available in wetland, ponds, or lakes it may be possible to adjust hydrology to allow access with equipment or to flood undesirable species. Available hydrology will influence the effectiveness of flooding. Flooding has been an effective method of management for cattails and non-native phragmites. Mowing or clipping may be necessary prior to inundation to eliminate oxygen transport to roots (even some dead stems can still transport oxygen). The influence of drawdowns or flooding on wildlife species should be considered, particularly during reproductive periods when nests might be drowned or amphibian eggs dried out by changing water levels. DNR permits are needed for control of cattails in public waters and are likely needed for controlling water levels.

Burning

Prescribed burning is beneficial to remove thatch, control invading woody and invasive plants in wetlands, prairies, and savannas, fertilize the soil with ashes, stimulate seed germination and new plant growth, and increase diversity in plantings. Some practitioners feel that burning may increase reed canary grass in wet meadow plantings where the species is a threat, likely due to added nutrients and light levels promoting germination (fall burning may have less benefit for invasive species). Other rhizomonous species may also be stimulated by burning, so other management methods (e.g. herbicide application or mowing) may be needed after burning. Burning is typically initiated after the third or fourth years of establishment, after native vegetation is reaching maturity. Uplands benefit from burning every three to five years. Fall and spring burns should be alternated periodically to simulate natural variation. Burn plans are needed to define the details of how the burn will be conducted, who will be involved and for contingency planning. In many cases, permits are also required.



Prescribed burning to control woody plants in a wetland restoration

It is recommended to only burn one-half or less of a project site at a time if they are large (over 50 acres), or don't have any adjacent refuge such as other conservation lands adjacent to the site for wildlife species. Partial burns and burns that are patchy may also benefit pollinator populations if timed correctly (when pollinators are not actively foraging or pollinators have pupated and are mobile).

Spot Treatment of Weeds

Problematic perennial weeds that cannot be managed effectively with other methods may require spot treatment with herbicide for sufficient control. Examples include reed canary grass, smooth brome, quack grass, purple loosestrife, Canada thistle, Kentucky bluegrass, crown vetch, and birds-foot trefoil. In some cases, herbicide treatment is not conducted during the first or second year of establishment to avoid impact to seedlings but it may be important to control some weeds before they have a chance to spread. A common practice for Canada thistle control involves clipping seedheads while they are in the bud stage (usually early June) and conducting herbicide application with a broad-leaf specific herbicide in the fall (mid to late October). This timing limits the application of herbicide while pollinators are active.



Spot herbicide treatment of reed canary grass

Grass-specific herbicides are used to control reed canary grass in wet meadow restorations, particularly on sites dominated by forbs and sedges that will not be affected. Grass-specific herbicides are most effective on young reed canary plants than on mature plants. There is some evidence that using surfactants along with herbicides and disking prior to application may improve effectiveness. It should be noted that grass specific herbicides are not aquatically certified and should not be used near open water.

When using a broad-spectrum herbicide it is important that an aquatic safe form of glyphosate and surfactant be used near open water. When using herbicides, labels must be followed, certified applicators must conduct the treatment and Personal Protective Equipment (PPE) must be used according to label instructions.

Woody Tree Control

Tree and woody brush control is usually essential in most projects to prevent woody species from outcompeting the desired plant community. Tree control in conservation plantings is a common practice in the prairie region of Minnesota to improve habitat for ground nesting grassland birds. Methods of control include prescribed burning; mowing/cutting; mowing/cutting followed by stem herbicide treatment or basal herbicide treatment; foliar herbicide treatment; and grazing and pulling. The method that will be most effective in a certain situation will depend on site conditions, size of woody plants, density and timing. Prescribed burning in the fall and mowing with a flail type mower (leaving the cut surface rough vs. a clean cut) in late summer are generally the most cost effective methods for smaller trees and shrubs.



Cottonwood treated with herbicide

Guidance by Project Type

The following subsections of the guide provide recommendations for selecting seed and plants for specific project types. Project types include:

- **Native Prairie Reconstruction**
- **Pollinator Habitat**
- **Wetland Restoration**
- **Agricultural BMPs**
- **Stormwater Basins**
- **Raingardens and Biofiltration Areas**
- **Lakeshores**
- **Forests/Woodlands**
- **Native Plant Community Restoration**
- **Temporary Cover**
- **Streambank Stabilization**
- **Ravine Stabilization**



Buffer planting in Austin, Minnesota

Topics covered for each project type include: **General Considerations, Achieving High Function, Diversity, Source Recommendations, and Information Sources.**

Two BWSR publications that relate to a wide range of project types include:

The BWSR “What’s Working” Web Page- <http://www.bwsr.state.mn.us/grants/WhatsWorking.html>; this site includes practitioner information about restoration, and BMP techniques that have proven successful.

The BWSR website document “Summary of Functional Benefits of Native Plants in Designed and Natural Landscapes”- http://www.bwsr.state.mn.us/native_vegetation/Plant_Function_Resources.pdf. This resource provides a summary of research papers and other information about specific functions provided by native species.



Native Prairie Reconstruction

A variety of state programs focus on the reconstruction of native prairie communities. Reconstruction refers to efforts to establish a native plant community in a disturbed site such as an agricultural field. Program goals for native prairie reconstruction can vary widely from establishing perennial species to stabilize soil, and provide cover for game birds; to establishing high diversity plantings to provide habitat for a variety of wildlife species.



Achieving High Function - Deep rooted prairie grasses and forbs are often a focus of native prairie reconstruction projects for soil holding, water filtering and infiltration, and year round wildlife cover. Species from multiple plant guilds (warm season grasses, cool-season grasses, legumes, asters, and other forbs) are selected to ensure that complete plant communities are established, and benefits are provided to multiple species. Dry prairie mixes are used for upland sites with sandy or dry soils, while mesic prairie mixes are used for uplands with medium soil moisture and wet prairie mixes are used where the water table is within twelve inches of the soil surface during extended periods, resulting in saturated soils.

The NRCS 643 practice standard “Restoration and Management of Declining Habitats” (www.bwsr.state.mn.us/grantscostshare/native_buffer.html) provides specific seed mix and use specifications for RIM/WRP projects, as custom mixes are often developed for this program. State seed mixes have been developed for different prairie types in different regions of Minnesota and are another option for prairie restoration projects.

2103 state legislation states that “prairie restorations conducted on state lands or with state funds must include an appropriate diversity of native species selected to provide habitat for pollinators throughout the growing season”. To provide good habitat for pollinators a diversity of flowers providing nectar and pollen though the growing season is needed as well as nearby clean water sources and protection from pesticides. See additional pollinator guidance on page 31 of this guide as well as BWSR’s [pollinator webpage](#). Specific species beneficial to pollinators may be added to mixes to aid declining pollinator species. Specific pollinator plots/zones of a few acres in size may also be added to projects to maximize pollinator habitat.



Site Selection – Native prairie reconstruction projects should be located in areas that will have high value to wildlife and/or provide soil stabilization and water quality benefits. The “[Minnesota Prairie Conservation Plan](#)” provides guidance for the establishment of prairie habitat complexes across Minnesota by protecting and buffering existing prairie.

Key Plant Species - Grasses and forbs are the most common plant types in prairie seed mixes, with some low growing shrubs, as well as sedges and rushes being present in some prairies. Species should be selected that are native to the area and well adapted site conditions. The following table lists species commonly included in native prairie reconstruction projects.

| | |
|-----------------|--|
| Shrubs: | Wild roses, Leadplant |
| Grasses: | Big bluestem, Switchgrass, Little bluestem, Indian grass, Slender wheatgrass, Canada wild rye, Sideoats grama, Prairie cord grass, Kalm’s brome, Fringed brome, Western wheatgrass |
| Forbs: | Yellow coneflower, Butterfly milkweed, Common milkweed, Black-eyed Susan, Smooth aster, Golden alexanders, New-England aster, Maximillian sunflower, Purple prairie clover, Bush clover, Narrow-leaf coneflower, Coreopsis, Spiderwort, Wild bergamot, Mountain mint, Partridge pea, Cup plant, Blazingstars, Showy goldenrod, Stiff goldenrod, Penstemons, Canada milk vetch. |

Source Recommendations - The source sequence outlined in this guide is recommended for native prairie reconstruction projects to ensure long-term sustainability of projects and to protect remnant prairie communities. The NRCS 643 practice standard has been updated to correspond to these guidelines and can be used along with these guidelines to set specifications and standards for RIM/WRP projects. Ecovars (varieties) that have not been selected for certain traits and meet the source requirements of the program may be used for conservation programs focused on grassland establishment; however, native cultivars and varieties should not be used within 1/4 mile of remnant communities.



Establishment - Most prairie reconstructions are conducted on fields that were previously in soybeans or possibly corn, as agricultural production can help ensure that weeds are controlled. However, it is important to make sure that chemicals that inhibit germination have not been used, requiring use of a cover crop for one or two seasons to allow time for the chemicals to break down in the soil. Most agencies recommend drill seeding into soybean stubble, though broadcast seeding is conducted for some projects. Some loosening of the soil with cultipackers or harrows may be needed prior to broadcast seeding if a crust has formed on the soil surface. Fields that are in brome grass and other perennial weeds often need a combination of treatments such as mowing, herbicide application and tilling to prepare for seeding and multiple treatments may be needed for weedy sites dominated with brome grass, quack grass, Canada thistle and other perennial species.

Maintenance - Key steps to maintenance involve mowing annual and biennial weeds to 5-8 inches during the first couple of years as needed to provide sunlight and to decrease competition for seedlings. After the second year, spot herbicide treatment of perennial weeds is common; and prescribed burning to maintain diversity and to control woody species is common after year three. Conservation grazing, bioenergy harvest and biocontrol of invasive species may also be long-term maintenance strategies, though these management methods often require amendments to conservation plans.

Information Sources -

[NRCS practice standard 643](#)

www.bwsr.state.mn.us/grantscostshare/native-buffer.html

Minnesota Wetland Restoration Guide www.bwsr.state.mn.us/publications/restoration_guide.html

Pollinator Habitat

Each year native and domesticated bees pollinate around 30% of crops in the United States with a value of approximately \$23 billion. They also pollinate around 70-80 percent of flowering plants in the Midwest, playing a key role in their seed production. Native bee populations that include more than 4,000 species in North America have declined in recent years due to habitat loss and pesticide use among other factors. At the same time, managed colonies of European honey bees have suffered a 50% decline in recent decades.



While Honey Bees and Bumble Bees are the most commonly known pollinators, they only make up about 2% of bee species in Minnesota. The remaining species are solitary bees that do not live in colony systems like Honey or Bumble bees (with division of labor and cooperative rearing of young). Supporting native solitary bee habitat is important, as like honey bees, their populations are also in decline. Pay attention to the various pollinators and their habitat needs in the landscape to help protect and enhance their existing habitat.

Habitat complexes and corridors are important nesting and food sources for pollinators

Other pollinators of concern include beetles such as the Longhorned beetle, flies such as the Syrphid fly, moths and butterflies. Many of these pollinators have their own unique habits and needs, for example, many moths tend to pollinate white or dull colored blossoms that flower at night. Some pollinator species are dependent on certain plant species for the completion of their lifecycle, such as the Monarch butterflies dependence on milkweed, and the endangered Karner Blue butterflies need for Wild Lupine. By establishing native vegetation, one can support the intricate relationships forged between native pollinators and native vegetation and keep both populations healthy.



Bees pollinating marsh Milkweed

State legislation from 2013 states that “prairie restorations conducted on state lands or with state funds must include an appropriate diversity of native species selected to provide habitat for pollinators throughout the growing season”.

Site Selection- Adequate food, shelter, and nesting sites are all needed to support healthy pollinator populations. The following are key considerations for selecting areas for pollinators:

- 1) Look for areas away from pesticide and fungicide use, as well as areas that lack widespread disturbances that may impact pollinators.
- 2) Habitat complexes and corridors provide “safe zones” and natural passageways for pollinators, as well as nesting and forage sites, and sources of water.
- 3) Some bees have a relatively small flight distance and benefit from having water and food sources within 200 feet of nesting sites.
- 4) Ground nesting bees benefit from planting clump forming native grasses. Bees that nest in tree and stem cavities benefit from farm hedgerows, windbreaks and treelines, as well as man-made nest structures. As a general rule, plant communities that historically existed at a site will provide the most beneficial nesting habitat.



A native fly pollinating an aster

Achieving High Function - Seed mixes for pollinators should include at least fifteen species and have a high percentage of forbs (30-60% by seed count). At least 30% forbs is recommended for large acreage areas (over 50 acres) and at least 50% forbs is recommended for pollinator zones/plots of a few acres in size. Grasses are also important for community structure, nesting sites and to provide fuel for prescribed burning. Shorter grasses can benefit forb growth and pollinator use. It is recommended to include at least three flowering species in each bloom period so there is a continuous food source throughout the season (few early blooming species are typically included in mixes). It is also helpful to plant forbs in masses to make them easier for pollinators to find and to increase foraging efficiency. Including a wide range of flower colors and shapes will benefit a variety of pollinator species. Annual species that commonly establish from native seedbanks such as jewelweed, fleabane, beggarticks and smartweeds also provide important pollinator habitat. These species, along with annual cover crops can often effectively compete with weeds and stabilize sites prior to the installation of seed mixes. In addition to herbaceous plants, flowering trees and shrubs can be an important source of pollen and nectar for pollinators, particularly early in the spring. Avoid clearing fallen or dead trees (unless the trees are inhibiting the use of ground nesting prairie bird species), as they help create nesting sites for a wide range of pollinators.

Key Plant Species -Plant species can be selected for projects to support specific insects, such as planting milkweed species for monarchs (and a variety of pollinators), lupine for Karner Blue Butterfly, or basswood for a variety of bee species. The following are key pollen and nectar sources for pollinators in the spring, summer and fall. Species should be selected that are native to the area and well adapted to site conditions.

| | |
|----------------|--|
| Spring: | Willows, Basswood, Dogwoods, Viburnums, Juneberries, Plums, Cherries, Blueberry, Lupine, Bloodroot, Buttercups, Dutchman’s breeches, Columbine, Virginia bluebells, Spiderwort, Lobelias, Golden alexanders |
| Summer: | Buttonbush, Dogwoods, False indigo, New Jersey tea, Wild rose, Prairie clovers, Milkweed, Wild bergamot, Giant hyssop, Penstemons, Bush clovers, Canada milkvetch, Culver’s root, Hedge nettle, Evening primrose, Ironweed, Leadplant, Coreopsis, Canada tick trefoil, Lobelias, Obedient plant, Mountain mint, Partridge pea, Yellow coneflower, Cup plant, Joe-pye weed and Blazing stars. |
| Fall: | Asters, Sneezeweed, Grass-leaved goldenrod, Gentian, Boneset, Goldenrods, Sunflowers |



A native bee collecting nectar from obedient plant

Source Recommendations - Local seed and plant sources are recommended for pollinator habitat projects to protect nearby native prairie populations and to provide plant species that are compatible with local insect populations. It is important that plants are purchased from nurseries that do not use pesticides as part of their production process.

Establishment - Thorough weed control is essential prior to establishing pollinator habitat. In many cases, projects are seeded into fields that were previously in soybeans or corn, as agricultural production can help ensure that weeds are sufficiently controlled. Additional management may be needed to ensure that Canada thistle is sufficiently controlled prior to planting as it is not always effectively removed as part of agricultural production.



Wild bergamot in a conservation planting

It is important that pesticides (such as neonicotinoids) that persist in the soil were not used prior to planting, as they can be taken up into plant tissues and affect pollinators. Individual pesticides should be investigated to determine their persistence in the soil. When converting pastures or fields dominated with perennial weeds such as smooth brome grass, quack grass and Canada thistle multiple treatments of herbicide application and tilling may be needed to achieve sufficient control prior to planting. In residential yards it is recommended to cut away the sod prior to planting to remove weed roots and seed.



Beyond bees, many other insects are useful pollinators like this sand wasp

Cover crops such as oats or winter wheat can be used to stabilize sites if additional time is needed for pesticides to break down in the soil or to stabilize soils prior to the planned seeding date. Drill or broadcast seeding is often conducted in the fall to allow forbs to naturally stratify over winter and compete with grasses in the spring. Some forbs that are important for pollinators such as sneezeweed, Dutchman's breeches, bugleweed, wild bergamot, evening primrose, smooth blue aster, mountain mint and aromatic aster do not require pre-stratification and can be successfully seeded in the spring. If broadcasting seed, light raking and/or rolling can be used afterward to help ensure good seed to soil contact and prevent the loss of seed from wind and birds.

Maintenance – The maintenance of pollinator plantings can be challenging due to the high forb diversity and difficulty of removing weeds such as thistles without harming native plants or pollinators. Key steps to the maintenance of pollinator plantings involve:

- Mowing annual and biennial weeds to 5-8 inches as needed during the first one to two years of establishment provides sunlight and decreases competition for seedlings. After the site is established mowing can be used to help control noxious weeds. Spot mowing is recommended to maintain insect refugia and vegetative cover should be maintained into the fall for overwintering habitat.
- Hand pulling of weeds is an effective strategy for smaller plantings. This is often most effective after rainfall when weeds are easier to pull
- Prescribed burning is often initiated after the third year and can help to maintain diversity and to control woody species. Burning should only be conducted on 1/4-1/2 of large sites each year to minimize impact on insects and patchy burns are ideal to provide areas of refuge. Burns are often conducted in the fall or early spring to promote floral diversity and minimize impact to pollinators.
- Conservation grazing following grazing plans can be used to reduce the percent of cool-season grasses in conservation plantings and promote floral diversity. Separate grazing units are often needed to effectively manage the timing and duration of grazing.
- Biocontrol of invasive species may also be a long-term maintenance strategy to minimize herbicide use and control weeds. Biocontrols are available for leafy spurge, spotted knapweed, purple loosestrife and Canada thistle.
- When herbicides will be used for management it is important that target species (such as Canada thistle or wild parsnip) are not in bloom when they are sprayed and that spot herbicide application is conducted rather than



Early spring prescribed burn

broadcast spraying. Herbicide is typically not conducted the first or second year after planting, as it can damage native plant seedlings.

Information Sources -

[BWSR Pollinator Toolbox](#)

[Minnesota NRCS Pollinator Conservation Planning Documents](#)

[Pollinator Habitat Assessment Form and Guide](#)

[Upper Midwest Plants for Native Bees](#)

[Pollinators and Roadsides, Roadside Management for Bees and Butterflies](#)

[Pollinator Conservation in Minnesota and Wisconsin](#)

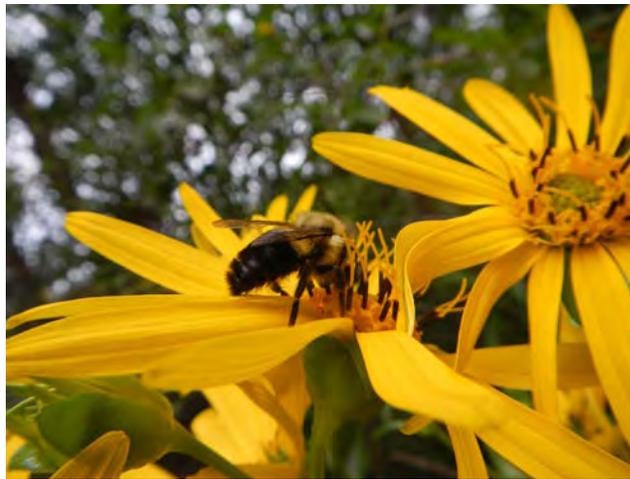
[Pollinators in Natural Areas](#)

[Protecting Bees from Neonicotinoids in Your Garden](#)

[Using Farm Bill Programs for Pollinator Conservation](#)

[Monarch Habitat Guidebook](#)

[Conserving Bumblebees](#)



Wetland Restoration

Individual conservation and mitigation programs provide guidance for goals related to native vegetation establishment in wetlands. Some programs primarily focus on the use of native seedbanks that are present in the soil, while others focus more on seeding grasses, sedges, rushes and forbs. Invasive species control, particularly reed canary grass is often a concern for wetland projects and need sufficient control to allow native vegetation to thrive. Native seedbank plays an important role in the establishment of wetland vegetation as a primary source of native vegetation. The viability of native seedbank can vary depending on the number of years a site has been in agricultural production, the amount of sediment that has accumulated and weed invasion. A wide variety of wetland species are also becoming commercially available for seeding wet meadows and shallow marshes and restoration professionals are learning how to effectively conduct wetland seeding.



Site Selection – The Minnesota [Wetland Restoration Strategy](#) provides a framework for selecting wetland restoration projects. It is important that individual projects be selected to meet specific program goals such as water quality improvement, flood reduction, wetland replacement and wildlife habitat. GIS analysis of watersheds, water quality testing, and wildlife habitat assessments are all useful tools that may be used to guide project selection. Multiple state and federal programs focus on wetland restoration and local conservation staff play a key role in working with landowners to identify projects.



Shallow marsh restoration

Achieving High Function - Wetland grasses, sedges, rushes and forbs all play important roles in providing habitat for a wide range of wildlife species. Some research has shown that higher diversity levels can also aid in water quality functions such as denitrification in open water areas and increase carbon sequestration rates. Ensuring sufficient control of invasive species will aid native species establishment and ensure long-term sustainability of ecological functions.

Native seedbank may supplement wetland restoration projects, but seedbanks are sometimes unpredictable, and not all species do well from seedbank. Most wet meadow seed mixes contain around 20-30 species. Shallow marsh communities may be seeded with mixes of 10-20 species; it is also common to use containerized plants when establishing emergent species, as it is difficult for seedlings to grow from seed along the edge of open water where waves and water level fluctuations can inhibit growth. Specific conservation and mitigation programs will define diversity goals. Higher diversity mixes will help support pollinators and other invertebrates that play a key role in the health of wetland habitats.

Key Plant Species - Trees, shrubs, grasses, forbs, sedges, rushes and ferns are all commonly used as part of wetland restoration projects. Species should be selected that are native to the area and well adapted to site conditions.

| | |
|-----------------|---|
| Trees: | Tamarack, Black spruce, Red maple, Silver Maple, Black ash |
| Shrubs: | Willows, Red-osier dogwoods, Nannyberry viburnum, Spiraea sp., High bush Cranberry, Bog birch, Blueberry, Buttonbush |
| Grasses: | American slough grass, Prairie cordgrass, Manna grasses, fowl bluegrass, rice-cut grass, Canada blue-joint grass |
| Forbs: | Marsh milkweed, Culver’s root, Blue lobelia, Cup plant, Mountain mint, Grass-leaved goldenrod, Joe-pye weed, Boneset, Red-stemmed aster, Sneezeweed, Swamp aster, Marsh aster, Giant goldenrod, Giant-bur reed, Sweet flag, Wild iris |
| Sedges: | Tussock sedge, Bottlebrush sedge, Lake sedge, Slough sedge, Porcupine sedge, Pointed-broom sedge |
| Rushes: | Torrey’s rush, Riverbulrush, Soft-stem bulrush, Spikerushes, Green bulrush, Soft rush, Three-square bulrush |
| Ferns: | Sensitive fern, Marsh fern |

Source Recommendations - Most wetland species common to prairie potholes and river systems likely had a wider dispersal through waterfowl and water flow than many prairie species. As a result, a wider source distance may be appropriate for some species, but local resource staff should be involved in decision making about source distance. Calcareous fens are a rare plant community type in Minnesota, only very local sources should be used in and around calcareous fens.

Establishment - Wetlands are typically dormant seeded in the fall or seeded in spring after hydrology conditions have stabilized. An advantage of fall dormant seeding is that forb and sedge seed is allowed to stratify over winter. Most wetland seed is very small and should be planted near the soil surface, so it is common broadcast wetland seed. Emergent wetland species may be seeded but are also commonly planted on the edge of open water and allowed to move to deeper areas on their own.



Wet Meadow Restoration

Maintenance - Similar to prairies, wet meadow restoration also benefit from mowing during the first couple years of establishment, particularly in dry conditions where agricultural weeds may be common. Mowing should not be conducted where rutting and soil disturbance will occur. It is common to spot treat problematic perennial weeds such as reed canary grass and Canada thistle with herbicide. Aquatic safe herbicides and surfactants should be used in areas of standing water. Biocontrol is commonly used for purple loosestrife. Cattails may be controlled depending on project diversity and wildlife goals.

Information Sources -

Minnesota Wetland Restoration Guide www.bwsr.state.mn.us/publications/restoration_guide.html

Agricultural BMPs (Including Harvestable Perennials and Cover Crops)

There are a wide variety of agricultural BMPs designed to stabilize soils and promote water quality, including grass waterways, filter strips, windbreaks, cover crops and riparian buffers. In many cases, these projects are funded through federal and/or state programs. Primary goals of these projects are to stabilize soil, to filter and infiltrate stormwater, and to protect surface water and groundwater resources. In some cases, they may also provide wildlife cover and food sources.



There is also increasing interest in perennial crops that can be grown and harvested for biomass, livestock forage and feed, and, in some cases, food. Examples include switchgrass, native prairie grasses such as big bluestem and Indian grass, intermediate wheatgrass/Kernza (the harvestable seed), alfalfa, and other legumes such as clovers. These crops may replace conventional row crops or may be used as part of a rotation with corn or soybeans.

Site Selection – Agricultural BMPs should be targeted where they can make significant improvements in soil stabilization, water quality and protection of downstream resources. GIS mapping of watersheds and water quality monitoring data are useful tools for prioritization of projects. Local conservation staff play a key role in working with willing landowners in priority areas. To define the specific benefits of projects BWSR has developed [calculators](#) for soil and water quality benefits.

Achieving High Function - Deep rooted prairie grasses are often a major component of agricultural BMP plantings, as they have many stems, stand upright in flowing water, and their root systems help increase organic content in soil, prevent erosion and develop root channels that increase infiltration rates. The root systems of trees and shrubs can also effectively filter, intercept and absorb stormwater.



Forbs may not be an appropriate focus of planting if pesticide drift is a concern. Pollinators that are attracted to forbs may be negatively impacted when pesticide overspray occurs. Higher diversity buffers, including environmentally suitable annual, biennial and perennial species are commonly planted in areas of low pesticide use where project goals may include providing habitat for pollinators, birds and a wide range of other species, or to develop areas for future seed collection. The Minnesota Department of Agriculture oversees the state's [Pesticide Applicator Licensing](#). NRCS Agronomy Technical Note 9 "[Preventing or Mitigating Potential Negative Impacts of Pesticide on Pollinators Using Integrated Pest Management and Other Conservation Practices](#)" as well as a BWSR fact sheet on [Protecting Conservation Lands from Pesticides](#) provide detailed information about methods to minimize impacts to pollinators.

Shorter lived cover crops such as annual ryegrass, winter cereal rye, buckwheat, oats, radish, field peas, etc. also play a key role in stabilizing soils in agricultural areas. Cover crops can substantially reduce wind and water erosion when the soil would otherwise be bare in early spring, fall or winter. Cover crops can improve water and soil quality by adding soil organic matter via more roots more of the time that holds plant available water and creates an open soil structure that promotes water infiltration, reducing runoff. Cover crops also protect groundwater quality by reducing or preventing nitrogen from leaching into the water table.

Key Plant Species - Agricultural BMPs tend to focus on trees and shrubs for windbreaks and some buffer plantings, and grasses and forbs for grass waterways, filter strips, critical area plantings, and riparian buffers. Species should be selected that are native to the area and well adapted to site conditions.

| | |
|-----------------|--|
| Shrubs: | Willows, Red-osier dogwoods, Gray dogwood, High bush cranberry, serviceberry, prairie plum, black cherry, chokecherry, wild rose |
| Grasses: | Big bluestem, Indian grass, Little bluestem, Switchgrass, Canada wild rye, Virginia wild rye, Slender wheatgrass, Kalm's brome, Prairie brome |
| Forbs: | Yellow coneflower, golden alexanders, New England aster, Maximillian sunflower, Prairie clovers, Bergamot, Mountain mint, Grass-leaved goldenrod, Showy goldenrod, Canada goldenrod, Stiff goldenrod, Penstemons, Canada milk vetch, Sneezeweed, Cup plant |

Source Recommendations - The source requirements for native vegetation summarized in these guidelines should be followed for agricultural BMP projects, with the exceptions discussed below. Cultivars and certain varieties of native species (and non-native forage species) should not be used if the agricultural BMP is next to a remnant prairie (within 1/4 mile).

For BWSR funded projects, native vegetation should be the first priority for planting. However, local conservation professionals can make decisions about when non-native temporary covers (cover crops) can be used to stabilize soils. Harvestable perennials that are non-native and non-invasive can also be used as forage crops, as part of a conservation crop rotation, for grass waterways, and for required buffers. These species (including perennial rye grass, timothy, Kentucky bluegrass, orchard grass, smooth brome grass, red clover, alsike clover, white clover, etc.) can also be planted in buffers that will be hayed, grazed, or exposed to pesticides.” Local conservation professionals are able to make decisions about use of these species, and should contact BWSR with questions, or when additional flexibility is needed. These non-native species are treated differently in these guidelines than other conservation practices, because they are typically introduced into small areas and commonly integrated into agricultural production systems where frequent disturbance or pesticide drift can harm pollinators and other wildlife species, and inhibit the establishment of native vegetation. Invasive species, state Noxious Weeds and aggressive species, such as reed canary grass, sweet clover, Phragmites species and Miscanthus species cannot be used (see invasive species section of these guidelines).

Establishment - Drill seeding into fields that were in corn or soybeans is most commonly conducted for agricultural BMPs. Broadcast seeding followed by rolling may be conducted for areas inaccessible for seed drills. It is important that seed has good contact with the soil; some projects may need erosion control mulching or blankets to prevent erosion.

Maintenance and Harvest - Key steps to maintenance involve mowing annual and biennial weeds to 4-6 inches during the first couple years, as needed to provide sunlight and to decrease competition for seedlings; hand weeding or spot herbicide treatment of perennial weeds, and may involve prescribed burning to maintain diversity and to control woody species after establishment. Conservation grazing, and biocontrol of invasive species may also be long-term maintenance strategies. Haying for feed or bioenergy may be allowed by some conservation programs. Conservation plans may need to include information about the timing, frequency and mowing height for haying. Haying should be planned during times that will minimize impact to ground-nesting birds. The nesting season is generally considered to be between June 1 and August 1st in the north half of the state and between May 15 and August 1st in the southern half of the state (for state and federal programs). As a result, haying is commonly conducted in August or September.

Typical cutting heights of grass for haying are between 4-6 inches. Cutting at this height leaves more leaf area for rapid re-growth to rebuild root reserves for future growth and maintains stubble to filter stormwater. Cutting height should be increased if the cutting date is delayed, or if the site has a slow growth rate.

Mowing equipment can be a vector for the spread of weed seeds due to seeds becoming lodged on the mower, in dried clippings, or mud attached to equipment. It is important that seed be removed from mowing equipment before the mower is brought to a new part of a restoration site, or to a new project. To the extent possible, mowing should be conducted shortly before invasive plants flower to prevent them from setting viable seeds.

Forage or biomass production sites with a dominance of warm season native grasses are typically hayed once a year or every other year to allow for adequate growth of plant material. The re-growth is essential for rebuilding root reserves and for providing important nesting and wintering cover for grassland wildlife. The yield gained from a second cutting in one season will often reduce yields by the same amount the following year.



To avoid significant impacts to wildlife, it is recommended that no more than fifty percent of a field be hayed in any given year. This can dramatically improve production in the future and maintain adequate cover for wildlife habitat. It can also help maintain species diversity that otherwise might be lost by harvesting the same time each year. While a rest-hay rotation may seem inefficient, prairies managed under this scenario can produce as much tonnage from one-half of the prairie as when the entire prairie is hayed annually. The rested portion will often produce enough forage the year after resting to compensate for production lost the year of rest. Brushy vegetation will be less of a concern even in a rest-hay rotation, especially if prescribed burning is introduced. A rest-hay rotation will also help lower equipment and fuel costs for the operator.

Information Sources -

NRCS Field Office Technical Guide: <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg>
[Agricultural BMP Handbook for Minnesota \(MN Department of Agriculture\): https://bbe.umn.edu/agricultural-best-management-practices-handbook-minnesota](https://bbe.umn.edu/agricultural-best-management-practices-handbook-minnesota)
[Buffer Toolbox \[new link\]](#)
[Buffer Program: What to Plant in Buffers](#)

Stormwater Basins

Stormwater basins are often areas of high disturbance due to fluctuating water levels, pollutants and sedimentation that are associated with stormwater treatment. Plants are often needed that can handle these conditions such as floodplain forest species. More water tolerant species are commonly planted in the base of retention (open water) basins, while dry prairie, mesic prairie or woodland species are typically planted on side slopes. Basins that are typically dry detention basins need to be able to handle periods of wetness as well as periods of dryness, floodplain species are often well suited to these conditions. Stormwater basins are prone to invasion of weed species, so routine weed control is often needed.



Site Selection – Stormwater basins may be required along with other water quality management practices for new developments. Locations and sizing can be determined by subwatershed assessments and water quality modeling. Models commonly in use include Win SLAMM: the watershed runoff model, WAM: Watershed Assessment Tool, and AGWA: Automated Geospatial Watershed Assessment. Existing basins may also require updating and improvement. The size of basins generally depends on soils and the amount of impervious surfaces in a watershed but also will depend on the number of other stormwater management practices to be used, such as raingardens that will decrease flows to stormwater basins.

Achieving High Function - A key to achieving high function in stormwater ponds involves creating suitable conditions for species as they establish; and planting species that can thrive in the site conditions - as plants that are healthy will aid water infiltration, filtering, toxin remediation, and evapotranspiration. The design of forebays to capture the majority of sediment entering a system will help sustain plantings. The establishment of shallow water shelves will also promote emergent plant growth that can increase water treatment effectiveness. The base of retention basins typically are not planted as they will be too deep to sustain most commercially available species.



Urban stormwater basin

Medium diversity levels are often used for stormwater basin side slopes (10-30 species). A combination of native grasses and forbs on side slopes will help provide competition from weed species. The sides of stormwater basins can provide important habitat for pollinators so it is beneficial to plant species that will provide nectar and pollen sources through the entire growing season.

Key Plant Species - Stormwater basins are often planned in zones to aid species selection, establishment and maintenance. Species should be selected that are native to the area and well adapted to site conditions.

| | |
|-----------------------------|--|
| Upper Slope Grasses: | Big bluestem, Indian grass, Switchgrass, Slender wheat grass, Little bluestem, Canada wild rye, Kalm's brome, Fringed brome |
| Upper Slope Forbs: | Yellow coneflower, Black-eyed Susan, Golden alexanders, New England aster, Maximilian sunflower, Sawtooth sunflower, Prairie clovers, Spiderwort, Showy goldenrod, Canada milk vetch, Stiff goldenrod |
| Edge of Open Water | River bulrush, Wild iris, Sweet flag, Soft-stem bulrush, Three-square bulrush, Lake sedge |
| Dry Pond Base | (Grasses) Switchgrass, Rice-cut grass, Prairie brome, Fowl bluegrass, Virginia wild rye, (forbs), Golden alexanders, New England aster, Bergamot, Mountain mint, Grass-leaved goldenrod, Sneezeweed, Green-headed coneflower, Canada anemone |

Source Recommendations - Stormwater basins are typically connected to downstream wetlands and other waterbodies, so species should not be used that may negatively influence downstream resources. It is also important that invasive species be controlled in stormwater basins to avoid downstream impacts.

Establishment - separate zones (upper slopes, edge of open water, etc.) are often planted differently as part of vegetation establishment. Upper slopes are typically drill seeded unless they are too steep, where they may be broadcast seeded and rolled or hydroseeded and rolled or harrowed. It is important that seed has good seed to soil contact on side slopes. The edge of open water is commonly planted with a combination of seed and containerized plants, or pre-vegetated mats; many emergent species will spread into deeper water. It is important that water levels do not raise above the height of establishing plants. Dry pond bases are typically grass dominated and seeded with native seed drills.

Maintenance - Key steps to maintenance involve mowing annual and biennial weeds to 4-6 inches during the first couple years as needed to provide sunlight and to decrease competition for seedlings; hand weeding or spot herbicide treatment of perennial weeds, and prescribed burning as applicable to maintain diversity and to control woody species after establishment. Biocontrol of invasive species such as spotted knapweed, leafy spurge and purple loosestrife may also be long-term maintenance strategies.

Information Sources -

Plants for Stormwater Design www.pca.state.mn.us/publications/manuals/stormwaterplants.html

Minnesota Stormwater Manual <http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-management/minnesotas-stormwater-manual.html>

Raingardens and Biofiltration Areas

Urban rain gardens and biofiltration areas are typically small in size and are in front yards or other visible locations where aesthetics is a consideration. Engineered soils consisting of sand and compost are often used in raingardens and biofiltration areas to aid water infiltration and the base of these systems are designed to be flat; as a result, mesic prairie or woodland species are most adapted to the site conditions.

Site Selection – Subwatershed assessments and stormwater modeling are useful to aid raingarden site selection. The [Recarga model](#) is one that is commonly used. Local conservation staff play a key role in finding willing landowners and projects that will have significant water quality benefits.

Achieving High Function - Deep rooted prairie grasses and flowers have been shown to increase infiltration rates in these systems over time, and should be a focus for projects. It is often beneficial to create a matrix of prairie grasses and then add desired forbs for large areas but to group species to aid in weed identification. Some plantings can also include woody plants, as they have extensive root systems that can have higher rates of evapotranspiration and may require less maintenance. Plantings with only shrubs have been established where little maintenance will occur. Stormwater plantings can be great places to support pollinator populations by planting species that will provide nectar and pollen sources through the entire growing season.

Key Plant Species - Trees, shrubs, grasses, forbs, sedges, rushes and ferns are all commonly used as part of wetland restoration projects. Species should be selected that are native to the area and well adapted to site conditions.

| | |
|-----------------|---|
| Shrubs: | Dwarf-bush honeysuckle, Black chokeberry, Winterberry Holly, Red-osier dogwoods |
| Grasses; | Switchgrass, Little bluestem, Indian grass |
| Forbs: | Butterfly milkweed, Marsh milkweed, Joe-pye weed, Cardinal flower, Blue lobelia, Culver’s root, Liatris species, Narrow-leaf coneflower, Smooth aster, Panicked aster, golden alexanders, Wild iris |
| Sedges | Fox sedge, Bottlebrush sedge, Porcupine sedge, Tussock sedge |
| Rushes: | Soft rush, Path rush |



Diversity - Often low to medium diversity levels (10-30 species) are often used due to a focus on aesthetics and water treatment. As long as the intended functions are being accomplished, diversity levels can be adjusted as needed. Species are sometimes grouped together in these plantings to aid weed identification by maintenance crews.

Source Recommendations - The source sequence outlined in these guidelines should be used for these systems, though additional native cultivars may be used in raingardens and biofiltration areas where aesthetics are a major consideration. Cultivars/varieties of native species should not be used if the project is connected to or directly drains into a wetland or other natural system.



Raingarden with a diversity of grasses, forbs and sedges

Establishment - Raingardens are commonly planted with containerized plants (often plugs) spaced 12-24 inches apart. Most plantings are mulched with double shredded hardwood mulch and watering is important to ensure the success of plantings.

Maintenance - Maintenance typically involves hand weeding every few weeks the first year or two followed by weeding about three times a year after plants are established. Removing sediment, ensuring proper function of berms and pipes and mulching are also periodic maintenance tasks.

Information Sources -

Plants for Stormwater Design www.pca.state.mn.us/publications/manuals/stormwaterplants.html

Plants for Stormwater Design Volume II

Blue Thumb Plant Selector <http://bluethumb.org/plants/>

Minnesota Stormwater Manual <http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-management/minnesotas-stormwater-manual.html>

Lakeshores

Lakeshores are typically areas of high wildlife use and can play an important role for water quality improvement and slope stability.

Site Selection – Projects should be located where they will have the greatest functional water quality or habitat benefits (depending on program goals). When selecting projects for wildlife it is important to define specific species that will be targeted by the project. The [Minnesota Wildlife Action Plan](#) is a document that outlines a set of species of greatest conservation need for different areas of Minnesota. [Fact sheets](#) about habitat needs for specific species are also available. Buffers should be planned based on slopes, topography, watershed size, soils, vegetation cover, target wildlife species, adjacent corridors and natural areas, as well as landowner and partner input. Buffer widths should typically be a minimum of 30-100 feet landward of the ordinary high water level for water quality projects, and 100-330 feet for wildlife habitat projects depending on habitat needs of target wildlife species. Buffers should also cover at least 75% of the shoreline lengthwise.



Achieving High Function - A variety of trees, shrubs, grasses, sedges and flowers can be used along shorelines to provide wildlife and water quality functions. Shrubs and various bioengineering techniques are sometimes used if there is a focus on stabilizing soils along steep banks.



Medium to high diversity levels (20-40+ species) are typically planted to provide habitat for a variety of wildlife species ranging from pollinators to amphibians, reptiles and bird species. To support pollinators species should be planted that will provide nectar and pollen sources through the entire growing season.

Key Plant Species - Trees, shrubs, grasses, forbs, sedges, rushes and ferns are all commonly used as part of shoreline restoration projects. Emergent species (plants that grow in and next to the water) can be an important component. Species should be selected that are native to the area and well adapted to site conditions. The Minnesota DNR's ["Restore Your Shore" website](#) is an effective tool for species selection.

| | |
|-----------------|---|
| Trees: | Tamarack, Black spruce, Basswood, Oaks, Maples, Hackberry, Birch, Cherries |
| Shrubs: | Willows, Dogwoods, Viburnums, Elderberry, Alder, Serviceberries, Prairie plum, High bush cranberry, Buttonbush, False Indigo |
| Grasses: | Prairie cordgrass, Manna grasses, fowl bluegrass, rice-cut grass, Canada blue-joint grass, Big bluestem, Indian grass, Kalm's brome, Prairie brome |
| Forbs: | Marsh milkweed, Butterfly milkweed, Culver's root, Blue lobelia, Cup plant, Mountain mint, Grass-leaved goldenrod, Joe-pye weed, Boneset, Red-stemmed aster, Swamp aster, Marsh aster, Giant goldenrod, Giant-bur reed, Sweet flag, Wild iris, Common ox-eye, Black-eyed Susan, Stiff goldenrod |
| Sedges: | Tussock sedge, Bottlebrush sedge, Lake sedge, Slough sedge, Porcupine sedge |
| Rushes: | Torrey's rush, Riverbulrush, Soft-stem bulrush, Spikerushes, Green bulrush, Soft rush |

Source Recommendations - Local sources of seed and plants are recommended for shoreline projects, as these areas may have direct connections to natural plant communities where genetic interactions may be a consideration. The seed/plant source sequence outlined in the guide is recommended for shoreline projects.

Establishment - A variety of techniques are commonly used to establish shorelines depending on slopes, moisture levels, and erosion. Seeding is commonly conducted in upland portions of projects, while containerized plants are typically used along the edge of open water for more rapid establishment. Biologs are commonly used along the water's edge to break the force of wave and to prevent erosions as plants establish. A variety of bioengineering techniques may also be used for eroding slopes.

Maintenance - Upland portion of plantings may be mowed during the first couple years to suppress annual and biennial weeds and promote seedling growth. Hand weeding is commonly conducted in smaller lakeshore plantings to control weeds. Spot herbicide treatment may be used for perennials such as reed canary grass but it is important that aquatic safe herbicides be used.

Information Sources -

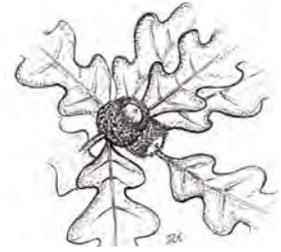
A Soil Bioengineering Guide for Streambank and Shoreline Stabilization: www.fs.fed.us/publications/soil-bio-guide/
Restore Your Shore: <http://www.dnr.state.mn.us/restoreyourshore/index.html>



Shoreline restoration with native grasses, forbs, sedges and rushes

Forest/Woodlands

The goals of forest plantings can vary greatly from natural regeneration efforts following logging operations, to efforts to increase diversity in forest stands, to the seeding or planting of trees and shrubs into agricultural fields to establish forest stands.



Site Selection – Projects should be planned to meet functional goals for soil stabilization, water quality, and habitat. When selecting projects for wildlife it is important to define specific species that will be targeted by the project. The [Minnesota Wildlife Action Plan](#) is a document that outlines a set of species of greatest conservation need for different areas of Minnesota. [Fact sheets](#) about habitat needs for specific species are also available. Local forestry staff play a key role in providing site selection recommendations and developing forest stewardship plans.

Achieving High Function - Target species for forest/woodland projects will vary depending on the plant community being restored, and project goals for water quality, wildlife and lumber production. High diversity levels of 10 to 25 species are recommended for wildlife habitat focused projects. Diversity levels will often be limited by the number of species available that are suitable for a project site. Herbaceous species may also be planted at the same time as trees and shrubs if the site is transitioning from a disturbed conditions (agricultural field, etc.). Mix diversity will depend on site conditions and project goals. Relatively low diversity mixes may be used if woodland trees, shrubs, forbs, ferns, and grasses may re-establish at the project site. Appropriate species will vary depending on project locations. The Minnesota Department of Natural Resources nurseries are a good information source for species selection.

Key Plant Species - Species should be selected that are native to the area and well adapted to site conditions. As there is a wide variety of forest types in Minnesota the DNR Field Guides to Native Plant communities of Minnesota <http://www.dnr.state.mn.us/npc/classification.html> are a good resource for species selection. These guides will list the dominant tree, shrubs, grass, forb, rush, sedge and fern species for each community type.

Source Recommendations - Many forest nurseries document the seed source for their trees and shrubs, this is useful information for making decisions about suitable sources and to ensure that trees and shrubs that are planted will produce viable seed. Some nurseries can also contract grow trees and shrubs from seed or cuttings. The Minnesota Department of Natural Resource has developed seed zones for Minnesota that are widely used for determining appropriate seed sources: http://www.dnr.state.mn.us/forestry/ecs_silv/fieldpractices/seedcollection.html for forest projects.

Establishment - A variety of techniques are used for forest/woodland establishment. Seedling trees are commonly used with tree tubes or other protection from herbivores. Seeds of trees and shrubs planted into a prepared seedbed has also become a common practice for restoring large areas. After logging is conducted, natural regeneration is often the primary method of establishment, though additional species may be added to increase diversity or improve wildlife habitat.

Maintenance - Maintenance often involves mowing around trees and shrubs so it is important that they are well marked and spaced far enough apart to allow for mowing. Mowing can also be conducted above the height of woody plants that have been planted as seed. Herbicide treatment may also be used around seedlings with herbicides that will not affect woody plants or by



Trees in protective plastic tubes

taking precautions to go around the seedlings. Cutting and treating stumps of undesirable woody plants such as buckthorn is also commonly conducted.

Information Sources –

DNR Forestry Website: <http://www.dnr.state.mn.us/forestry/index.html>

Plant Community Restoration

Plant community restoration refers to efforts to restore intact/remnant plant communities such as prairies, savannas and rare wetland communities. Restoration is often accomplished by removing invasive species, or restoring natural disturbance such as prescribed fire or natural hydrology conditions.



Site Selection – Intact native plant communities can degrade over time due to invasive species, lack of natural disturbance, changes in hydrology and other factors. As a result, restoration efforts may be needed to promote plant community resiliency and plant diversity. Projects are often selected based on the quality of plant communities, how rare individual communities are, and the threat posed by invasive species or other impacts. Local resource managers and ecologists play a key role in prioritizing restoration areas and prescribing restoration methods.

Achieving High Function - A common goal of plant community restoration is to increase ecological function through removing invasive species and increasing the diversity and cover of native plant populations. Some efforts focus on improving wildlife habitat for rare and declining species and may involve the restoration of key plant species that are important for wildlife.

Diversity goals typically focus on restoring diversity to levels that are characteristic of high quality communities. The diversity of natural communities can vary significantly with some marsh communities having relatively low diversity, and mesic prairies having around 200 species.

Key Plant Species - The species growing at project sites or species that may establish from the seedbank after restoration efforts are the focus for native plant community restoration projects. It is uncommon to bring new species to plant community restoration sites unless specific species are missing that play a key role for a plant community integrity or wildlife habitat (such as introducing lupine for Karner blue butterfly habitat).



Remnant prairie in the bluffs of Goodhue County

Source Recommendations - If seeding will be conducted as part of a restoration effort there should be a focus on collecting seed from the restoration site or intact communities nearby the site. In some cases, seed is obtained from ecological subsections, particularly if species are being re-introduced to a community.

Establishment and Maintenance - Methods of managing native plant communities can vary depending on the community type and the natural disturbance that is part of that community. Prescribed fire is an important management tool for fire dependent communities such as prairies, savannas and some woodlands. Removal of invasive species through a variety of methods is also a common technique to allow native vegetation to thrive. A long-term approach is needed to effectively manage native plant communities.

Information Sources –

Minnesota Wetland Restoration Guide www.bwsr.state.mn.us/publications/restoration_guide.html

Going Native, A Prairie Restoration Guide for Minnesota Landowners

www.dnr.state.mn.us/eco/pubs_restoration.html

Temporary Cover for Restoration

Temporary covers are used in a wide variety of situations related to conservation plantings. In some cases, cereal grains may be planted to stabilize sites in preparation of seeding permanent seed mixes. In other cases, perennial native grasses are planted in low diversity stands to stabilize construction areas to prepare sites for adding more species after weeds are controlled, or to allow for the colonization of native trees and shrubs, such as floodplain forest restorations where species such as switchgrass or Virginia wild rye are planted to stabilize the site. Annual species such as American Slough grass can also be used to stabilize areas to be established with shallow and deep marsh plant communities or where native seedbanks will aid establishment.



Site Selection – The decision about whether to use temporary cover crops should be based on whether their use will aid in reaching project goals by decreasing erosion, providing weed competition and promoting the germination and growth of seedlings.

Achieving High Function - The goal of temporary stabilization involves promoting sufficient establishment of grass species to hold soil and prevent sediment loss while creating good conditions (such as allowing microbial populations to increase) for native vegetation establishment. Once additional species are added to (or colonize) a site additional wildlife and plant community functions can be attained.



Canada wild rye providing temporary cover

Key Plant Species - Annual and perennial grasses as well as perennial legumes play a key role in providing temporary cover

| | |
|-------------------------------------|--|
| Cereal grain annual grasses: | Oats (<i>Avena sativa</i>), Winter wheat (<i>Triticum aestivum</i>) |
| Non-native annual legumes: | Field peas (<i>Pisum sativum</i>) |
| Perennial Grasses: | Big bluestem, Side oats grama, Fringed brome, Nodding Wild Rye, Slender Wheat grass, Virginia wild rye, Switch grass, Fowl bluegrass, Indian grass |
| Perennial legumes: | Canada milk vetch, Partridge pea, American vetch |

Source Recommendations - The source sequence included in this guide is recommended for temporary cover plantings, particularly if perennial species are planted near natural communities. Source is less of a concern for short lived native species that are used for stabilization such as cereal grains.

Establishment - Seeding with agricultural seed drills or broadcast seeders in fields that were in corn or soybeans is commonly conducted to aid establishment of cover species.

Maintenance - Little maintenance is typically needed in established temporary cover plantings. The use of temporary covers can be an effective method of spotting and treating perennial weed problems before permanent native seed mixes are seeded.

Information Sources –

Minnesota Wetland Restoration Guide www.bwsr.state.mn.us/publications/restoration_guide.html

Streambank Stabilization

Stabilization of stream banks and river banks has been part of many projects in Minnesota focused on decreasing soil loss, preventing damage to infrastructure, improving water quality, and improving wildlife habitat. Thorough assessments are needed for streambank projects- investigating geology, soils, existing vegetation, flow velocities, normal high water levels, extent of the project floodplain, and use of the watercourse. Various engineering or bioengineering solutions are often needed in addition to revegetation strategies for areas with severe erosion. As each reach of a stream is unique, streambank protection techniques must be selected on a site by site basis and often require the involvement of technical specialists. Streams are dynamic and constantly changing, so it is important to note that not all areas of erosion are in need of repair. Also, additional measures may be needed in the watershed to address hydrologic fluctuations that are stressing streams.

Engineering solutions may include the installation of rock (and underlying fabric) to secure the toe of the slope, or regrading to direct stormwater flows or to decrease the steepness of the bank. Bank stability will vary depending on soil type with stability being reached in clay soils with slopes around 1:1, and in sandy soils stability is reached with slopes of 2-4:1. Erosion usually occurs at the outside bank of a stream bend where the water velocity is the highest, so rock may be used along the toe of the slope for the entire bend.

Bioengineering techniques can include branch packing, brush layering, brush mattresses, live fascines, toe wood sod mats, and live stakes. A variety of methods may be used to plant steep slopes along streambanks including hydroseeding, broadcast seeding, tree plantings, and promoting natural succession. Erosion fabrics are often needed in combination with seeding to ensure good seed to soil contact, to prevent the loss of seed, and to hold moisture. A combination of fast establishing species, and species that will persist into the future are typically used for slope stabilization. Deep rooted plants are also needed to promote future slope stability.



Bank stabilization with cedar revetments and erosion fabric along the St.Croix River

Site Selection – Program and project goals should be reviewed as a first step for site selection, Projects for streambank restoration are commonly selected based on identified threats to human safety, infrastructure and homes, impairment of water quality and wildlife habitat needs. Streambank projects may be part of efforts to widen habitat corridors that can provide multiple landscape benefits. Before a project is started the watershed should be assessed to determine the factors that may influence the success and sustainability of the project. The assessment can also help identify the highest priority areas along a waterway. As stabilization efforts can be costly it may be beneficial to start at the head of the stream and work downstream. Some projects also focus on stabilizing the toe of the slop along larger areas and letting the upper slope naturally revegetate, though this can lead to invasive species dominance.

Achieving High Function - The goal of slope stabilization is to provide rapid establishment as well as long term slope integrity. Fast growing species are often used to ensure initial stability. More long lived and deep rooted species are used for long term stability. Native legumes that add nitrogen and promote plant growth are also commonly planted and can have an added benefit of supporting pollinators. Many trees and shrubs can play an important role in providing long-term slope stability. Species with tap roots such as bur oak, hickory, pines and walnut can be effective at anchoring slopes. Species such as willow and dogwoods that establish from cuttings can also be used as part of

bioengineering methods (branch packing, brush layering, brush mattress, live fascines, live stakes, etc.). Sufficient moisture is needed for establishment of vegetation on steep slopes so supplemental watering is typically needed.

Key Plant Species -A combination of fast growing native species, deep rooted species, legumes, trees and shrubs are commonly used for bank stabilization.

| | |
|---|---|
| Cover Crops | Oats (<i>Avena sativa</i>), Winter wheat (<i>Triticum aestivum</i>) |
| Fast growing native grasses and forbs: | Side oats grama, Fringed brome, Nodding Wild Rye, Slender Wheat grass, Virginia wild rye, Fowl bluegrass, |
| Long lived deep rooted native grasses: | Big bluestem, Indian grass, Switch grass, Little bluestem, Hairy grama, Blue grama, Western wheat grass, Prairie dropseed |
| Long lived deep rooted native forbs: | Liatris, Coreopsis, Coneflowers, Asters, Sunflowers, Showy goldenrod |
| Native legumes: | Canada milk vetch, Partridge pea, American vetch, Prairie clovers, Lupine |
| Deep rooted native trees and shrubs: | Bur oak, White Oak, Northern pin oak, Red oak, Walnut, Butternut, hickory, Red oak, Basswood, Pines, Ironwood, Blue beach, Hazelnut, Paper birch, Hackberry, Hawthorn, Red cedar, Black cherry, American basswood |
| Plants that establish from cuttings: | Dogwoods, Willows, Viburnum |

Source Recommendations - The source sequence included in this guide is recommended for bank stabilization projects, particularly if perennial species are planted near natural communities. Source is less of a concern for short lived cereal grains, and native cover species that are used for stabilization such as wild ryes and slender wheatgrass.

Establishment – Engineering solutions such as the installation of rock or re-grading are typically conducted as a first step in slope stabilization, followed by bioengineering practices. Upland portions of restored slopes are typically broadcast or hydroseeded, as they are often too steep for seed drills. Seed to soil contact is very important for successful establishment, so the use of rollers or erosion control fabric to cover seed will aid establishment. Very steep eroding banks can be very difficult to stabilize. In some cases, slopes can be re-graded to decrease steepness. If re-grading is not possible, willow cuttings can sometimes be inserted from the base of the slope. Hydroseeding may also be an option where seed and water is simultaneously blown onto slopes followed by a tackifier to improve seed to soil contact. Plants that can germinate and grow on dry slopes should be a priority for these types of plantings. Trees and shrubs are commonly planted into slopes to aid stabilization and establishment.



Steep bank stabilized with flowers, grasses and erosion fabric

Maintenance - Upland portions of plantings may be mowed with mechanical or hand held equipment during the first couple years to suppress annual and biennial weeds and promote seedling growth. Hand weeding is conducted in some smaller plantings to control weeds. Spot herbicide treatment may be used for perennial weeds, but it is important that aquatic safe herbicides are used when applying next to water. Supplemental watering is often necessary on steep slopes to support the growth of trees and shrubs and herbaceous plant seedlings. A water truck with a fine spray nozzle may be needed to spray water from the top of steep slopes. Fencing or signage may be needed to minimize foot traffic as vegetation establishes. Streams are subject to changes over time so periodic monitoring is needed to ensure the future success of projects.

Information Sources

Slope and Site Stabilization <http://www.pca.state.mn.us/index.php/view-document.html?gid=7421>

A Soil Bioengineering Guide for Streambank and Shoreline Stabilization www.fs.fed.us/publications/soil-bio-guide/

Restore Your Shore <http://www.dnr.state.mn.us/restoreyourshore/index.html>

Minnesota Soil Bioengineering Handbook, Minnesota Department of Transportation, 1999.

Ravine Stabilization

Stabilization of eroding ravines and bluff slopes requires detailed analysis of watershed and site conditions and often involves both engineering strategies as well as re-vegetation strategies. In addition to the reduction of sediment loss, restoration of severely eroded areas often provide important water quality and wildlife habitat benefits. Stormwater runoff is the biggest source of ravine erosion, so it is important that sources of water from agricultural fields and developed areas be managed with appropriate best management practices such as vegetated buffers, raingardens, biofiltration, and stormwater detention before vegetation establishment practices are implemented. Engineering solutions often involve re-grading to decrease the angle of slope, the use of rock to stabilize the toe of the slope, as well as a variety of solutions to manage water flow including terraces, swales, pipes and check dams. A variety of methods may be used to plant steep eroding slopes including hydroseeding, broadcast seeding, tree plantings, and promoting natural succession. Erosion fabrics are often used in combination with seeding to prevent erosion, ensure good seed to soil contact, prevent the loss of seed, suppress weeds and maintain soil moisture. A combination of fast establishing species, and species that will persist into the future is often needed for slope stabilization. Deep rooted plants are also needed to promote future slope stability. Early successional trees such as elm, boxelder, ash, cottonwood and buckthorn are sometimes removed from the edges of ravine restoration projects to allow access of earth moving equipment and to allow sufficient light levels to promote seedling germination and growth but tree removal should be limited to the extent possible to prevent further erosion.

Site Selection – Ravine restoration projects are often selected based on identified threats to human safety, infrastructure, homes, and impairment of water quality. When multiple eroding ravines are being assessed for water quality projects, potential sediment reduction, cost-effectiveness and long-term sustainability are important considerations.

Achieving High Function - Goals of slope stabilization involve providing rapid establishment, as well as long term slope integrity. Fast growing species are often used to ensure initial stability. More long lived and deep rooted species are used for long term stability. Native legumes that add nitrogen and promote plant growth are also commonly planted and can have an added benefit of supporting pollinators. For severely eroding slopes non-native legumes such as red clover and alfalfa that establish quickly and have deep root systems are sometimes used in combination with native species to add nitrogen and anchor the slope with deep roots, though the proportion of these species should be carefully considered in mixes to ensure that they do not out-compete native species that are planted. In many cases, these non-native species will decrease in abundance as woody plants establish in ravines or riverbanks. Many trees and shrubs can play an important role in providing slope stability. Species with tap roots such as bur oak, hickory, pines and walnut can be effective at anchoring slopes. Species such as willow and dogwoods that establish from cuttings can also be used as part of bioengineering methods (branch packing, brush layering, brush mattress, live fascines, live stakes, etc.). Slopes may be heavily compacted after the earthwork is completed.



Key Plant Species -A combination of fast growing native species, deep rooted species, legumes, trees and shrubs are commonly used for ravine stabilization.

| | |
|---|---|
| Cover Crops | Oats (<i>Avena sativa</i>), Winter wheat (<i>Triticum aestivum</i>) |
| Fast growing native grasses and forbs: | Side oats grama, Fringed brome, Nodding wild rye, Slender Wheat grass, Virginia wild rye, Fowl bluegrass, |
| Long lived deep rooted native grasses and forbs: | Big bluestem, Indian grass, Switch grass, Little bluestem, Hairy grama, Blue grama, Western wheat grass, Prairie dropseed |
| Native legumes: | Canada milk vetch, Partridge pea, American vetch, Prairie clovers, Lupine |
| Deep rooted native trees and shrubs: | Bur oak, White Oak, Northern pin oak, Red oak, Walnut, Butternut, Hickory, Red oak, Basswood, Pines, Ironwood, Blue beach, Hazelnut, Paper birch, Hackberry, Hawthorn, Red cedar, Black cherry, American basswood |
| Plants that establish from cuttings: | Dogwoods, Willows, Viburnum |

Source Recommendations - The source sequence included in this guide is recommended for slope stabilization projects, particularly if perennial species are planted near natural communities. Source is less of a concern for short lived cereal grains, and native cover species that are used for stabilization such as wild ryes and slender wheatgrass.

Establishment - Upland portions of restored slopes are typically broadcast or hydroseeded, as slopes are too steep for drill seeding. Seed to soil contact is very important for successful establishment, so the use of rollers or erosion control fabric to cover seed will aid establishment. For steep portions of slopes hydroseeding may be the most viable seeding option. Seed should be applied to slopes with water followed by the application of a tackifier to aid seed to soil contact. Trees and shrubs are commonly planted into slopes (in areas where trees and shrubs would have historically occurred) to aid stabilization and establishment. It is important that compaction is loosened in planting holes as trees and shrubs are planted to allow their roots to spread.

Maintenance - Upland portion of plantings may be mowed with mechanical or hand-held equipment during the first couple years to suppress annual and biennial weeds and promote seedling growth. Hand weeding can be conducted for smaller patches of weeds. Spot herbicide treatment may be used for perennial non-native plants but it is important that aquatic safe herbicides be used near water. Supplemental watering may be needed for seeding herbaceous and woody plants. A water truck with a fine spray nozzle may be needed to apply water from the top of the slope.

Information Sources –

- Slope and Site Stabilization <http://www.pca.state.mn.us/index.php/view-document.html?gid=7421>
- A Soil Bioengineering Guide for Streambank and Shoreline Stabilization www.fs.fed.us/publications/soil-bio-guide/
- Restore Your Shore <http://www.dnr.state.mn.us/restoreyourshore/index.html>
- Ravine Restoration Toolkit <http://www.greatlakes.org/document.doc?id=1370>



Ravine stabilized with stone, seeded grasses and flowers and planted shrubs

Appendix A. Recommended Steps for Obtaining and Documenting Plant Materials:

- 1) Determine the Project Type (Native Prairie Reconstruction; Wetland Restoration; Agricultural BMPs; Stormwater Basins; Urban Raingardens and Biofiltration Areas; Shorelines; Forests/Woodlands; Native Plant Community Restoration etc.)
- 2) Analyze the project site (topography, soils, hydrology, precipitation, elevation, drainage, aspect, sun/shade, climate, habitat needs, existing native plants, native seedbank potential, invasive species, erosion problems, other environmental stressors, etc.). Also investigate surrounding land uses, and populations of native and non-native species
- 3) Set project functional goals (soil stabilization, water quality, wildlife habitat, diversity, native plant community restoration, etc.).
- 4) Determine the site preparation, installation and maintenance restoration strategies that will be used to establish native vegetation including the use of native seedbank and local seed collection. Refer to restoration publications as needed such as the “Minnesota Wetland Restoration Guide” www.bwsr.state.mn.us/publications/restoration_guide.html , “Restore Your Shore” <http://www.dnr.state.mn.us/restoreyourshore/index.html> or other design resources).
- 5) Develop a restoration schedule, and determine when plant materials are needed.
- 6) Determine an appropriate diversity level, and list of plant species/materials needed.
- 7) Work with project partners to determine the best way to find local, and site appropriate plant materials (local seed collection/harvest, seedbank, purchasing from local seed/plant vendors etc.). Look at the project location in relation to state seed zones Use the seed zone map and source sequence as guidance for obtaining seed.
- 8) Develop or select seed mixes that are needed for the project. Factors that will influence seed mix development include: availability of local harvested seed, native seed bank potential, state seed mixes and substitution tables, and seed availability from vendors. If local locally harvested seed will be used, pure seed must be tested and “germination”, “hard seed” and “Pure Live Seed” information provided on seed tags for all species that are required through a program or project diversity standard. Supplement locally harvested seed mixes as needed to meet diversity, or quantity requirements. When purchasing standard mixes, investigate availability of yellow-tag seed (<http://www.mncia.org/>).
- 9) Obtain multiple bids that include specifications for plant materials and use the BWSR [best value calculator](#) to factor both cost and source into bid selection. Revise seed mixes or project sequencing as needed based on availability of seed and plants. It is recommended that project managers print, sign, date and file the final approved species list.
- 10) Upon installation, keep seed tags (showing origin).





Appendix B. Definitions:

Allele – A variant (one of two or more forms of a gene) of the DNA sequence at a given locus (location of a gene or DNA Sequence on a chromosome).

Cultivar – A cultivated plant that has been selected and given a unique name because of desired characteristics and when propagated (usually vegetatively) retains those characteristics.

Generation 0 – Seed harvested from remnant prairie tracts that will be used to grow new plants (G1). Generation 0 seeds are considered genetically unaltered by human activity and the collection site should be in a natural state. Generation 0 seed has not been through an intentional selection process and its origin is generally definable by a geographic location from which the seed is collected.

Generation 1 - Seed harvested from fields reconstructed with source-identified Generation 0 seed.

Genetic contamination – Loss of native plant population fitness due to the addition of non-local genes into native populations via pollen, seed or plant material.

Genetic sensitivity – The sensitivity of an individual species to inbreeding, loss of adaptation or out-breeding depression.

Genotype – The genetic makeup of a cell or organism (the allele makeup of an organism).

Germplasm – The hereditary material that is transmitted from one generation to another.

Hard seed— Seeds that remain hard at the end of the prescribed test period because they have not absorbed water due to an impermeable seed coat.

Herbicides – Chemicals that are used to target and kill plant species.

Inbreeding – The breeding of related individuals within an isolated or a small population of plants, sometimes leading to decreased genetic diversity and fitness.

Insecticides – Chemicals that are used to target and kill insects.

Locus – The specific location of a gene or DNA sequence on a chromosome. A variant of the DNA sequence at a given locus is called an allele.

Native Plant Community Restoration or Reconstruction. Re-establishment of a native plant community, such as a prairie, wetland or forest, using seeds, seedlings, cuttings, or transplants on a site. Reconstructions are typically defined as sites with little/no actively growing remnant vegetation. Restorations augment degraded remnants by replacing missing species and/or species abundance. The aim of restoration or reconstruction projects is to replicate ecologically complete historic native plant communities; re-establish wildlife and aquatic habitat by returning elements of a site's natural ecological structure and composition; and/or restore ecological components of native forest communities.

Out-breeding depression – When offspring from crosses between individuals from two different plant populations have lower fitness than progeny from crosses between individuals from the same population.

Pesticides – Chemicals that are used to kill living organisms such as fungus, bacteria, insects, plant diseases, slugs, or weeds.

Plant fitness – An individual's contribution of young to later generations, measured by longevity and reproductive success.

Prairie reconstruction – The establishment of prairie species on a site that contains no actively growing remnant vegetation; such as an agricultural field or lawn.

Provenance – The geographic sources where the seeds/plant material naturally originated.

Pure live seed (PLS) – The measurement of the amount of seed that germinates in a standard (14 day) germination test, plus the amount found to be alive from a viability (tz) test. PLS is determined by multiplying the percent germination success by the purity of seed.

Pure seed – Seed exclusive of inert matter and all other seeds not of the kind of seed being considered as defined by the rules for testing seeds of the Association of Official Seed Analysts.

Remnant – Fragment of a climax plant community that remains from a former period, typically before European settlement.

Resilient Native Plant Communities. Those communities which have the ability to absorb or adapt to the effects of climate change or other external forces and continue to function, although possibly in different ways or with a different suite of species than in a

prior state. The resilience of a native plant community often depends on the degree of genetic variation that resides within the species which comprise that community.

Seed Transfer Zone – The geographic range in which a given plant population will likely thrive, based on variables such as soils, topography, geology, precipitation, and temperature range.

Selected traits – Traits that are promoted intentionally or in some cases unintentionally such as height, flower color, form, leaf color, forage quality and leafiness.

Variety – A taxonomic subdivision of a species consisting of naturally occurring or selectively bred populations (usually propagated by seed) or individuals that differ from the remainder of the species in certain minor characteristics.

Wild harvest – Seed that is harvested from remnant native plant communities.

Yellow tag seed – Source identified seed that is comprised of the least selected germplasm for a species. The location where the material was originally collected from native stands (genetic origin) is indicated on the certification label.

Appendix C. Literature Cited



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DNR Pollinator Best Management Practices and Habitat Restoration Guidelines



Minnesota DNR's 5.5 million acres of land encompass a wide diversity of pollinator habitat.

Introduction

Executive Summary

This document provides best management practices (BMPs) for restoring and enhancing habitat for native insect pollinators (bees, butterflies, moths, flies, etc.) on Minnesota Department of Natural Resources-managed lands and on state-funded prairie restoration projects.

These lands are a major source of pollinator habitat in the state and include multiple habitat types. Restoration projects on DNR-managed lands are typically designed to meet specific objectives, such as providing nesting cover for upland game birds or replicating appropriate native plant communities (NPCs) previously found on the site. Enhancing restoration activities to benefit native pollinators can be done in ways that meet multiple objectives.

To have diverse, abundant, and productive pollinator populations in Minnesota, land managers must do two things. First, they must ensure we are managing existing and newly restored acres to best benefit habitat. Second, they must add habitat through restoration projects across the landscape.

When selecting species to plant, managers should use a suite of species that bloom across the entire growing season so multiple foraging resources are available for pollinators. Consider host plants for caterpillars and nesting materials for bees. Guidelines such as Operational Order 124 (Plant Material Standards for Native Plant Community Restoration), do not recommend planting non-native or invasive species to enhance pollinator habitat on DNR lands.

While this document targets native plant communities, it does not mandate specific species or seed mixes to use in a restoration. These guidelines don't dictate management on sites such as parking lots, around buildings, other facility-oriented lands or farmed fields. We want to provide land managers with information on how to augment native plant community practices to comply with state law covering pollinator habitat. For the latest in pollinator resources visit: http://www.dnr.state.mn.us/pollinator_resources/index.html



Law requires the DNR to develop and use pollinator BMPs and restoration guidelines.

Legislation

Minnesota Statutes, Chapter 84.973 POLLINATOR HABITAT PROGRAM was created in 2013 directing the DNR to establish pollinator best management practices and habitat restoration guidelines:

(a) The commissioner shall develop *best management practices* and *habitat restoration guidelines* for pollinator habitat enhancement. Best management practices and guidelines developed under this section must be used for all habitat enhancement or restoration of *lands under the commissioner's control*.

(b) *Prairie restorations* conducted on *state lands* or with *state funds* must include an *appropriate diversity of native species* selected to provide habitat for pollinators throughout the growing season.

DNR Lands and Mission

The DNR manages 5.5 million acres, about 10 percent of the state. In Minnesota, 25 percent of the land is publicly owned, including federal, state and county lands. These public lands are unevenly distributed throughout the state.

While these best practices apply to all DNR lands, because the DNR and other conservation or nongovernment organizations (NGOs) own and manage a small percentage of the land in the prairie parkland, and because pollinators of greatest concern inhabit this prairie parkland, these practices focus on the prairie region. This area is in the greatest need of habitat reservoirs on an otherwise fragmented landscape.

Natural areas provide three important functions for pollinator communities (Black et al. 2007). Natural areas:

1. Serve as a source from which pollinators can travel to pollinate agricultural crops.
2. Act as refugia (undisturbed land) from which native pollinators can recolonize agricultural areas impacted by pesticide applications, tilling, and other farming practices.
3. Serve as habitat for native pollinators of nonagricultural plants.



Land ownership by public agencies differs greatly between ecological provinces.

Bee Hives - All DNR land management divisions provide habitat for native pollinating insects. Each division has slightly different goals for the land's purpose and many units restrict activities on the property. For that reason, at this time, no DNR fee title property can accommodate private honeybee hives. On DNR easement property, placement of hives will depend upon the easement language. However, a beekeeper can place hives on private lands adjacent to DNR properties with permission from the private landowner. In general, bee hives or other personal property or business venture not providing a service to the DNR or not being used as management tools are prohibited on state lands. Consult division rules and policies for details.

Pollinators, Habitat and Population Decline

Pollinators are any animal species that pollinate flowering plants. In Minnesota, this is almost exclusively insects. Although pollinators are diverse and have a wide range of habitat, generally they need adult food sources (pollen and nectar from flowers), nesting sites, overwintering sites and larval habitat. An understanding of the features that provide these resources is essential to enhancing and restoring pollinator habitat.

Recently, there have been many reports of significant declines in populations of both native pollinating insects and managed honeybee colonies (National Research Council 2006). Numerous causes of pollinator declines have been identified, including: loss of habitat, poor diet due to limited diversity and abundance of floral resources (nectar and pollen), parasites, bacterial and viral infections, and pesticides (Black et al. 2007), as well as interactions between all of the above. The neonicotinoid class of pesticides has faced especially close scrutiny.



Minnesota has approximately 350-400 species of bees.

Within the United States and Canada alone, there are about 4,000 species of bees (Minnesota has about 350-400 species), 760 species of butterflies (Minnesota, approximately 146), 10,470 species of moths (Minnesota, about 2,000-2,500), and numerous other species of beetles, flies and ants.

“Weed laws” often dictate that DNR managers spray herbicides to control invasive species. Even when spot spraying patches instead of broadcast spraying, herbicides inevitably impact some of the native plants and pollinators managers are trying to encourage. In other cases, roadsides along DNR lands are mowed or hayed at times that may hurt pollinators and other wildlife. More communication between the natural resource community, weed inspectors, road authorities and others would help determine how best to address competing goals of providing wildlife or pollinator habitat, or both, and road maintenance while controlling invasive species.

DNR Pollinator Best Management Practices

Most of the DNR's habitat management practices promote diverse native pollinator communities. So even though it hasn't been the explicit goal, DNR lands already benefit pollinators. There are three broad management areas that could directly or indirectly impact pollinators. What follows is a discussion of best management practices to minimize negative impacts for pollinators and accentuate positive effects. When multiple management activities occur on one site, cumulative activities should not impact more than half to two-thirds of the site per year to allow for pollinator refugia.

Not all habitats are equal. Each pollinator species has different habitat requirements. We cannot manage one area or unit for the greatest benefit of all species all the time. Any management activity has the potential to hurt some species and help others. Fire, haying, or grazing, for example, may impact some habitats or populations, make habitat temporarily unavailable for pollinators, or remove some from the population. These activities are necessary for the long-term diversity and productivity of the ecosystem. We should strive to provide habitat for all pollinator species across the larger landscape each year.



I. Grassland Management

Prescribed Fire

Insects may winter above or below ground as eggs, larvae, pupae, or adults, depending on the species. Burning can hurt species that overwinter above ground in vegetation or are at an immobile life stage (eggs, larvae, pupae) during the typical March through May fire season. About 30 percent of bee species nest in cavities such as hollow or pithy plant stems, or tunnels in wood created by boring beetles. Queen bumblebees, including two imperiled species found in Minnesota, nest in grass thatch. Other pollinator species overwinter in grass thatch or leaf litter. Grass fires are generally fast moving and don't last long. Research from grassland habitats in other parts of the country suggests insects below ground during a fire seldom die as a direct result of the fire. The flush of flowering plants after the burn will benefit all pollinating insects. Keep in mind, burning all of one habitat type could extirpate fire-sensitive species from a site.

For burning, the BMPs encourage leaving refuges. This can be done by creating smaller burn units, patch burning, and allowing skips (try to burn no more than half to two-thirds of a habitat type). Also, retain important habitat and extend intervals when possible.

Specific recommendations for prescribed fire include:

- Fire refugia (unburned areas) play an important role in invertebrate conservation. Avoid burning more than half to two-thirds of a habitat type in the same year while also providing for two consecutive years of unburned refugia on a site for pollinator life cycles to be completed. Refugia can be established in a number of ways such as: creation of burn units within larger management units, and using the burn prescription to create internal refugia. Intentionally leave “skips” or unburned areas within the burn unit; they provide natural refugia.
- Land managers should ensure that all known locations of rare insects within a unit (park, scientific and natural areas, wildlife management areas) are not burned in the same year. It is important to consider how prescribed fire may impact the life cycle of those species.
- When selecting refugia for pollinators, land managers should consider:
 - If there are plant species that are known overwintering or egg-laying sites, include areas with these species within the refugia.
 - Within a management unit, ensure that refugia occur within the variety of “habitat types” in the unit. (For example, if a unit consists of wet and dry prairies, each prairie type should have some refugia.) When managing remnant habitats, ensure that some portion (at least a third) remains unburned for two consecutive years at all time. This may mean subdividing into multiple units or providing for one-third refugia each time the remnant is burned.
 - When management units include both remnant and restored habitats, ensure that refugia are created in both.
 - When planning for refugia, managers can look beyond the boundaries of the unit since adjacent properties may serve as adequate refugia.
- Intervals between fires are important to allow invertebrate populations to recover. If the composition of invertebrate species on the site is known, use recommendations from scientific literature to help determine fire return intervals. When the species composition is unknown consider these general recommendations from the literature:
 - A variety of studies suggest that three to 10 years between prairie fires provides adequate time for recovery of pollinator populations, assuming adequate refugia and adjacent populations (Black et al. 2007).
 - Allowing four to five years to elapse without fire (i.e., five-to-six-year rotation) may benefit some groups or species (Wallner et al. 2012).
 - In many cases, more frequent fire intervals can help control woody vegetation or invasive species. Managers cannot develop burn plans based solely on pollinator populations, but should incorporate these considerations when possible.
 - When possible, managers should vary the season when burns are conducted to prevent repeated impact to the same species in the same location.

Invasive Species Control and Pesticide Use



The DNR will continue to manage invasive species and practice IPM when using all pesticides (Op Order 59). Ensure applicators recognize target species target species and use proper chemicals.

Herbicides are the most commonly used pesticide on DNR land. They are primarily used to control invasive plant species or to prepare a site for restoration. Herbicides aren't usually a direct problem for pollinators although some herbicides can be. Herbicides can remove floral resources, host plants, and nesting habitat. When using pesticides, be sure to read all labeling, use proper PPE, and adhere to Operational Order 59 to minimize risks to both applicator and the environment.

The DNR uses insecticides minimally where necessary – mainly on wasp nests in high-use areas around buildings. When insecticides must be used, integrated pest management practices and label specifications should be strictly observed.

Specific recommendations for invasive species control include:

- Invasive plant species should be controlled, even if they serve as a pollen or nectar source.
- Standard invasive species best management practices (see DNR Operational Order 113, Invasive Species and applicable division guidelines) will continue to be a priority.
- Alternatively, spot mowing of invasive plant species two to three times a summer can prevent seed production and slow the spread of the species.
- Select spot treatments over broadcast applications whenever possible to minimize potential impact to pollinators and associated nectar or host plants.
- Ensure that field crews recognize target species to avoid adverse effects to nontarget native species.
- Insecticides and herbicides should be selected to be the most target-specific and applied on the smallest area practical to meet management objectives (see DNR Operational Order 59, Pesticides and Pest Control).
- Avoid neonicotinoid insecticides and other insecticides that are highly toxic to pollinators. Avoid plant materials that have been treated with neonicotinoid insecticides. Labeling guidelines make this challenging. Examples of neonicotinoids that may be used as seed dressing, soil drench, granules, injection or sprays include: imidacloprid, clothianidin, thiamethoxam, dinotefuran and acetamiprid.
- Avoid pesticide application if wind speeds exceed 10 mph.

- In most cases, reduce the spread of the invasive plants by eliminating outlying populations first and then working toward the center of the infestation.
- Spray in early morning or evening when bees and other pollinators are less active.
- Choose bio-control over pesticides if available.

Mowing, Haying and Native Seed Harvest

Managers should recognize that mowing or haying native prairie, established prairie, and recently planted restorations will have different effects on each of these plant communities. Significantly more research into the effects on plant and invertebrate communities is needed.

Normally managers are encouraged to “mix up” the management at a site, but mowing or haying the same area every year may encourage an early spring plant community. This assumes only a small percentage of an area would receive this treatment. Mowing the entire area can abruptly remove pollinator foraging resources, overwintering habitat (Hatfield et al. 2012), and host plant vegetation (Johst et al. 2006). Each pollinator species uses different parts of the habitat or vegetation at different times of the year. Mowing or haying at any time of the year will benefit some species and impact others.



Key BMPs for mowing include: providing refugia, mowing after mid-September, spot mowing for invasive species and partnering with road authorities.

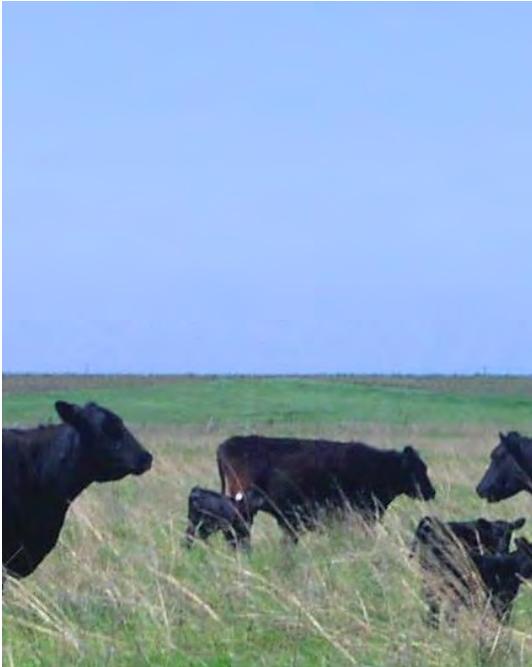
Specific recommendations for mowing and haying include:

- It's important to avoid mowing the whole area at once. It is better to mow different areas at different times to avoid impacting the entire population of any species on that unit. Leave one-third to half of the habitat type as refugia—areas left undisturbed—with no mowing or haying if possible.
- If mowing the entire unit is necessary to meet other management goals, subdivide the unit into at least two units and mow the areas several weeks apart so that the whole unit isn't affected at once. Consider seasonality, plant species and pollinators when identifying the refugia similar to prescribed fire practices.
- When mowing to control invasive species or encroachment of woody species, focus on patches of invasives or woody species, leaving the rest of the habitat intact.
- Mowing (cutting) should be as high as possible to meet the management goals and make the most of the nesting and overwintering habitat left on site.

Conservation Grazing

Well-managed cattle grazing along with controlled burns, invasive species control and rest is gaining greater acceptance as a tool for managing grassland habitats in Minnesota.

Grazing is particularly useful for altering vegetation height and providing short grass



When grazing leave refugia, limit duration and have a diversity of stubble heights.

habitat required by several prairie obligate animal species. Grazers primarily target grasses (Plumb and Dodd, 1993), so forbs don't have to compete with these grasses. Several studies demonstrate increases in plant species diversity and forb abundance in upland prairies in portions of the tallgrass prairie region (Hickman et al. 2004, Symstad et al. 2010). Properly managed grazing should have limited negative impact on overall pollen and nectar resources. Some pollinator-preferred plant species such as purple coneflower respond well to periodic grazing. Grazing can create patchiness in the fuels that carry prescribed fire, increasing the patchiness of fires and the unburned refugia that enhance the recolonization of fire-sensitive invertebrates. Short-term grazing targeted to suppress smooth brome may promote greater expression of native forbs in portions of a site overrun by brome.

Like any management tool, grazing has some potential negative consequences for insects. An increase in plant species diversity as a result of grazing management is not necessarily the same as an increase in the abundance or quality of nectar resources. Many species that increase with grazing have little value for pollinators (e.g., prairie ragweed, *Ambrosia psilostachya*, wooly plantain, *Plantago patagonica*, fringed sage, *Artemisia frigida*—all wind pollinated). Though cattle consume mostly grasses, they seek palatable forbs more than bison (Plumb and Dodd, 1994, Helzer and Steuter, 2005) and selectively target some nectar-producing forb species particularly attractive to them (Curtis, 1959). Some cattle, for example, will target several native milkweed species that are high-quality nectar resources and also host plants for the monarch butterfly. Though episodes of grazing may increase the density of flowers in some forbs for a couple of subsequent years of little or no grazing, flower density can be greatly reduced the year of the grazing (Moranz et al. 2014). Some imperiled butterflies and moths such as Dakota skipper and Poweshiek skipperling (USFWS, 2013) depend upon standing stems and foliage of warm season grasses for larval feeding and shelter. Grazing intensity that appreciably removes this resource can be bad for the insects. Trampling may also be a problem for them. Grazing can increase problem species such as leafy spurge or invasive thistles, which has prompted some managers to use herbicides to the point of eliminating native forbs (Spomer, 2004).

The DNR's management direction toward conservation grazing as a means to enhance wildlife habitat should be consistent with pollinator conservation.

Specific recommendations for grazing include:

- Limit the duration and intensity of grazing on sites so that residual cover is left after livestock are removed. However, there will be times when the grass is grazed shorter to meet specific management objectives at that site.
- Manage grazing so the more sensitive plant species that are part of the prairie do not decline.
- Monitor grazing to create a range of habitat structures (height of plants) to create diversity that is generally beneficial to forbs and pollinators as well as other wildlife.
- Where heavier grazing of a site is called for, leave one-third to half of the important habitats ungrazed as refugia for pollinators.
- On larger units, managers can set up grazing paddocks or regimes to rotate grazers within the site to retain some nectar and host plants. Alter the grazing cycle so sites aren't grazed during the same time each year.
- Insecticides used for parasite control in cattle are systemic and can benefit insects as well as pests. The DNR worked with the state veterinarian, Board of Animal Health, and cattle producers to set up parasite control guidelines that are sensitive to native insects and has developed a list of acceptable products and practices that can be found on the Minnesota Pollinator Resources webpage.

Farming Practices

Although the DNR uses native vegetation as much as possible, policy allows the use of cropland management to meet specific objectives, including habitat restoration, habitat management, supplemental food for wildlife, and attracting wildlife for viewing and photography. Four farming practices can impact pollinators: plant selection, crop diversity and rotation, tillage and weed control and insecticides.

Farming activities were not included in these guidelines because farmed fields are not considered a native plant community. As the guidelines were being drafted, it was apparent that farming activities are both a tool used as a means to restore native plant communities and as a tool to manage for wildlife and wildlife-related recreation. Due to the profound impact farming practices potentially pose to pollinators, farming practices will be reviewed and addressed in a follow-up document.

II. Forest Management

The Minnesota Forest Resources Council's site-level forest management guidelines have been designed to protect wildlife populations associated with forested plant communities during the course of vegetation management activities.

(See [http://mn.gov/frc/documents/council/site-level/MFRC_Revised%20Forest%20Management%20Guidelines%20\(2012\).pdf](http://mn.gov/frc/documents/council/site-level/MFRC_Revised%20Forest%20Management%20Guidelines%20(2012).pdf)) The guidelines define wildlife as "all forms of life that are wild, including plants, animals and microorganisms." The guidelines have been designed to minimize the risk to habitat

wildlife populations depend on, during forest management activities. In some cases these activities are designed specifically to enhance wildlife habitat. These guidelines also apply to pollinators.

Forest management practices will indirectly benefit pollinator species by maintaining functional forest ecosystem components. Forest management activities can potentially enhance or remove habitat for a variety of wildlife, including pollinator insects, by altering the composition of vegetation in a given area. As more information about pollinator use of forest environments becomes known, forest managers' ability to design activities to achieve more specific habitat goals, including pollinator habitat enhancements, will increase.



Forest management practices should include providing refugia, designing treatment and harvest to avoid impact to spring nectar producers, retaining nesting structure, and encouraging site and landscape diversity.

The Minnesota DNR manages forested native pollinator communities for a range of native species through management activities and allowing for natural processes that result in a range of conditions across the landscape. While new information on pollinator use of forest habitats will be helpful for determining potential habitat enhancements forest managers may influence, the DNR intends to manage native species largely within plant communities in which they have historically existed. Introducing flowering plants (for pollinator resources) into forested plant communities where they have not historically been, whether these are non-native and invasive species or species native to the state but planted outside their geographic range, has the potential to disrupt the natural ecology of that community, and is not an acceptable strategy. Knowledge of the interrelationships of pollinating insects and forest plants is limited.

Under law, state lands are managed for multiple uses; consequently, it's not practical to design forest management practices exclusively for pollinators. Using techniques designed to lessen negative impacts from management activities will help sustain forest-dependent pollinators.

Specific recommendations for forest management activities include:

- Use pesticides judiciously. Avoid broadcast spraying when other effective means of control are available; encourage the use of spot treatments.
- When managing for legacy elements (patches within a treatment area that retain native plants), select areas to include as many plants as possible that produce pollen and nectar.
- Strive to minimize impact to spring ephemerals.

- Maintain a variety of plant communities and conditions across the landscape.
- When designing timber harvest, retain standing dead and downed dead logs. These can serve as nesting habitat for bees, as well as feeding habitat for beetle and hoverfly pollinators whose larvae are saproxylic (dependent on decaying wood).
- Design forest management activities to protect the soil (and thereby protect underground plant structures that regenerate flowering plants and protect ground nesting pollinators).
- When planting trees or shrubs consider the floral resources for added spring and early summer blooming resources. Consult the native plant community pollinator tables (http://files.dnr.state.mn.us/natural_resources/npc/pollinator_booklet_single.pdf) for specific species.

III. Riparian and Shoreline Management

Riparian areas can provide valuable habitat and travel corridors for pollinators, linking other foraging and nesting habitat. Riparian areas provide a unique opportunity to supply early-flowering willow and in dry areas, late flowering native forbs. Many DNR properties contain rivers, streams, wetlands, lakes, bogs and other waterways. Erosion and water quality concerns have prompted stricter management guidelines for these areas than other upland property. Many guidelines for grassland management and forest management still apply. However, the natural species mix will be different. Consider the NPC adjacent to the site when selecting species to plant in a riparian area.

Specific recommendations for stream bank and shoreline activities include:

- Plants attractive to pollinators can be used along waterways, but planting should not interfere with the hydraulic function of the waterway and the primary objective of stabilizing the bank against erosion.
- To enhance habitat for native bee communities, increase the diversity and abundance of flowering plants growing on a site and add nesting habitat. Consider pollinator needs when choosing native tree species for riparian forest buffers. For example, willow, dogwood, and goldenrod benefit pollinators.
- Seed mixes can include native legumes or other forbs that provide pollen and nectar for native bees. These sites may be able to support flowering forbs with higher water requirements and provide bloom later in the summer. Consult the [native plant community pollinator tables](#) for specific species.
- Maximizing plant diversity along riparian corridors will result in more pollinators and also other terrestrial insects that act as forage for fish.

Habitat Restoration Guidelines-Providing New Habitat

Native plant community restoration adds to the resources required for pollinator populations to thrive. The following restoration guidelines primarily focus on the state's prairie region where native plant communities are scarce and may be limiting factors in pollinator populations. In the prairie region, restoration usually means starting with bare soil, crop stubble, and planting seeds of native grasses and forbs. "Restoration" in this context means "starting from scratch" as opposed to forestry practices where seed banks and roots are often already present after a timber harvest. In circumstances where forest restoration occurs by these standards, similar guidelines apply.

Restorations rarely if ever have the full complement of species found in remnant native plant communities. Specifically, early blooming species are often absent from standard mixes, especially when seed sources are harvested by combine. If seed mixes are not custom assembled, early blooming species can be hard to find, more costly or difficult to establish. Conversely, late season blooming species, especially members of the aster or sunflower and legume family, are commonly used in seed mixes.

Pollinator species fall on a spectrum between generalist feeders and specialists dependent on a plant family or species. By increasing restoration diversity and paying special attention to plants specifically associated with a pollinator species, the DNR can support the intricate relationships between native pollinators and native vegetation that keep both communities healthy.

General recommendations for habitat restorations include:

- Restoration planning, especially species selection, should be guided by knowledge of the expected native plant community on the site and any natural resource surveys (plants, invertebrates, soils, hydrology) that might inform the effort.
- Refer to the [native plant community pollinator tables](#) for specific host species.
- Plant selection should include those species that support endangered, threatened, special concern or rare-pollinating species. These pollinating invertebrate species often have specific host plant species.



Restoration efforts will be guided by native plant communities.

- Current research indicates that it is difficult to successfully interseed forbs into dense well established grass. Alternatives include extensive disking to weaken the grass and expose soil or to consider establishing 5-10 acre pollinator plots. Minimum size and number of plots needed to impact pollinators remains unknown and is likely dependent upon the site.
- When buying seed mixes, live plants, shrubs or trees from a native plant producer or a garden center, make sure that the plant material will not hurt pollinators. Avoid plant materials with seed, plant or soil sources treated with neonicotinoid insecticides. Labeling guidelines can make this challenging. Examples of neonicotinoids that may be used as seed dressing, soil drench, granules, injection or sprays include: imidacloprid, clothianidin, thiamethoxam, dinotefuran and acetamiprid.
- These guidelines recognize that management activities for restoration sites often include actions such as mowing, prescribed fire, herbicide applications and even farming, applied in a manner that may seem inconsistent with pollinator conservation in the short term but may be necessary to establish the plant community and keep it healthy long term.

Landscape Level Considerations

Habitat complexes and corridors provide natural passageways for all wildlife, including pollinators. If managers consider the landscape in which the restoration exists, they can optimize the location of pollinator habitat enhancements. Pay attention to how a particular restoration contributes to landscape level planning.

Specific recommendations for habitat restorations include:

- Sites that are adjacent to existing remnant plant communities, next to known pollinator areas, or connected to pollinator areas by suitable habitat corridors are ideal locations for restoration. Existing populations of pollinators may more easily colonize new habitat in these areas. Remnant prairie protection through prairie bank and other programs is vital to providing pollinator habitat.
- Pay attention to past and present insecticide use on and adjacent to the site so that appropriate mitigation can be applied.
- Consider the distance between available foraging, nesting and water resources. Keep in mind the flight distance of native bees ranges from as little as 200 feet to a mile or more.

Site Level Considerations

These guidelines minimally require nine pollinator-supporting species, three each with blooming periods early, middle, and late summer, on at least 10 percent of the site (Refer to the [pollinator tables](#)). Consider this a minimum. Strive to make the most of the diversity of seed mixes for species appropriate to the site but keep economic considerations in mind. Many of the more desirable species, especially those spring blooming species, can be expensive. Rely on your best judgment in the trade-off between increasing the number of species and buying more inexpensive seed and increasing the density of forbs on the site.

When planting some of the more expensive species, take extra care to consider micro-sites for planting. For example, planting pasqueflower seed along a wetland margin will be challenging. Also note that many of the spring species are short and often do best with a haying or grazing regime that removes much of the late summer thatch and allows the species to emerge early. Take long-term management into consideration when planting some of these species. Remember that restorations in the prairie region are all quite different, which also adds to landscape level diversity.

Site Prep for Restoration or Enhancement

Site preparation for restoring new pollinator habitat should begin by assessing past practices on the acres being restored and the potential for pesticide exposure from adjacent lands.



Consider the landscape context in which the native plant community restoration exists.

Specific recommendations for site prep include:

- Place pollinator habitat enhancement plantings on soils free of persistent pesticides harmful to pollinators, such as insecticides known as neonicotinoids. Systemic insecticides, like the neonicotinoids, can be stored in the soil and absorbed by new plantings and transferred to pollinators that forage on them (see Hopwood et al. 2012 for review). Since it often takes several years for many native forbs to become established and bloom, this may not be a problem.
- Emphasize pollinator planting efforts away from adjoining lands where there is potential for pesticide drift harmful to pollinators. When appropriate with other objectives, identify areas within the restoration where increased diversity consistent with pollinator habitat needs could be emphasized. Specific recommendations for these “patches” can be found in the Foraging Habitat section.

Enhancing Diversity in Existing Grasslands

Many consider restoration as starting from bare soil and soybean stubble. There may also be an interest in enhancing existing grasslands. Many conservation acres under fee title were planted decades ago with brome or low diversity native grasses. On private lands there are also many acres, such as early CRP mixes, that have a low diversity of native forbs.

Interseeding into existing grass has shown limited success in the literature and should be approached with caution. Even in native prairie, almost no plants are established from seeds (Benson and Hartnett 2006) except on disturbed areas such as gopher mounds

(Rogers and Hartnett, 2001). Competition with tall robust grasses makes it difficult for forbs to become established from seed.

Specific recommendations for enhancing diversity in existing grasslands include:

- Chemical treatment (Roundup®) of the vegetation before planting. To get good seed-soil contact, burn the site in the fall before seeding.
- Disking the soil both weakens established plants and creates the bare soil patches seeds need to become established.
- Grazing an area interseeded with forbs can also reduce grass competition and aid in forb establishment (Martin and Wilsey, 2006).

Seed Selection and Planting – Foraging Habitat & Nesting Habitat

Foraging Habitat

Diversity is a critical factor in the design of pollinator foraging habitat. Flowering plants should be available throughout the entire growing season to provide protein and carbohydrates to sustain pollinator populations. Include a diversity of plants with different flower colors, sizes, and shapes as well as varying plant heights and growth patterns to encourage the greatest numbers and diverse mix of pollinators. Also, research shows that the higher the density of flowering plants, the more attractive the area is to pollinating insects. It is important to insure that species selected are within their natural range and that Op Order 124, Plant Material Standards for Native Plant Community Restoration, is followed. Use nearby or similar reference communities or the [native plant community pollinator tables](#) to help in species selection.

Specific recommendations for foraging habitat include:

- Within the species associated with the native plant community, include a diverse mix of native flowers to attract a broad range of pollinators. Bees typically visit flowers that are purple, violet, yellow, white and blue. Butterflies visit a similarly wide range of colors, including red. Flies are primarily attracted to white and yellow flowers.
- Strive for at least three different pollinator supporting species within each of the three blooming periods (early, mid or late season).



Strive for at least three native flowers blooming in spring, summer and fall. The more diversity, the better.

In addition to herbaceous plants, flowering shrubs can be an important source of pollen and nectar for pollinators, particularly early in the spring. Refer to the [pollinator tables for species](#) recommendations appropriate in your area. Ideally, a native plant community approach should be taken and appropriate species mixes

should be planted on an entire site. In some cases, it may be necessary to take a “patch” approach. In this situation, at least 10 percent of the site should contain the required pollinator supporting species.

- Plant diverse grasses; don’t rely on just big bluestem and Indiangrass. Include shorter grasses (side-oats grama), bunchgrasses (little bluestem), and native cool-season grasses if the soils are appropriate with the plant community. Short statured grasses will decrease light competition for flowering species. Refer to the [pollinator tables](#) for specific species recommendations.
- Increase the seed rate for flowering species and decrease the seed rate for grass species.

Nesting Habitat

Pollinating insects nest in a variety of habitats; soil, the bases of bunch grasses, the hollow stems of grasses and shrubs. Make sure all of these habitats are available within the management area.

Specific recommendations for nesting habitat include:

- Plant some native bunch grasses (such as little bluestem), as opposed to primarily rhizomatous or sod grasses, that leave small patches of bare ground exposed. These grasses can also provide forage resources for the larval stages of native butterflies, as well as overwintering sites for other beneficial insects.
- When conducting management activities, leave some patches of undisturbed grass so rodents can nest and create future nesting sites for bumblebees.
- Avoid clearing or burning fallen or dead trees when consistent with other objectives, as they contain potential nesting sites for a wide range of pollinators, including cavity-nesting bees, as well as larval food sources for many species of pollinating beetles and hoverflies. These decisions will be site specific. In many prairie projects, it’s often best to remove the woody material. If working in shrublands, forests, or riparian areas, some woody debris should be left on-site.

Prairie Restorations with State Funds

Section (b) of the pollinator habitat legislation states: “Prairie restorations conducted on state lands or with state funds must include an appropriate diversity of native species selected to provide habitat for pollinators throughout the growing season.” This language is specific to prairie restorations only. Prairie restoration projects that use state funds include but are not limited to all Operational and Dedicated Funds, Working Lands Initiative Projects, Environment and Natural Resource Trust Fund, Outdoor Heritage Fund, Conservation Partners Legacy Grants, Aquatic Habitat Restoration Grants, Recreation Grants, Parks and Trails Legacy Grants, and Local Trail Connection Grants. These are subject to the restoration guidelines in this document.

Contract Language

DNR grant agreements and contract work to accomplish habitat restoration or enhancement on DNR lands or prairie restorations using state funds are also subject to the best management practices and guidelines in this document. **The following standard language should be included in grants and contracts for all habitat enhancements or restoration work:**



Conservation partners Legacy projects and working lands projects must use diverse native species to provide pollinator habitat.

Specific Pollinator Best Management Practices for Grants and Contracts

Habitat Restoration Guidelines:

- Place pollinator habitat enhancement plantings on soil free of persistent pesticides harmful to pollinators.
- Pay attention to past and present insecticide use on and adjacent to the site so that appropriate mitigation can be applied.
- Emphasize pollinator planting efforts away from adjoining lands where there is potential for pesticide drift harmful to pollinators.
- Avoid clearing or burning fallen or dead trees when consistent with other objectives, as they contain potential nesting sites.
- Species selection should be guided by knowledge of the expected native plant communities on the site and any natural resource surveys (plants, invertebrates, soils, hydrology) that might inform the restoration effort.
- Refer to the [pollinator tables](#) for specific host species.
- Include a diverse mix of native flowers to attract a broad range of pollinators. Strive for at least three different pollinator supporting species within each of the three blooming periods (early, mid or late season).
- Plant some native bunch grasses (such as little bluestem).
- Plant selection should include plant species that support endangered, threatened, special concern or rare-pollinating species.
- Avoid plant materials with seed, plant or soil sources that have been treated with neonicotinoid insecticides.

Stream Bank and Shoreline Guidelines:

- Plants attractive to pollinators can be used along waterways, but the planting should not interfere with the hydraulic function of the waterway and the primary objective of stabilizing the bank against erosion.

- To enhance habitat for native bee communities, increase the diversity and number of flowering plants growing on a site and add nesting habitat. Consider pollinator needs when choosing trees for riparian forest buffers. For example, willow, dogwood and goldenrod benefit pollinators.
- Seed mixes can include legumes or other forbs that provide pollen and nectar for native bees. These sites may be able to support flowering forbs with higher water requirements and provide bloom later in the summer. Consult the [native plant community pollinator tables](#) for specific species.
- Maximizing plant diversity along riparian corridors will result in more pollinators and other terrestrial insects that act as forage for fish.

Prescribed Disturbance- Fire/Mowing/Haying:

- Ensure that all known locations of rare insects are not disturbed in the same year.
- Avoid impacting more than half to two-thirds of a habitat type in the same year.
- Allow 3 to 10 years rest between disturbances to provide recovery time for pollinator populations.
- Vary the season when disturbances are conducted to prevent repeated impacts to the same species in the same location.
- When selecting refugia for pollinators, consider:
 - If there are plant species that are known overwintering or egg-laying sites, include areas with these species within the refugia.
 - Within a management unit, ensure that refugia occur within the unit's variety of "habitat types." When managing remnant habitats, ensure that at least a third remains unburned for two consecutive years at all time.
 - When management units include both remnant and restored habitats, ensure that refugia are created in both.
- If disturbance to the entire area is necessary to meet other management goals, subdivide the unit into at least two units and burn or mow or hay the areas several weeks apart so the whole unit isn't affected at once.
- When controlling invasive species or encroachment of woody species, target undesirable patches, leaving the rest of the habitat intact.
- Mowing should occur as high as possible to still meet the management goals in order to make the most of nesting or overwintering habitat left on site.

Invasive species control:

- Invasive plant species should be controlled, even if they serve as a pollen or nectar source.
- Avoid neonicotinoid insecticides.
- Select spot treatments over broadcast applications.
- Choose bio-control over pesticides if available.
- Insecticides and herbicides should be selected to be the most target-specific and applied on the smallest area practical to meet management objectives.
- Ensure that crews recognize target species.
- Spray in early morning or evening when bees and other pollinators are less active.
- Avoid pesticide application if wind speeds exceed 10 mph.

- Eliminate outlying populations of invasive species first and then work towards the center of the infestation.
- Monitor pesticides for dispersal by drift, erosion or runoff.

Conservation grazing:

- Limit the duration and intensity of grazing on sites so that residual cover is left after the livestock are removed if consistent with key management objectives.
- On larger units, set up grazing paddocks or regimes to rotate grazers within the site and allow for retention of some nectar and host plants. Alter the grazing cycle so any site is not grazed during the same time each year.
- Monitor grazing to create a range of habitat structures (height of plants) to create diversity.
- Where heavier grazing of a site is called for, leave one-third to half of the important habitats ungrazed.
- Manage grazing so that the more sensitive plant species that are prairie components do not decline.
- Insecticides used for parasite control in cattle are systemic and can benefit insects as well as pests. The DNR worked with the state veterinarian, Board of Animal Health, and cattle producers to set up parasite control guidelines that are sensitive to native insects and has developed a list of acceptable products and practices that can be found on the Minnesota Pollinator Resources [webpage](#).

Specific best management practices for forest management activities include:

- Avoid broadcast spraying of pesticides when other effective means of control are available; encourage the use of spot treatments.
- When managing for legacy elements (patches within a treatment area that retain native plant community representation), select areas to include as many plants as possible that produce pollen and nectar.
- Minimize impact to spring ephemerals.
- Maintain a variety of plant communities and conditions across the landscape.
- Retain standing dead and downed dead logs where possible to serve as nesting habitat for bees, as well as feeding habitat for beetle and hoverfly pollinators whose larvae are saproxylic.
- Design forest management activities to protect the soil (and thereby protect underground plant structures that serve to regenerate flowering plants and protect ground nesting pollinators from impact).
- When planting trees or shrubs consider floral resources for added spring and early summer blooming resources (For example, American basswood, serviceberry, and willow where ecologically appropriate).

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IDENTIFYING PROGRAMS & FUNDING FOR MINNESOTA POLLINATOR HABITAT

Available funding for habitat projects plays a key role in the support of pollinator populations. The table on the following page summarizes state and federal water quality and habitat focused conservation programs that can be used to restore pollinator habitat as primary or secondary project goals.



Most of the state programs listed in the table are focused on solving water quality issues or providing high quality habitat and are competitive grant programs. The federal sources listed generally have primary goals of restoring habitat and environmental quality as part of agricultural production.

Local [conservation districts](#) and [watershed districts](#) are generally the most knowledgeable about what state and federal programs may be the best fit for an individual project; and if there are other “local” sources of funding that could be used for smaller projects that may not be eligible for state or federal funding. The last row of the table lists potential sources for smaller planting projects.





IDENTIFYING PROGRAMS & FUNDING FOR MINNESOTA POLLINATOR HABITAT



This table is designed to aid the selection of conservation programs that can be used to restore pollinator habitat. The table summarizes state and federal programs, and sources of additional match. Links in blue text provide funding for projects solely on agricultural land while those in brown text are for urban or agricultural land. Landowners should work with local NRCS, SWCD or DNR staff as needed for additional guidance.

| Program Categories | Program | Program Goals | How to Incorporate Pollinator Habitat |
|--------------------|---|---|--|
| State Programs | <u>Clean Water Fund (BWSR)</u> | To protect, enhance, and restore lakes, rivers, streams, and groundwater. | These competitive grants focus on water quality issues. However, plantings done as part of projects such as rain gardens or stormwater basins encourage secondary benefits such as pollinator habitat. Plans for restoring pollinator habitat should be included in the competitive grant application. There is no minimum acreage size for projects. |
| | <u>State Cost-Share (BWSR)</u> | To provide grants for installing conservation practices that protect and improve water quality by controlling soil erosion and reducing sedimentation. | This program involves partnerships with local Soil and Water Conservation Districts. Diverse plantings are encouraged and should be included in project plans when applicable for the project type to provide pollinator habitat. There is no minimum acreage size for projects. |
| | <u>Reinvest in Minnesota RIM (BWSR)</u> | To restore marginal and environmentally sensitive agricultural land, protect soil and water quality, and restore fish and wildlife habitat. | A competitive process is used to select lands for the establishment of permanent conservation easements. The land remains in private ownership and the landowner retains responsibility for maintenance. Diverse mixes are promoted for plantings, and separate floral rich pollinator plantings of a few acres in size can be included. Funding may also be available to enhance diversity in existing plantings. There is a three acre minimum size for projects. |
| | <u>Roadsides for Wildlife (MDNR)</u> | To reduce disturbance of roadside cover until after August 1st; Include native prairie species in roadside plantings; Explain the benefits of a diverse and undisturbed roadside environment. | Currently funding is not available for this program. The following things can be done to promote roadside habitat for pollinators: Improve the management of your adjacent roadsides for wildlife. Encourage other landowners and local road authorities to reduce mowing and haying during the nesting season. Promote pollinator cost-share assistance for new or re-vegetated roadside projects. Discuss opportunities to partner on roadside projects with local road authorities. |
| | <u>Conservation Partners Legacy Grant Program CPL (MDNR)</u> | To enhance, restore, or protect the forests, wetlands, prairies, and habitat for fish, game, or wildlife in Minnesota. | These Competitive grants focused on restoring wildlife habitat are provided to local, regional, state, and national nonprofit organizations, including government entities. Diverse plantings are promoted for projects and detailed information about plans for restoring pollinator habitat should be included in grant applications. There is no minimum acreage size for projects. |
| | <u>Living Snow Fences (MN DOT)</u> | To protect roadways and provide multiple environmental and agricultural benefits. | Funding is available to install living snow fences and guidance is provided about how to best benefit pollinators with the plantings. |
| Federal Programs | <u>Conservation Reserve Program CRP and Conservation Reserve Enhancement Program CREP (FSA)</u> | To retire and convert highly erodible cropland and other environmentally sensitive acreage to vegetative cover. | Funding is available to provide 50% cost-share for pollinator plantings using practice standard CP42 that require 3 species from each bloom period (9 minimum) and a minimum 75% forbs in plantings. 10-15 year contracts are used for CRP. There is no minimum acreage size for projects. There is also a new mid-contract management option to enhance honey bee habitat through establishment of honey bee beneficial cover. |

| | | | | |
|-----------------------------------|---|---|---|---|
| | <u>Conservation Stewardship Program CSP (NRCS)</u> | To encourage agricultural producers to address resource concerns in a comprehensive manner. | Pollinator plantings are eligible through this program. The plantings require a minimum of 15 species and a minimum of 50% forbs, as well as species selected from each flowering group of spring, summer and fall are required. There is no minimum acreage size for projects. | |
| | <u>Agricultural Conservation Easement Program ACEP (NRCS)</u> | To provide support for grazing operations, enhancement of plant and animal biodiversity, and restoration and protection of grasslands under threat of conversion to other uses. | Agricultural Lands Easements (ALE) - Participants may conduct prescribed burning, and construct fences to improve diversity and grassland quality. Enrollment options include 30 year or permanent easements. A grazing management plan is required for participants that can address management for pollinator species. There is no minimum acreage size for projects. | |
| | | Provides assistance to restore, protect, and enhance wetlands and adjacent uplands through wetland reserve easements and plans. | Wetland Reserve Easements (WRE) - Enrollment options include 30 year or permanent easements. A restoration plan is required for participants that can provide specific guidance on seed mixes and management to benefit pollinator species. There is no minimum size for projects. | |
| | <u>Environmental Quality Incentives Program EQIP (NRCS)</u> | To promote compatibility between agricultural production and environmental quality through technical and financial assistance. | Funding is available for pollinator habitat with a focus on supporting honey bees. Through an agreement landowners agree to maintain the practice (1-10 years). There is a minimum of 75 % forbs for seed mixes, as well as species selected from each flowering group for spring, summer and fall are required for pollinator plantings. There is no minimum acreage size for projects. The program also provides funding for the development of a Pollinator “Conservation Activity Plan” (CAP) to maximize pollinator habitat. | |
| Match Sources for Programs | Landowner Match Local Foundations Garden Clubs Soil & Water Conservation Districts Counties Private Companies | | Local Sportsmen’s Clubs Environmental Non-profits Watershed Districts Cities Lake Associations Neighborhood Associations | Master Gardeners Schools School Clubs |

Minnesota Noxious Weeds

Includes Native and Nonnative Look-alike Species for Comparison



Oriental bittersweet, *Prohibited: Eradicate*

2017-10-26

Minnesota State Listed Noxious Weeds

| Page | Common Name | Scientific Name | Family |
|--------------------------|---|--|------------------|
| Prohibited: Eradicate | 4 Black swallow-wort | <i>Cynanchum louiseae</i> Kartesz & Gandhi | Asclepiadaceae |
| | 5-6 Common / cutleaf teasel | <i>Dipsacus fullonum</i> L. and <i>D. laciniatus</i> L. | Dipsacaceae |
| | 7 Dalmatian toadflax | <i>Linaria dalmatica</i> (L.) Mill. | Scrophulariaceae |
| | 8 Giant hogweed | <i>Heracleum mantegazzianum</i> Sommier & Levier | Apiaceae |
| | 9 Grecian foxglove | <i>Digitalis lanata</i> Ehrh. | Scrophulariaceae |
| | 10 Japanese hops | <i>Humulus japonicus</i> Siebold & Zucc. | Cannabaceae |
| | 11 Oriental bittersweet | <i>Celastrus orbiculatus</i> Thunb. | Celastraceae |
| | 12 Palmer amaranth | <i>Amaranthus palmeri</i> S. Watson | Amaranthaceae |
| | 13 Poison hemlock | <i>Conium maculatum</i> L. | Apiaceae |
| | 14 Yellow starthistle | <i>Centaurea solstitialis</i> L. | Asteraceae |
| Prohibited: Control | 15-16 Brown knapweed | <i>Centaurea jacea</i> L. | Asteraceae |
| | Meadow knapweed | <i>Centaurea x moncktonii</i> C.E. Britton [<i>jacea</i> x <i>nigra</i>] | Asteraceae |
| | Diffuse knapweed | <i>Centaurea diffusa</i> Lam. | Asteraceae |
| | 17 Spotted knapweed | <i>Centaurea stoebe</i> L. subsp. <i>micranthos</i> (Gugler) Hayek | Asteraceae |
| | 18 Barberry, common | <i>Berberis vulgaris</i> L. | Berberidaceae |
| Restricted Noxious Weeds | 19 Canada thistle | <i>Cirsium arvense</i> (L.) Scop. | Asteraceae |
| | 20 Plumeless thistle | <i>Carduus acanthoides</i> L. | Asteraceae |
| | 21 Leafy spurge | <i>Euphorbia esula</i> L. | Euphorbiaceae |
| | 22 Narrowleaf bittercress | <i>Cardamine impatiens</i> L. | Brassicaceae |
| | 23 Purple loosestrife | <i>Lythrum salicaria</i> L. and <i>Lythrum virgatum</i> L. | Lythraceae |
| | 24 Common tansy | <i>Tanacetum vulgare</i> L. | Asteraceae |
| | 25 Wild parsnip | <i>Pastinaca sativa</i> L. | Apiaceae |
| | 26 Asian bush honeysuckles | <i>Lonicera</i> spp. | Caprifoliaceae |
| | 27 Black locust | <i>Robinia pseudoacacia</i> L. | Fabaceae |
| | 28 Crown Vetch | <i>Securigera varia</i> (L.) Lassen | Fabaceae |
| Specially Regulated | 29 Common buckthorn | <i>Rhamnus cathartica</i> L. | Rhamnaceae |
| | 30 Glossy buckthorn | <i>Frangula alnus</i> Mill. | Rhamnaceae |
| | 31 Garlic mustard | <i>Alliaria petiolata</i> (M. Bieb.) Cavara & Grande | Brassicaceae |
| | 32-33 Japanese barberries | <i>Berberis thunbergii</i> DC. and listed hybrids and cultivars. | Berberidaceae |
| | 34 Multiflora rose | <i>Rosa multiflora</i> Thunb. | Rosaceae |
| | 35 Nonnative phragmites | <i>Phragmites australis</i> (Cav.) Trin. Ex Steud. subsp. <i>Australis</i> | Poaceae |
| | 36 Porcelain berry | <i>Ampelopsis brevipedunculata</i> (Maxim) Trautv. | Vitaceae |
| | 37 Tree-of-heaven | <i>Ailanthus altissima</i> (Mill.) Swingle | Simaroubaceae |
| | 38 Wild carrot | <i>Daucus carota</i> L. | Apiaceae |
| | 39 Amur maple | <i>Acer ginnala</i> Maxim. | Aceraceae |
| Specially Regulated | 40-41 Knotweed, Japanese | <i>Polygonum cuspidatum</i> Siebold & Zucc. | Polygonaceae |
| | Knotweed, giant | <i>Polygonum sachalinense</i> F. Schmidt ex Maxim. | Polygonaceae |
| | 42 Poison ivy - western | <i>Toxicodendron rydbergii</i> (Small) Green | Anacardiaceae |
| | Poison ivy - common | <i>T. radicans</i> (L.) Kuntze subsp. <i>negundo</i> (Greene) Gillis | Anacardiaceae |

Each Specially Regulated species is subject to unique restrictions. See notes on [page 74](#)

Scientific names (genus and species) were sourced from : [USDA Plants Database](#)



Dalmatian toadflax



Japanese hops



Garlic mustard

Plant descriptions provided for comparison: nonnative and native Minnesota plants.

Following are plants, commonly misidentified as a species on the noxious weed list. It is important to identify and protect the native plants, while at the same time managing the State listed noxious weeds.

As for the nonnatives listed here, while these plants may be aggressive on some sites, management is usually not a high priority.

| | Page | Common Name | Scientific Name | Family |
|---|---|---|---|-----------------|
| Nonnative Plants Provided for comparison | 43 | Alfalfa | <i>Medicago sativa</i> L. | Fabaceae |
| | | Hairy vetch | <i>Vicia villosa</i> Roth | Fabaceae |
| | 44 | Balkan catchfly | <i>Silene csereii</i> Baumgarten | Caryophyllaceae |
| | 45 | Carrot look-alikes | Various genus and species of the carrot family | Apiaceae |
| | 46 | Chervil, wild | <i>Anthriscus sylvestris</i> (L.) Hoffm. | Apiaceae |
| | 47 | Musk or nodding thistle | <i>Carduus nutans</i> L. | Asteraceae |
| | 48 | Yellow rocket | <i>Barbarea vulgaris</i> W.T. Aiton | Brassicaceae |
| Minnesota Native Plants Provided for comparison | 49 | American bitterweet | <i>Celastrus scandens</i> L. | Celastraceae |
| | 50 | American vetch | <i>Vicia americana</i> Muhl. Ex Willd. | Fabaceae |
| | | Canadian milkvetch | <i>Astragalus canadensis</i> L. | Fabaceae |
| | 51 | Cherries / wild plum | <i>Prunus</i> spp. | Rosaceae |
| | 52 | Common hops | <i>Humulus lupulus</i> L. | Cannabaceae |
| | 53 | Cow-parsnip | <i>Heracleum maximum</i> W. Bartram | Apiaceae |
| | 54 | Cucumber, wild and bur | <i>Echinocystis lobata</i> Michx. and <i>Sicyos angulatus</i> L. | Cucurbitaceae |
| | 55 | Fireweed | <i>Chamerion angustifolium</i> (L.) Holub subsp. <i>angustifolium</i> | Onagraceae |
| | 56 | Golden alexanders | <i>Zizia</i> spp. | Apiaceae |
| | 57 | Goldenrods | <i>Solidago</i> spp. | Asteraceae |
| | 58 | Grape, riverbank | <i>Vitis riparia</i> Michx. | Vitaceae |
| | 59 | Honeysuckles, native | <i>Diervilla lonicera</i> and <i>Lonicera</i> spp. | Caprifoliaceae |
| | 60 | Native phragmites | <i>Phragmites australis</i> subsp. <i>americanus</i> Saltonstall | Poaceae |
| | 61 | Sumacs | <i>Rhus typhina</i> L. and <i>R. glabra</i> L. | Anacardiaceae |
| | 62 | Swamp thistle | <i>Cirsium muticum</i> Michx. | Asteraceae |
| 63 | Virginia creeper / Woodbine | <i>Parthenocissus quinquefolia</i> (L.) Planch. <i>P. vitacea</i> (Knerr) Hitch. | Vitaceae | |
| 64 | Water hemlock | <i>Cicuta maculata</i> L. | Apiaceae | |
| 65 | Yarrow, Common | <i>Achillea millefolium</i> L. | Asteraceae | |

- 66-71 [Citations](#) to images and web links to reference materials.
- 72 [Control Calendar](#): Suggested timing of control options
- 74 [Definitions](#) of noxious weed categories.



Field thistle (native)



Cow parsnip (native)



Stiff goldenrod (native)

Prohibited: Eradicate

Black swallow-wort : *Cynanchum louiseae* Kartesz & Gandhi



Identification: Synonyms: *C. nigrum* (L.) Pers., non Cav.; *Vincetoxicum nigrum* (L.) Moench

Plant: A perennial, herbaceous vine with a twining habit reaching heights of 3-8 feet. Only milkweed family member in Minnesota that vines. Also, plants have clear sap, not milky.

Leaves: Opposite, shiny and dark green foliage has a smooth (toothless) edge terminated by a pointed tip. Leaves are somewhat oval at 3-4 inches long by 2-3 inches wide.

Flower: Clustered, small (1/4 inch) dark purple flowers with five downy, thickened petals.

Bloom time is June to July.

Fruit and seed: Slender pods, taper to a point at about 1½-3 inches. Pods are described as milkweed-like and at maturity split open to release flattened seeds carried on the wind by downy, filamentous fibers.

Life History: Herbaceous vine that dies back to the ground every winter. Below ground rhizomes sprout to create a group of stems. With more stems, plants in full sun will produce more flowers and set more seed (up to 2,000/meter square). Long distance wind dispersal of seeds can begin in late July. Seeds contain one to four embryos which helps to ensure germination. Seed viability is potentially 5 years.

Habitat: Prefers full sun in upland soils. Disturbances, natural or human caused, provide an opening in which black swallow-wort can gain a foothold. Old fields, grasslands, road or rail corridors, quarries and other disturbed areas provide excellent habitat.

Management: Goals should be to control seed production and stimulate competitive plant cover. **Manual** removal and destruction of plants and root crowns will meet these goals.

Repeated mowing or cutting can impact plants, but will not eradicate a population. After early season mowing or cutting, plans must be in place to monitor and repeat the process as necessary. Black swallow-wort if cut early in the season can still produce seed that year and the goal of cutting is to eliminate seed production. If seeds are present, clean equipment before moving offsite.

Prescribed fire can be used in conjunction with other management efforts to encourage stands of native grasses that will compete with black swallow-wort for resources. Monitoring will be necessary to control resprouting and seedlings that germinate after burns are completed.

Herbicide applications should target plants at or beyond flowering stage. As plants reach maturity, foliar applications of glyphosate or triclopyr ester cover enough surface area to potentially deliver a lethal dose to the root system. Timing the application prior to pod formation may limit the production of viable seed that season. Applying herbicide to early emerging plants with limited foliar area will likely result in roots remaining viable and plants resprouting.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-------|-----|------|------|------|-------|------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Foliar | | | | | | | | | |
| | Cut stem | | | | | | | | | |
| | Mow | | | | | | | | | |
| | Don't mow | | | | | | | | | |
| Flowering Period | | | | | | | | | | |

Treat actively growing plants - once flowering has begun. Treat plants having enough foliage to carry a lethal dose to the root system.

Follow-up mowing to control seed production.

Prohibited: Eradicate

Common teasel : *Dipsacus fullonum* L.



UGA1459703



UGA1459708



UGA1459713

Above: Bracts may be longer than flower head

Image right: common teasel (L), cutleaf teasel (R).

Identification: Compare to [Cutleaf teasel](#) (next page) flower bracts and leaves.

Plant: Herbaceous, monocarpic perennial (plant dies after bearing fruit), first identifiable as a basal rosette. At maturity 2-7 feet tall with erect, ridged and prickly stems.

Leaves: On upright stems - opposite, stalkless (sessile), cup-forming, up to 12 inches long by 3 inches wide, hairless, yellowish to reddish-green, *lance-shaped with a wavy edged margin*. Central leaf vein forms a whitish line on top with stout prickles below.

Flower: Many irregular, 4-parted and white to lavender flowers. Dense, cylindrically clustered heads up to 4 inches tall and 1½ inches wide.

Stiff and spiny flower bracts are very narrow (linear) and may be taller than flower clusters.

Bloom time is June to October.

Fruit and seed: Each floret or small flower produces one capsule containing a grayish-brown, slightly hairy seed.

Life History: During the rosette stage, which may extend beyond one season, the plant creates a substantial tap root, up to 24 inches long by 1 inch wide at the crown.

Each flower head can produce upwards of 2000 seeds with germination success of 30-80%. Seed on immature heads may still ripen. Seed is viable for approximately two years with typical dispersal up to 50 feet. Seed may be transported longer distances via water.

Habitat: Disturbed, open sunny site with moist to dry soils. Common on roadsides and disturbed areas.

Management:

Cutting of roots below ground and removal of as much as possible will limit sprouting. Accomplish cutting and removal of either life stage with tools such as dandelion pullers or a sharp shovel.

Mowing of the rosette stage does not kill the plant, however mowing of the flowering stalks can disrupt seed production. After mowing or cutting of flowering plants monitor for new flower heads. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

Prescribed fire can be used to increase competition from native warm season grasses, if they are present. Fire can also be used in combination with follow-up herbicide treatments. Keep in mind, high density infestations (large numbers of plants) will not burn well.

Herbicides such as metsulfuron methyl, clopyralid, triclopyr or 2,4-D amine are broadleaf specific herbicides that work on teasel at the rosette stage. Glyphosate is applicable but care must be exercised since it is not broadleaf specific.



UGA2187029



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|-----------|---|-----|------|------|------|-------|------|------|----------|--|
| Herbicide | Burn | | | | | | | | | | |
| | Foliar | | | | | | | | | | |
| | Cut stem | Not applicable. | | | | | | | | | |
| | Mow | Mowing is not recommended: mowing does not kill the plant and flowering may still occur. Seed dispersal can occur if mature plants are mowed. Mower scalping creates a good seed bed. | | | | | | | | | |
| | Don't mow | | | | | | | | | | |
| Flowering Period | | | | | | | | | | | |

Prohibited: Eradicate

Cutleaf teasel : *Dipsacus laciniatus* L.



Lobed or cut leaves

Clustered flower and short bracts



Left: teasel flowering on short stems after being mowed.
Right: Prickles underside of leaf.



Identification: Compare to [common teasel](#) (previous page) flower bracts and leaf shape.

Plant: Herbaceous, monocarpic perennial (plant dies after bearing fruit), first identifiable as a basal rosette. Matures to 2-7 feet tall with erect, ridged and prickly stems.

Leaves: On upright stems - opposite, stalkless (sessile), cup-forming, up to 12 inches long by 3 inches wide, hairless, lance-shaped, lobed with sinuses cut almost to the midrib. Prominent leaf vein with stout prickles below.

Flower: Many irregular, 4-parted and white to lavender flowers. Dense, cylindrically clustered heads up to 4 inches tall and 1½ inches wide.

Spiny, stiff flower bracts are not taller than flower cluster and are wider than cut-leaf teasel.

Bloom time is July to September.

Fruit and seed: Each floret or small flower produces one capsule containing a grayish-brown, slightly hairy seed.

Life History: During the rosette stage, which may extend beyond one season, the plant creates a substantial tap root, up to 24 inches long by 1 inch wide at the crown.

Each flower head can produce upwards of 2000 seeds with germination success of 30-80%. Seed on immature heads may reach viability. Seed is viable for approximately 2 years with typical dispersal up to 50 feet. Seed may be transported longer distances via water.

Habitat: Disturbed, open sunny site with moist to dry soils. Common on roadsides and disturbed areas.

Management:

Cutting of roots below ground and removal of as much as possible will limit sprouting. Accomplish cutting and removal of either life stage with tools such as dandelion pullers or a sharp shovel.

Mowing of the rosette stage does not kill the plant, however mowing of the flowering stalks can disrupt seed production. After mowing or cutting of flowering plants monitor for new flower heads. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

Prescribed fire can be used to increase competition from native warm season grasses, if they are present. Fire can also be used in combination with follow-up herbicide treatments. Keep in mind, high density infestations (large numbers of plants) will not burn well.

Herbicides such as metsulfuron methyl, clopyralid, triclopyr or 2,4-D amine are broadleaf specific herbicides that work on teasel at the rosette stage. Glyphosate is applicable but care must be exercised since it is a non-selective herbicide.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-----------------|-----|------|------|------|-------|------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Foliar | | | | | | | | | |
| | Cut stem | | | | | | | | | |
| | | Not applicable. | | | | | | | | |
| | Mow | | | | | | | | | |
| | Don't mow | | | | | | | | | |
| Flowering Period | | | | | | | | | | |

Mowing is not recommended: mowing does not kill the plant and flowering may still occur. Seed dispersal can occur if mature plants are mowed. Mower scalping creates a good seed bed.

Prohibited: Eradicate

Dalmatian toadflax : *Linaria dalmatica* (L.) Mill.



Identification: Compare to introduced [Balkan catchfly](#) (*Silene csereii*). See page 44.

Plant: A short-lived herbaceous perennial up to 4 feet tall. Base may be woody and plant is often branched. Waxy stems and leaves have a bluish-gray color.

Leaves: Alternate leaves 1-3 inch in length clasp stems, are wider and more heart-shaped than similarly flowered butter-and-eggs (*Linaria vulgaris*).

Flower: Erect, spike-like racemes of yellow flowers with orangey center markings. Flowers are 1-1½ inches long with slender spurs extending downward from the back.

Bloom time is May to September.

Fruit and Seed: On average 140-250 seeds are contained in ½ inch long pods. Seeds are dark in color, flattened, angular and 3-edged with a slight, narrow wing on each edge. Mature plants produce up to 500,000 seeds with soil viability up to 10 years.

Life History: Reproduction is primarily by seed that is viable in the seedbank up to 10 years, but the plant also forms colonies via vegetative reproduction from roots.

Habitat: Rapidly colonizes disturbed sites such as roadsides, rail right-of-way, and other locations including cultivated ground. Prefers a drier site in coarse, well-drained soils.



Management: Recommendation - identify and treat early.

Eradication is the goal in Minnesota; therefore, biological control is not a compatible option at this time.

Prescribed fire can set plants back and drain some energy while **mowing** can prevent or delay seed production. However, both stimulate vegetative reproduction, thus potentially increasing stem counts. Monitor the infestation and consider follow-up treatments of periodic mowing and / or herbicide treatments.

Manual methods including, **cutting, hand pulling** or **tillage** if done repeatedly and in conjunction with other treatments may control infestations. **Grazers** eat the flowers, but may also carry the seeds.

Herbicide formulations of chlorsulfuron, dicamba, imazapic or picloram have had reported success. Also, combinations of picloram and chlorsulfuron or imazapic and chlorsulfuron or diflufenzopyr and picloram and chlorsulfuron are being used in some areas. Re-treatment is likely necessary.

Below center: early season regrowth.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|-----------|--|-----|------|------|------|-------|------|------|----------|--|
| Herbicide | Burn | Fire does not kill rhizomes. Result is likely an increased stem count. | | | | | | | | | |
| | Foliar | | | | | | | | | | |
| | Cut stem | | | | | | | | | | |
| | Mow | Mowing can prevent seed production, but forces vegetative reproduction. | | | | | | | | | |
| | Don't mow | Therefore, after mowing, monitoring and repeating the process is likely necessary. | | | | | | | | | |
| Flowering Period | | | | | | | | | | | |

Prohibited: Eradicate

Giant hogweed : *Heracleum mantegazzianum* Sommier & Levier



UGA1460060



UGA2121077



UGA5272016

Identification: Compare to native [cow-parsnip](#) (*Heracleum lanatum*). See page 53.

Plant: Herbaceous, biennial giant at 10-15 feet tall (potentially 20 feet). When flowering the second year, 2-4 inch diameter hollow stalks are mottled reddish-purple with sturdy bristles.

Leaves: Alternate, up to 5 feet across, compound leaves with 3 deeply incised (cut) leaflets which may be further divided. The spotted leaf stalks, underside of leaves and stems are covered with coarse white hairs.

Flower: Large, flat umbels of small white florets create massive displays up to 2½ feet in diameter.

Bloom time is June to July.

Fruit and Seed: Seed is large, flattened, with visible brown resin canals.

Life History: A single flower head can produce upwards of 1500 seeds. First season basal rosette foliage can be 1-5 feet across with flower stalks typically appearing in the second season. When plants die a large bare patch of soil results which creates a good seed bed and potential erosion problems.

Habitat: Moist soils of woodlands and riparian zones with partial shade as found on woodland edges.

Management:

Caution! Use protective clothing, goggles or face mask. **Caution!**

Phytophotodermatitis,

contact with bristles (stiff hairs) or sap of plants (i.e., phyto)
when combined with exposure to sunlight (i.e., photo)
can cause severe blistering and swelling (i.e., dermatitis).

Manual methods including cutting and removal by hand are effective on small infestations. The focus of this method is to prevent seed production. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

Root systems can be weakened by repeated cutting but consider removal for best results. After cutting, monitor sites for follow-up treatment needs.

Herbicide applications of triclopyr or glyphosate are effective when applied early season to basal rosettes. If manual methods such as cutting are used early in the season, plan on returning to chemically treat re-sprouts.



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| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|---------------------------|-----|------|------|--------------------------------|--------------------------|----------------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Foliar | Before the plant flowers. | | | | | | Treat rosettes | | |
| | Cut stem | | | | | | | | | |
| | Mow | | | | | | Cut and remove roots and | | | |
| | Don't mow | | | | | or seeds by hand for disposal. | | | | |
| Flowering Period | | | | | | | | | | |

Prohibited: Eradicate

Grecian foxglove : *Digitalis lanata* Ehrh.



Identification:

Plant: Herbaceous, perennial beginning its first year as a basal rosette with a single flowering stalk from 2-5 feet tall in subsequent years.

Leaves: Alternate, smooth, stalk-less upper leaves with toothless edges are narrow (lance-shaped). Basal leaves are more oval with rounded tips and are densely woolly.

Flower: Many tubular flowers attached to a central stalk (raceme) with bloom progression from the bottom to the top of the stalk. Flowers have a brown or purple veined upper hood and a creamy-white, elongated lower lip.

Bloom time is June to July.

Fruit and seed: Seed capsules are 2-parted and split to release tiny reddish-brown seed with 3-4 year viability. The hook (stiff, persistent style of the flower) on the seed pods are easily caught on clothing or fur and transported to new locations.

Life History: A perennial plant that blooms following its first year as a basal rosette. Each flower produces numerous seeds that are viable for up to 4 years. Small wingless seeds are easily transported by birds, animals, human activity as well as wind and water.

Habitat: Minnesota sites are in full sun to partial shade along roads, woodland edges and in open fields.

Management: **Caution!** Grecian foxglove contains toxins (cardiac glycosides) that potentially can be absorbed through the skin. These compounds are harmful to livestock and humans. Do not pull or handle this plant without protective clothing, in particular, rubber gloves and long sleeves are required.

Repeated mowing or cutting to prevent flowering throughout the year and over several years can drain plants of energy and help control an infestation. Since flowering can occur on mowed, short stems follow-up treatments with herbicide may be necessary.

Prescribed fire, there is no research information available at this time.

Herbicide applications in May and again in July are beneficial to knock down plants before flowering can occur. A fall application is also recommended to kill basal rosettes that were missed earlier or that developed during the season. Metsulfuron-methyl formulations are recommended for good control.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-------|-----|------|------|------|-------|------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Foliar | | | | | | | | | |
| | Cut stem | | | | | | | | | |
| | Mow | | | | | | | | | |
| | Don't mow | | | | | | | | | |
| Flowering Period | | | | | | | | | | |

Prohibited: Eradicate

Japanese hops : *Humulus japonicus* Siebold & Zucc.



Below left: Male flower structure.
Below right: Female flower structure.



Identification: Compare to native [common hops](#) (*Humulus lupulus*). See page 52.

Compare to native [cucumbers, wild and bur](#) (*Echinocystis lobata* and *Sicyos angulatus*). See page 54.

Compare to native [Virginia creeper/woodbine](#) (*Parthenocissus* spp.). See page 63.

Plant: Herbaceous, annual vine trailing on the ground or climbing vegetation and infrastructure. Stems are covered with downward pointing prickles.

Leaves: Opposite, 2-5 inches long and almost as wide, with 5-7 (maybe 9) palmate lobes. Compare to common hops: typically 3-lobed occasionally 5. Japanese hops leaves are rough and edges are toothed. Two bracts (stipules) are at leaf stalk bases and the leaf stalks (petioles) are as long or longer than the leaves.

Flower: Male flowers and female flowers are on separate plants (dioecious). Flowers are small and greenish to reddish, not showy. Male flowers are branched clusters (panicles) while the female flowers are drooping structures that are rather plump and composed of overlapping reddish bracts or scales (hops).

Bloom time is July into August.

Fruit and Seed: Single flattened seeds from each female flower. Each inflorescence produces several seeds that mature in September.

Life History: An annual plant germinating early spring and growing quickly as summer progresses. Vines quickly cover small trees and shrubs weighing them down to the point of breakage and limiting their sunlight. Japanese hops flower in July-August, seeds mature in September. Soon after a killing frost, fragile vines fall apart dispersing their seed.

Habitat: Tolerant of disturbed roadside conditions if there is moist soil. Species prefers conditions found in riparian areas including full sunlight and exposed soils that are moist and rich.

Management: **Caution!** Stem prickles are known to irritate the skin, long clothing and gloves are recommended.

Manual methods including **cutting** and **pulling**, while labor intensive, can be successful on small infestations. Efforts should be focused on early season work when plants are small and limited entanglement with surrounding vegetation or structures has occurred.

If the area is accessible to **mowers** and vines have limited structure for climbing, such as trees and fences, then **mowing** is an effective method to control maturity and seed production.

Herbicides include pre-emergent and post-emergent applications. Both are useful since this is an annual plant with prolific seed production capabilities. Pre-emergent should be applied prior to the growing season beginning in late March or early April. Once germination has occurred a switch to foliar applications should be made in an effort to keep plants from maturing and producing seed.

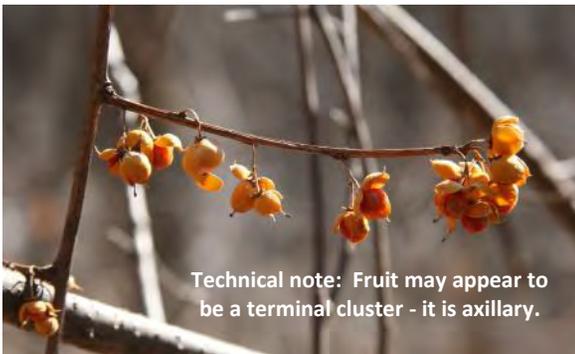
Below: Stem prickles



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-------------|-------|-----|------|------|------|-------|------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Post-emerge | | | | | | | | | |
| | Pre-emerge | | | | | | | | | |
| | Mow | | | | | | | | | |
| | Don't mow | | | | | | | | | |
| Flowering Period | | | | | | | | | | |

Prohibited: Eradicate

Oriental bittersweet : *Celastrus orbiculatus* Thunb.



Above: location of fruit is in leaf axils (where leaves attach to stem).

Identification: Compare to native [American bittersweet](#) (*Celastrus scandens*). See page 49.
Plant: Woody, twining, perennial vines up to 60 feet long, reaches tree tops and covers fences. Stem diameters of 4 inches documented in Minnesota.
Leaves: Alternate, fine rounded teeth on the leaf edge, dark green and shiny turning yellow in autumn. Typically, elliptical with a blunt leaf tip and nearly as wide as long at 2-5 inches.
Flower: Female flowers are small, inconspicuous, greenish clumped (3-7) in leaf axils along stems. Dioecious species, male and female flowers on separate plants. Male flowers are also axial but may be terminal. Compare white pollen on male flowers to *yellowish pollen* on *American bittersweet* flowers. Also, *American bittersweet* flowers are similar in size and color but are found **only terminal** on vine branches (on the ends).



Bloom time is May to June.

Fruit and Seed: Along the vine in leaf axils are potentially 3-7 yellowish, 3-parted capsules enclosing reddish-colored, 3-parted, berry-like arils. Each part contains 1-2 seeds; therefore, potential total of 3-6 seeds per fruit. Dioecious, separate fruiting (female) and non-fruiting (male) plants. *American bittersweet's* 3-parted fruit is more red, the 3-parted capsules more orange and fruits are terminal on the vine branches (on the ends).

Life History: Vegetative reproduction occurs from below-ground rhizomes, above-ground stolons and suckering of roots. Birds will eat the fruits (arils) during the winter and disperse the seeds. Seeds germinate late spring.

Habitat: Readily invades disturbed, open, sunny sites, yet Oriental bittersweet is moderately tolerant of shade allowing it to grow in open woodlands.

Management:

Prescribed fire research has shown that basal sprouting is stimulated and stand density increases dramatically.

Cutting of stems can be used to kill above ground portions of plants especially if the infestation is covering large areas or is climbing high into forest canopy. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#). Combine with herbicide applications for best results.

Herbicides that act systemically such as formulations of triclopyr or glyphosate can be applied as foliar, basal bark or cut stem applications. Foliar applications are reserved for easy to reach foliage, re-sprouting or along fence lines. Once foliage is out of reach, application to cut stems or basal bark will yield the best results.



Left above: greenish, female flower.
Left below: greenish male flower, note white pollen grains on anthers of the upper flower.



Right: Light brown seeds. Each structure is 3 parted and each part contains 1-2 seeds. Image shows 5 seeds from a single fruit.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|------------|----------------------------|-----|------|------|------|-------|------|------|----------|
| Herbicide | Burn | Burning is not recommended | | | | | | | | |
| | Basal Bark | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | Foliar | | ■ | ■ | ■ | ■ | ■ | | | |
| | Cut stem | | | | ■ | ■ | ■ | ■ | ■ | ■ |
| | | Mowing is not recommended. | | | | | | | | |
| | | | ■ | ■ | ■ | | | | | |
| Flowering Period | | | ■ | ■ | ■ | | | | | |

Prohibited: Eradicate

Palmer amaranth : *Amaranthus palmeri* S. Watson



Above: male plants have soft flower spikes, female flower spikes have sharp bracts (below - upper right).

Below: poinsettia-like foliage, white V-shaped markings (inset), and thick stems.



Identification: Palmer amaranth is one of several native pigweeds and is native to southwestern deserts of the United States. [Link: Pigweed Identification, a pictorial guide.](#)

Plant: Herbaceous, annual plant, a potential growth rate of 2-3 inches per day. Plants attain heights of 6-8 feet, potentially 10 feet. Stems are stout, up to 2 inches thick and without hairs (smooth). Top-view of plants as foliage develops resembles a poinsettia.

Leaves: Alternate, green color, some plants with white V-shaped markings on leaves. Elliptical to diamond-shaped leaf blades terminated by a small spine. Petioles up to 2-3 times longer than leaves, image at right.

Flower: Plants are dioecious with male and female flowers on separate plants. Flowers are not showy, but flower spikes are significant and useful in positive identification.

Bloom time is June to Sept. Flowers can occur 8 weeks post-emergence to end of season.

Fruit and seed: Seeds are dark colored and extremely small. Research shows pigweeds including palmer amaranth can produce upwards of 250,000 or more seeds per plant.

Life History: Seedling emergence can occur throughout the growing season; thus, flowering and seed set can persist late into the season. **Monitoring** is a necessary activity for control efforts. Seeds germinate in spring if within an inch of soil surface. Research on pigweeds suggests if seed is buried deeper than 3 inches viability is decreased annually with a potential longevity of approximately 3 years. Research on redroot pigweed (*A. retroflexus*) and waterhemp (*A. rudis*) suggests longevity can be as short as 3-4 years in Mississippi/Illinois or as long as 12 years in Nebraska.

Habitat: Native habitat is desert climate, species performs well during heat of summer. Pigweeds are shade intolerant.

Management: Preventing establishment is key. Proper identification and frequent scouting to limit seed production.

Repeated mowing or cutting are not effective at controlling Palmer amaranth infestations. Continue monitoring and consider alternative methods such as cultivation, manual methods like hand-pulling or herbicide applications.

Prescribed fire has the potential to kill seedlings and drain energy from maturing plants, but fire should be considered as a tool to strengthen the health and competitive advantage of the desirable plant community.

Biotypes have shown resistance to **herbicides** in groups 2, 3, 5, 9 and 27 (Group number - check herbicide labels). Yet, **herbicide** applications both pre- and post- emergent are possible. Roger Becker (Univ. of MN, Agronomist) provided the following comment: "There are many products that will control the pigweed group across the different labeled sites, but the challenge will be knowing what the resistance of the particular biotype is that gets here (Minnesota), if at all. Many of the standard ROW (right-of-way) broadleaf materials will control non-resistant palmer."

Useful herbicides in group 4 include 2,4-D, aminocyclopyrachlor, aminopyralid, clopyralid, and dicamba. Group 2 herbicides include imazapyr, imazapic, metsulfuron and sulfometuron. Nonselective glyphosate, group 9 and glufosinate, group 10 can be used depending on crop tolerance traits or desired vegetation outcomes for non-cropland sites.



White petiole bent back over a green leaf blade.

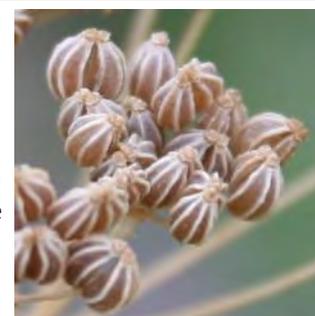
For best results, treat plants when they are small, under 1 foot tall.

As plants mature, use approved higher rates of herbicides.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-------------|---|-----|------------------------------|------|------|-------|--|------|----------|
| | Burn | Use fire to improve environment for competing native plant community. | | | | | | | | |
| Herbicide | Post-emerge | | | | | | | | | |
| | Pre-emerge | | | | | | | | | |
| | Mow | | | If seed present, do not mow. | | | | | | |
| | Don't mow | | | | | | | Follow-up mowing to control seed production. | | |
| Flowering Period | | | | | | | | | | |

Prohibited: Eradicate

Poison Hemlock : *Conium maculatum* L.



Caution All plant parts are **poisonous to humans** and livestock. **Caution**

It is reported that toxin can be absorbed through bare skin! Wear appropriate PPE.

Identification: Compare to [wild carrot](#) and native [water hemlock](#) on pages 38 and 64. Also compare to [carrot look-alikes](#), [wild chervil](#) and [common yarrow](#) on pages 45, 46 and 65.

Plant: Herbaceous, biennial, first year as a basal rosette and second year poison hemlock is a branched, 3-7 feet tall, robust plant. Stems are smooth (no hairs), hollow, appear ridged due to veins and are light green, mottled (spotted) with purplish spots.

Leaves: Alternate, generally triangular in form. Doubly or triply pinnately compound up to 18 inches long by 12 inches wide. Leaflets are fern-like, deeply divided and typically twice as long (2 inches) as wide (1 inch). Basal leaves tend to be larger and have longer petioles than upper stem leaves. Petiole to stem attachments are covered by a sheath.

Flower: Flat or slightly dome-shaped open compound umbels of 3-16 umbellets with 12-25 five-petaled, white florets. There are small ovate-lanceolate bracts with elongated tips under main umbels. Bracts are also present under umbellets.

Bloom time is variable - June to August.

Fruit and Seed: Paired seeds are 1/8 inch tall schizocarps, these split at maturity becoming two carpels. Each carpel is a seed, flattened on 1 side and lined vertically by broken ridges described as wavy ribs. There are no hairs.

Habitat: Partial shade is tolerated but preference is full sun with moist fertile soils. Often found near water or in riparian zones. Can tolerate drier conditions.

Management:

If performed frequently **cutting** or **mowing** are effective control methods to prevent seed production. Same is true for hand pulling, however roots and root fragments remaining in soil may resprout. Monitor and plan additional treatments.

Prescribed fire as a tool should be used to improve the health of surrounding native vegetation. Fire will kill seedlings and top kill other plants; however, after the fire healthy root systems will likely resprout.

Foliar herbicide applications to plants at rosette stage or during active growth (before flowering). Herbicide formulations with 2,4-D or 2,4-D including dicamba or triclopyr have produced good results. Nonselective herbicides such as glyphosate (concentration of 41% or greater) formulations can also produce results.

Other potential choices are formulations including aminopyralid, chlorsulfuron, clopyralid, dicamba, imazapic, imazapyr, metsulfuron-methyl or 2,4-D plus picloram.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|-----------|-------|--|----------------------|------|------|-------|------|------|----------|--|
| | Burn | | Stimulate surrounding vegetation | | | | | | | | |
| Herbicide | Foliar | | Target pre-flower. | | | | | | | | |
| | | | Target rosette | | | | | | | | |
| | Mow | | Mowing must be repeated to prevent flowering | | | | | | | | |
| | Don't mow | | | When seed is present | | | | | | | |
| Flowering Period | | | | | | | | | | | |

Prohibited: Eradicate

Yellow starthistle : *Centaurea solstitialis* L.



A member of the knapweeds, genus [Centaurea](#).

Identification:

Plant: Herbaceous, annual with heights of 6 to 36 inches. Plants start as a biennial or winter annual with a basal rosette the first season. Mature plants are described as bushy with a grayish or bluish cast to otherwise green color.

Leaves: Basal leaves are lobed, dandelion-like at about 8 inches. Basal leaves may not persist as plants bolt to flower. Stem leaves are alternate, narrow to oblong and an extended leaf attachment provides a winged appearance to stems.

Flower: Approximately 1 inch long flowers with substantial 3/4 inch yellowish spines emanating from bracts beneath flowers. Flowers are terminal and solitary on stems.

Bloom time is June to August.

Fruit and Seed: Each terminal flower produces between 35 to 80 plumeless or plumed seeds.

Life History: Yellow starthistle is a strong invader. Due to a lack of tufting on some seeds, reliance is on animals and humans for movement any distance from parent plants.

Habitat: Periods of summer drought favor infestations on disturbed sites such as roadsides. Also an invader of prairies, fields, woodlands and pastures where spines can cause injury to grazing animals.

Management: **Caution!** Gloves and long sleeves are recommended. Knapweeds have chemical and in some species physical defenses. These are known skin irritants.

Limit movement of seed on grazing animals, mowing equipment and vehicles.

Eradication is the goal in Minnesota; therefore, biological control is not a compatible option at this time.

Mowing, monitor infestations and time mowing at early flowering stages, soon after spine development.

Herbicide formulations of aminopyralid, clopyralid or picloram applied as foliar applications early in the growing season appear to be most effective.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-------|-----|------|------|------|-------|------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Foliar | | | | | | | | | |
| | Cut stem | | | | | | | | | |
| | Mow | | | | | | | | | |
| | Don't mow | | | | | | | | | |
| Flowering Period | | | | | | | | | | |

Prohibited: Eradicate

Knapweed complex : *Centaurea* spp.



Top: Brown Knapweed, images Bugwood.org
 Middle: Meadow knapweed, images T. Jacobson
 Below: *Spotted* (left), *Diffuse* (center), *Russian* (right)
 Image: Bugwood.org.



Prohibited: Eradicate Brown knapweed: *Centaurea jacea* L.
 Prohibited: Eradicate Diffuse knapweed: *Centaurea diffusa* Lam.
 Prohibited: Eradicate Meadow knapweed: *Centaurea x moncktonii* C. E. Britton [*jacea* x *nigra*]
 Not listed *Russian knapweed*: *Acroptilon repens* (L.) DC. - synonym: *Centaurea repens* L.
 Prohibited: Control *Spotted knapweed*: *Centaurea stoebe* L. ssp. *micranthos* (Gugler)

Advice, *spotted knapweed* is established in Minnesota. Learn to identify it and recognize when something is different.
 Please report infestations that are not easily identified as spotted knapweed to
 Early Detection and Distribution Mapping System *EDDMaps* or Minnesota Department of Agriculture's *Arrest the Pest*.
 Compare knapweeds on pages 15, 16 and 17. Compare to *thistles* (pages 19, 20, 47 and 62) and *alfalfa / vetches* (pages 43 and 50).

Identification:

| Species / Characteristic | Brown | Diffuse | Meadow | Russian (Not Listed in Minnesota) | Spotted (Prohibited: Control) |
|--------------------------|---|--|---|---|--|
| Root Types | Short-lived perennial, | Short-lived perennial, tap root | Short-lived perennial, | Long-lived perennial, creeping perennial, root spread horizontal. | Short-lived perennial, tap root. |
| Bracts | Brown, with a tan papery tip (edge) | Rigid, spine-like tips | Long fringed (insect-like) Coppery, shiny (mature). | Rounded bracts, smooth papery transparent tips | Darkened tip, short fringe. |
| Flowers | Rose to Purplish, 1-1½ inch wide. | Variable - white to rose Occasionally purplish | Rose to purplish ¼ inch wide. | Pink to lavender ⅝ to ½ inch | Pinkish, cream is rare Approximately 1 inch |
| Leaves | Not as deeply lobed as spotted knapweed | Basal leaves deeply and finely, divided with wide lobes. | Basal leaves mostly unlobed, smooth. | Basal leaves are seldom divided, roughly fuzzy. | Gray-green, Deeply lobed leaves, roughly fuzzy |
| Habitats | Prefers moist cooler soils. | Dry soils, disturbed sites | Moist soils, wet prairies | Dry to moist soils, saline soils, disturbed sites | Dry to moist soils, disturbed sites |

Table adapted from sources: <http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/Brochures/knapweed.pdf>
<http://bugwoodcloud.org/mura/mipn/assets/File/KnapweedBrochure072814WEB.pdf>

Plants: Herbaceous, typically short-lived perennials or biennial. Knapweeds ascend from woody root crowns and reach heights of 8 to 32 inches. Typically, multi branched with solitary, terminal disk flowers.

Leaves: Simple, alternate, green foliage. *Spotted* knapweed has foliage with fine hairs and a blue-gray color, while *meadow* knapweeds foliage is smooth and a green color. Some species are deeply lobed (*spotted*) while others like *brown knapweed* may not be lobed. In all species, basal leaves tend to be larger than the lance-shaped leaves above.

Flower: Flower colors varying from white to purplish make color a less reliable species identifier. Typically flowers are solitary, terminal to branches, purplish disk flowers that are surrounded by 5-petaled florets. Bracts that cover the bulb-like bases of flowers are 2-parted and the bract characteristics are diagnostic to species, especially the bract tips. Refer to the table above for comparison.

Prohibited: Eradicate

Knapweed complex : *Centaurea* spp.



Top: Brown knapweed
Images: Bugwood.org

Middle: Meadow knapweed
Images: Tom Jacobson, MnDOT.

Bottom left: Diffuse knapweed
Image: Bugwood.org

Bloom time is June to September.

Fruit and seed: Small (less than 1/8 inch) (2-3 mm), some have short, bristly hairs (pappus) at the top. A typical achene (seed) of the Aster family but pappus is limited and wind will not carry seeds.

Life History: Reproduction is by seed which can be moved by water, animals, and birds. Human activities are significant transporters of seed in products like mulch, soil or hay and straw. Seed is also potentially moved on construction or farm equipment, recreational vehicles, as well as on personal automobiles, clothes and recreational gear. Depending on species, seed viability can be up to eight years.

Currently unlisted and not known to be in Minnesota, Russian knapweed is a long-lived perennial with deep roots, potentially to 20 feet. Its roots are dark colored and scaly. Russian knapweeds foliage is blue-gray and has fine hairs, similar to spotted knapweed. It is reported that seed production of Russian knapweed is 'limited' but infestations spread aggressively by roots.

Habitat: *Brown and Meadow knapweeds* prefer moist soil types found along water, wet grasslands or meadows, irrigation ditches, roadsides and openings in woodlands. In contrast, other knapweeds tolerate drier sites such as old fields, road and rail right-of ways, gravel pits or similar disturbed areas.

All prefer full sun locations with the exception of *brown knapweed being tolerant of partial shade.*

Threat to Minnesota: potential development of hybrids that can take advantage of intermediate niches.

Management: **Caution!** When handling knapweed plants gloves and long sleeves are recommended since knapweeds have defenses that are known skin irritants.

Hand pulling or digging while time consuming can be an effective step when coupled with chemical treatments. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal.](#)

Repeated mowing or cutting can reduce seed production, but sites must be monitored and applications likely repeated or followed up with herbicide treatments.

Prescribed fire can be used to encourage stands of native grasses that will compete with knapweeds. However, monitoring is needed to check for knapweed germination in bare soil soon after burns are completed.

Herbicide foliar applications with formulations including aminopyralid, clopyralid, or picloram have proven effective in controlling knapweeds.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|-----------|--------|------------------------------------|------|------|------|-------|------|------|----------|--|
| Herbicide | Burn | Yellow | Yellow | | | | | | | | |
| | Foliar | | Foliar treatments target rosettes. | | | | | | | | |
| | Cut stem | | | | | | | | | | |
| Flowering Period | Mow | Green | Green | | | | | | | | |
| | Don't mow | | | Red | Red | Red | Red | Red | | | |

Prohibited: Control

Spotted knapweed : *Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek



Above: basal rosette,
Middle right:
basal foliage,
Middle Left: linear foliage
near top of plant,
Bottom right: flowers.

Identification: Compare to [knapweed complex](#) members. See pages 15 and 16.

Compare to nonnatives [alfalfa](#) and [hairy vetch](#). See page 43.

Advice, spotted knapweed is established in Minnesota. Learn to identify it and recognize when something is different.

Plant: Herbaceous, short-lived perennial living 1-4 years. Initial stage is a rosette before the plant produces 1-6 stems ranging from 1-4 feet tall.

Leaves: Simple, alternate, grayish-green basal rosette leaves up to 6 inches long have deep sinuses. Alternate leaves on mature stems vary from smaller, 1-3 inch, versions of the basal leaves to very small linear leaves near the top.

Key difference: meadow / brown knapweed - green leaves, lacking lobes.

Flower: Strongly resemble the flowers of thistles in their pink to purple color (rarely white) and multi-parted texture. Below the petals, flowers are held together by bracts that are stiff and tipped with darkened hairs (see image above).

Compare bract tips; brown - brown, tan papery edge; diffuse - rigid, sharp spines - terminal spine can be 1/2 inch long; meadow - long fringed; Russian - rounded, opaque with transparent tips; and spotted - dark tip, short fringe.

Bloom time is July to September.

Fruits and Seed: Small (1/8 inch long), brownish, tufted, seeds.

Life History: Allelopathic properties (chemicals exuded by the plant) can suppress the germination of seeds of other plants nearby. Plant removal can lead to bare patches of soil subject to erosion.

Seeds are the primary means of reproduction and a mature plant produces thousands of seeds that may remain viable for up to 5 years. Wind disperses seeds short distances while animal and human activity disperse it far and wide.

Habitat: In contrast to meadow knapweed's preference to moist sites, spotted knapweed prefers disturbed sites with gravelly or sandy dry soils. Roadsides, abandoned lots, old fields and gravel pits are habitat that support infestations.

Management: **Caution!** Knapweeds are known skin irritants, therefore; if handling knapweed plants gloves and long sleeves are recommended.

Biological controls approved for use in Minnesota are seedhead weevils (*Larinus minutus* and *L. obtusus*) and a root-boring weevil (*Cyphocleonus achates*). Weevils are collected July through September and released on infestation sites larger than 1/3 acre. When a combination of seedhead and root boring weevils work together, infestations can be reduced over a number of years.

While **cutting, mowing** and **prescribed fire** can encourage competition from native grasses and help reduce the extent of an infestation they will likely not eradicate it. Early spring prescribed fire is compatible with biological control.

Herbicide formulations including aminopyralid, clopyralid, glyphosate, imazapyr, aminocyclopyrachlor or picloram have demonstrated control with foliar applications.



Compare flower similarities to [Canada thistle](#), page 19.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|-----------|--------|------------------------------------|-------|------|------|-------|------|------|----------|--|
| Herbicide | Burn | Yellow | Yellow | | | | | | | | |
| | Foliar | | Foliar treatments target rosettes. | | | | | | | | |
| | Cut stem | | | | | | | | | | |
| | Mow | | Green | Green | | | | | | | |
| | Don't mow | | | | Red | Red | Red | Red | Red | Red | |
| Flowering Period | | | | | Red | Red | Red | Red | | | |



Identification: Compare to [Japanese barberry](#) on pages 32-33 and [Korean barberry](#) on page 33.

Plant: Deciduous shrub reaching 8-10 feet in height and up to 6 feet in width. Slender branches are straight between nodes, strongly grooved and common barberry may have single or multi-branched spines, usually 3-branched possibly 5. Bark on second year stems is gray as opposed to reddish second year branches of Korean barberry.

Key difference - *Japanese barberry spines, usually single maybe 3-branched. Korean has 1-5 (7), often 3, flat spines.*

Leaves: Alternate, but clustered not appearing alternate, simple leaves are ovate, narrow near the base, toothed on the edges, described as finely serrate, as few as 8, often 16 to 30 spiny teeth. In particular, young shoots have spiny leaves.

Key difference - *Japanese barberry leaves have smooth edges (no teeth). Korean barberry has toothed leaf edges.*

Flower: Drooping, 1-2 inch long clusters (racemes) of 10-20 yellow, ½ inch long flowers. Flowers are somewhat showy, however; fragrance is not described as pleasant.

Key difference - *Japanese barberry has 1-4 flowers hanging in loose clusters. Korean barberry has 10-25 flowers.*

Bloom time is May to June.

Fruit and Seed: Fruit is an oblong berry, up to ½ inch long, bright red and fleshy. Berries persist into and through winter. Each fruit contains 1-3 seeds. Based on studies in Minnesota and North Dakota the US Forest Service fire effects database indicates seed viability of 7-9 years in soil.

Key difference - *Japanese barberry berries are ¼ to ⅜ inch long with dry flesh. Korean barberry has ¼ inch fleshy berries and fruits are more rounded - not as oblong.*

Life History: Most propagation is by seed dispersal. Birds are a primary disperser. Vegetative reproduction is important to persistence. Mainly through sprouting from rhizomes and lower branches may root at points of ground contact.

Habitat: Typically, found in open or lightly shaded woods. Also found in pastures, fencerows and roadsides in full sun.

Management:

Cutting or mowing can be effective once mature shrubs are removed. Follow-up with frequent mowing to control regeneration or utilize other treatments as needed.

Repeated **prescribed fire** can damage above ground parts and drain energy from shrubs; however, resprouting will likely occur. Monitor after fire and follow up as necessary with additional treatments.

As with most woody species, there are several methods to apply **herbicide**. **Foliar** applications should be made when plants are fully leafed out and for best effect while plants are fruiting. Active ingredients include dicamba + 2,4-D, glyphosate, metsulfuron-methyl and triclopyr. **Cut stump** treatments using glyphosate or triclopyr will likely be successful and **basal bark** treatments with triclopyr or imazapyr formulations are also effective.



Above: common barberry spine variations.



Above: common barberry leaf variations.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|-----------|------------------|--|--------------------------------------|--|------|------|-------|------|------|----------|--|
| Herbicide | Burn | Yellow | Yellow | Yellow | | | | | | | |
| | Foliar | | | When fully leafed out and when in fruit. | | | | | | | |
| Herbicide | Basal Bark | Any time. | | | | | | | | | |
| | Cut stem | Any time except during heavy sap flow. | | | | | | | | | |
| | Mow | | Mow frequently to control seedlings. | | | | | | | | |
| Herbicide | Don't mow | | | | Red | Red | Red | Red | Red | | |
| | Flowering Period | | Light Red | | | | | | | | |



Identification: Compare to native [swamp thistle](#) (*Cirsium muticum*). See page 62.

Compare to nonnative [musk thistle](#) (*Carduus nutans*). See page 47.

Compare to nonnatives [alfalfa](#) and [hairy vetch](#). See page 43.

Compare flower similarities to [spotted knapweed](#), page 17.

Plant: Herbaceous, perennial with grooved, non-spiny, hairy and typically upright stems to a height of 2-6+ feet tall.

Leaves: Alternate, simple, pinnately lobed leaves that are generally lance-shaped. The leaves are irregularly lobed, with toothed, spiny edges. The leaves are stalkless (sessile) and at maturity are downy or hairy on the underside.

Flower: Male and female (dioecious) 3/4 inch flowers occur singly on the end of branches. The disk or composite inflorescence is comprised of numerous purple to pinkish small florets. Bracts below the inflorescence do not have spines on the tips.

Bloom time is June to October.

Fruit and Seed: Tufted light brown seeds are easily dispersed by wind.

Do not mow after seed has developed as this strongly aids seed dispersal.

Life History: Reproduction can occur from seed, root cuttings and from rhizomes. Clonal stands are common and spread significant from roots that can grow horizontally 10-12 feet per year.

Habitat: A successful inhabitant of disturbed areas such as roadsides and old fields but will also move into open woodlands and prairies. This species is also found where water levels fluctuate such as in wet meadows, along stream banks and ditches.

Management:

A **biological control** is under investigation, stem-mining weevil (*Ceutorhynchus litura*). This insect is available from commercial vendors and is acceptable for distribution in Minnesota.

Cutting or mowing should target plants that are approximately 3 inches tall and the process must be repeated throughout the season to maintain the plants at 3 inches or less in height. Continuing this approach for several years can drain the plants of reserves.

Repeated **prescribed fire** can be used to encourage stands of native grasses that will outcompete thistle. However, monitoring is needed to check for thistle that germinates in bare soil soon after burns are completed.

Herbicide foliar sprays with formulations of clopyralid, aminopyralid, or metsulfuron-methyl. These foliar applications are made as the plants bolt, prior to flower set, or in late summer/early autumn to rosettes.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-----------|-------------|-------------|-----------|-----------|-----------|-----------|------|----------|
| Herbicide | Burn | Yellow | Yellow | Yellow | | | | | | |
| | Foliar | Dark Blue | Dark Blue | | | | Dark Blue | Dark Blue | | |
| | Cut stem | | Dark Purple | Dark Purple | | | | | | |
| | Mow | | Dark Green | Dark Green | | | | | | |
| | Don't mow | | | | Red | Red | Red | Red | Red | |
| Flowering Period | | | | Light Red | Light Red | Light Red | Light Red | Light Red | | |



Identification: Compare to native [swamp thistle](#) (*Cirsium muticum*). See page 62.
 Compare to nonnative [musk thistle](#) (*Carduus nutans*). See page 47.
 Compare to nonnatives [alfalfa](#) and [hairy vetch](#). See page 43.

Plant: Herbaceous, biennial reaching heights of 1-4 feet. Unlike native thistles, the stems of plumeless thistle are winged and spiny.

Leaves: Edges of rosette leaves are wavy with yellowish spines. Stem leaves are alternate, attached directly to stems and typically have hairs on bottoms along mid-veins.

Flower: Numerous stem branches support terminal, single, composite flowers that are ½ to 1½ inches wide. Linear or narrow bracts with short spines are found immediately below pink to purple flowers.

Bloom time is July to October.

Fruit and Seed: Small seeds approximately 1/16 inch long described as straw colored and tufted with fibers on the terminal end. The fibers aid in wind dispersal.

Life History: Reproduction is by seed and seeding is prolific building a large seed bank in a short period of time. Thus, control measures should focus on eliminating seed production and exhaustion of seed banks. Movement is greatly increased by animal and/or human activities such as mowing or haying.

It is reported that musk thistle (*Carduus nutans*) and plumeless thistle hybridize.

Habitat: Found on dry to moist soils in pastures, woodlands, waste areas, along roadsides, ditches and stream banks.

Management:

Cutting taproots 1-2 inches below ground is effective but time consuming for large numbers of plants. **Mowing** should be timed at flower bud stage to prevent seed production and should be repeated 2-3 times per season to be effective. Avoid spreading seed with hay or straw and with mowing and vehicle movement through infestations.

Prescribed fire can be used to encourage stands of native grasses that will outcompete thistle. However, monitoring is needed to check for thistle that germinates in bare soil soon after burns are completed.

Herbicide applications timed at the early bolting phase are foliar applications of 2,4-D ester or dicamba formulations. For foliar applications at the budding to flower stage or fall applications to basal rosettes turn to formulations of aminopyralid, clopyralid, metsulfuron-methyl or triclopyr.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-----------|-----------|-----------|------|------|--------|-----------|-----------|----------|
| Herbicide | Burn | Yellow | Yellow | Yellow | | | Yellow | Yellow | Yellow | |
| | Foliar | Dark Blue | Dark Blue | Dark Blue | | | | Dark Blue | Dark Blue | |
| | Cut stem | | | | | | | | | |
| | Mow | | Green | Green | | | | | | |
| | Don't mow | | | | Red | Red | Red | Red | Red | |
| Flowering Period | | | | | Red | Red | Red | Red | | |

Prohibited: Control

Leafy spurge : *Euphorbia esula* L.



Above: Flower and bracts.
Right: Cut stem exuding white latex.



Squares = 1/4 inch.



Identification: Similar to *invasive cypress spurge* (*E. cyparissias*). Due to bloom period overlap confused with *introduced yellow rocket* (*Barbarea vulgaris*). Compare to *yellow rocket*, page 48.

Plant: Herbaceous, perennial to 3 feet tall. *Cypress spurge* is 8-14 inches tall. Broken stems of many *Euphorbia* spp. produce a milky sap (latex) that is a good identification characteristic.

Leaves: Alternate, linear to lance-like, bluish-green and 1-4 inches in length. *Cypress spurge* leaves are approximately 1 inch in length, alternate or whorled and narrower than leafy spurge leaves.

Flower: There are no petals or sepals on the small yellowish-green flowers. Upper stem leaves or bracts develop just below flowers and are yellow-green in color providing the appearance of yellowish petaled flowers. The bracts develop before the true flowers.

Bloom time is May to August.

Fruit and Seed: Three-celled capsules that expel seeds up to 20 feet. Each cell contains a seed.

Life History: Leafy and cypress spurge reproduction can be vegetative from buds on roots, rhizomes and root cuttings. The ability to reproduce vegetatively makes these plants difficult to control. Deep roots to 21 feet and extensive horizontal roots allow plants to store vast reserves providing the ability to recover after removal attempts. Seed production is significant with plants producing on average 140 seeds per stem. Seeds can remain viable in the soil up to 8 years.

Habitat: Leafy and cypress spurge readily invade dry sites in full sun, but tolerance of a range of conditions allows them to invade moist, rich soils as well.

Management: **Caution!** Some people are sensitive to the sap of spurges and develop skin rashes after pulling or handling plants, so gloves and long clothing are recommended. The milky sap is toxic to cattle and horses.

Biological controls are available for controlling leafy spurge. Flea beetles (*Aphthona lacertosa*) are widely used in Minnesota. Flea beetles are collected late May to early June and released on infested sites larger than 1/3 acre. Additionally in Minnesota, stem and root boring beetles (*Oberea erythrocephala*) provide some control. Early spring prescribed fire is compatible with biological control on this plant species.

Cutting or mowing if timed before flower development can reduce or limit seed production. Grazing goats and sheep can effectively limit the spread of infestations.

Prescribed fire is another tool that helps drain plants of reserve energy. Control of spurges typically requires a multi-tactic approach - eliminate or reduce seeding, exhaust seed banks, and drain reserves of existing plants while attempting to encourage native plants for competitive cover. So, consider spring mowing or fire with a fall application of imazapic.

Herbicide controls are applied as foliar applications and usually involve formulations of aminocyclopyrachlor, picloram, 2,4-D, glyphosate, dicamba, or imazapic. Repeated applications are likely necessary.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-----------|-----------|--------|------|------|-----------|-----------|--------|----------|
| Herbicide | Burn | Yellow | Yellow | Yellow | | | | Yellow | Yellow | |
| | Foliar | Dark Blue | Dark Blue | | | | Dark Blue | Dark Blue | | |
| | Cut stem | | | | | | | | | |
| | Mow | Green | Green | | | | | | | |
| | Don't mow | | | Red | Red | Red | Red | Red | Red | |
| Flowering Period | | | Pink | Pink | Pink | Pink | | | | |



Left: Leafy spurge
Right: Cypress spurge.

Prohibited: Control

Narrowleaf bittercress : *Cardamine impatiens* L.



Identification:

Plant: Herbaceous, annual or biennial starting its first season as a basal rosette and in the second season sending up a smooth flower stem to approximately two feet in height.

Leaves: Basal rosette leaves are pinnately compound with 3-11 round lobed leaflets. Alternate leaves on flowering stems, while still pinnately compound, likely will not have rounded lobes but 6-20 lance or arrowhead shaped leaflets. Edges of flowering stem leaves may be smooth or sharply toothed.

An important differentiation from other plants can be found at the point where leaves attach to stems, look for narrow pointed ears or auricles that grasp and may extend beyond stems.

Flower: Small (0.1 inch), white 4-parted flowers. White petals may not be present.

Bloom time is May to August.

Fruit and Seed: Similar to other mustard family members, seed pods are long (0.6 - 0.8 inch) and slender. Seed ripens from May to September and is dispersed short distances from plants.

Life History: Reproduction is by seed. Seed pods average 10-24 seeds and individual plants can produce thousands of seeds. Movement of seeds is aided by water, animals and human activities.

Habitat: Moist woodlands, forested areas and on margins of thickets. River bottom sites, streambanks and other moist areas are very good habitat and provide avenues for dispersal. This species can tolerate a variety of conditions and has been reported in areas such as roadsides, vacant lots, as well as yards and gardens.

Management: Recommendations at this time focus on hand pulling infestations.

Good advice from the Minnesota Department of Agriculture in reference to controlling narrowleaf bittercress;

“Following guidelines for controlling other biennial mustards such as garlic mustard, *Alliaria petiolata*, may be helpful.”

Hand pulling timed to prevent flower and/or seed production is recommended. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#). Subsequent re-treatments will be required due to germination and recruitment from the seedbank. If infestations are large or dense, consider the need for ground cover to prevent erosion and to provide competing vegetation.

Prescribed fire in spring to top-kill basal rosettes and seedlings. Follow-up treatment with **herbicide** is imperative after seedling germination to further slow growth of infestations.

Herbicide applications to foliage with formulations of triclopyr, metsulfuron-methyl, or imazapic. Use glyphosate or 2,4-D after native plants have entered dormancy and narrowleaf bittercress is still active.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Herbicide | Burn | Yellow | Yellow | | | | | | | |
| | Foliar | Dark Blue | | | | | | Dark Blue | Dark Blue | Dark Blue |
| | Cut stem | | | | | | | | | Dark Blue |
| | Mow | Green | Green | | | | | | | |
| | Don't mow | | | Red |
| Flowering Period | | | Light Red | | | |



Listing includes European wand loosestrife (*Lythrum virgatum* L.).

Identification: Compare to native [fireweed](#) (*Chamerion angustifolium*). See page 55.

Plant: Herbaceous, wetland perennial, 4-7 feet tall with a 4 to 6 sided wood-like stem.

Leaves: Opposite, sometimes whorled, lance-shaped, and downy with a slightly wavy yet smooth edge. Leaf pairs are positioned at right angles to the leaf pairs above and below.

Flower: Each plant can have from one to many spikes of pinkish-purple flowers. Center of the flower is yellowish and surrounded by 5-7 petals that have a wrinkled appearance.

Bloom time is July to September.

Fruit and seed: Tiny seeds are released from 2-parted capsules.

Life History: Reproduction by seeds and rhizomes produce large monoculture infestations.

Habitat: Purple loosestrife can be found on upland sites but is best known as an invader of wetlands or aquatic habitats such as ditches, wet meadows, ponds, marshes, river and stream banks as well as lake shores. Purple loosestrife disrupts aquatic habitats as it displaces wetland emergent species.

Management:

Biological controls in the form of two leaf feeding beetles of the same genus (*Galerucella calmariensis* and *G. pusilla*) have been very effective in Minnesota.

Mowing is seldom an option due to wet environments. **Cutting** of flower spikes can be an effective control of seed production. **Hand pulling** or **digging** of plants can also be effective but care should be taken to remove entire root systems if possible. Resprouting can occur from roots and root segments left in the ground or on the site. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

Herbicide formulations labeled for use on rights-of-way and near water; 2,4-D, glyphosate, imazamox, metsulfuron-methyl+aminopyralid, triclopyr, imazapyr and aminocyclopyrachlor.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-------|-----|------|------|------|-------|------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Foliar | | ■ | ■ | ■ | ■ | ■ | ■ | | |
| | Cut stem | | | ■ | ■ | | | | | |
| | Mow | | ■ | ■ | ■ | | | | | |
| | Don't mow | | | | | ■ | ■ | ■ | ■ | |
| Flowering Period | | | | | ■ | ■ | ■ | | | |



Identification: Compare to native [goldenrods](#) (*Solidago* spp.). See page 57.

Plant: Herbaceous, perennial reaching 2-5 feet in height. Stems appear woody, are slightly hairy to smooth and at the base are purplish-red.

Leaves: Alternate, pinnately divided, toothed on edges and 2-12 inches long, typically smaller near the top of plants. Leaves are strongly aromatic when crushed.

Flower: Single stems support multi-branched, flat clusters of bright yellow button-like flowers. Each ¼-½ inch wide button is comprised of many small florets and the flower heads, like the leaves, are strongly aromatic.

Key difference - Note the lack of ray petals surrounding the flower heads.
Compare to [goldenrods](#) which have ray petals.

Bloom time is July to October.

Fruit and seed: Small, yellowish-brown, dry, 5-toothed crowned seeds.

Life History: Reproduction is both vegetative from rhizomes and root fragments or by seed. Seeds are dispersed by wind, water and human activities such as vehicle traffic and mowing.

Habitat: Found most often in open, disturbed areas typical of stream and river banks, trail edges, roadsides, gravel pits and old farmsteads or pastures. Can be found in riparian areas, but most often in dry, well drained soils in full sun.

Management: **Caution!** The alkaloids contained in common tansy are toxic to livestock and humans if consumed in quantity. Toxins can potentially be absorbed through skin, gloves are recommended when handling or pulling this plant.

Mechanical methods like **tilling** can spread common tansy by spreading small root segments. **Pulling** also may leave root segments in the ground which may resprout.

Cutting or **mowing** to prevent seed production can be effective and should be timed just prior to flowering.

Prescribed fire can eliminate competition and create favorable conditions for common tansy by opening the canopy and preparing bare soil. Thus, fire can make an infestation worse; however, fire can be used to remove dead material to improve follow-up herbicide application providing better contact and potentially better control.

Herbicide formulations of metsulfuron-methyl, imazapyr, glyphosate or 2,4-D provide good control when applied as foliar applications in spring.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|-----------|-------|------------------------------------|------|------|------|-------|------|------|----------|--|
| Herbicide | Burn | | | | | | | | | | |
| | Foliar | | Foliar treatments target rosettes. | | | | | | | | |
| | Cut stem | | | | | | | | | | |
| | Mow | | | | | | | | | | |
| | Don't mow | | | | | | | | | | |
| Flowering Period | | | | | | | | | | | |



Identification: Compare to [golden alexanders](#) (*Zizia aurea*) and [heart-leaved golden alexanders](#) (*Z. aptera*), both native. See page 56.

Plant: Herbaceous, classed as a monocarpic perennial (plant dies after bearing fruit). Early life form is a basal rosette with mature stems developing a hollow, grooved flowering stalk potentially reaching 5 feet.

Leaves: Basal rosette leaves can be 6 inches in height and are pinnately compound with 5-15 leaflets. Flowering stalk leaves are alternate, 2-5 leaflets that become smaller near the top of the stem. Leaflets are coarsely toothed, sinuses cut to varying depths creating lobes of various sizes. The base of the leaf stalks wrap or clasp the grooved stem.

Flower: 12-35, 5-petaled, small yellow flowers on wide, flat umbels of 15-25 umbellets approximately 2 to 6 inches across.

Fruit and Seed: Flattened, yet ridged, oval seeds.

Bloom time is June to July.

Life History: Typical life span is two years, first year a basal rosette. At this stage, it is one of the first plants to green up in the spring and one of the last to brown down in autumn providing good opportunities for scouting and treating. Mid to late summer, mature second-year plants will bolt, flower and set dozens of seed per plant. Seeds are moved off infested sites by animal and human activity or wind and water movement. Seed is reported to be viable in soil for up to 4 years.

Habitat: Disturbed sites such as roadsides and abandoned fields or lots. Can occur in wet meadows but dry to mesic soils are more typical. Full to partial sun is a must for this species.

Management: **Caution!** Use protective clothing, goggles or face mask. Contact with the sap of the plant (i.e., phyto) when combined with exposure to sunlight (i.e., photo) can cause severe blistering and swelling (i.e., dermatitis) - phytophotodermatitis.

If **cutting** or **mowing** after seed set, clean equipment to leave seeds on the infested site. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#). If a site is mowed early in the season it must be monitored as plants will likely re-sprout, bolt and flower.

Prescribed fire can be used to encourage stands of native grasses for competition. However, follow-up treatments (herbicide or cutting) are still required to prevent seed production.

Herbicide controls include foliar applications of 2,4-D or metsulfuron-methyl to the rosette stage during May and June and again in September or October. If glyphosate is to be applied to rosettes, it is recommended to hold off until late fall to prevent damage to desirable plants that should then be dormant.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-------|-----|------|------|------|-------|------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Foliar | | ■ | ■ | | | ■ | ■ | | |
| | Cut stem | | | | | | | | | |
| | Mow | | ■ | ■ | | | | | | |
| | Don't mow | | | | ■ | ■ | ■ | ■ | ■ | |
| Flowering Period | | | | ■ | ■ | | | | | |



Tatarian honeysuckle (*L. tatarica* L.),
 Morrow's honeysuckle (*L. morrowii* Gray),
 Bell's or 'Bella' honeysuckle (*L. × bella* Zabel [*morrowii* × *tatarica*]),
 Amur honeysuckle (*L. maackii* [Rupr.] Herder) - not known to be in Minnesota.



Identification: Compare to native [honeysuckles](#). See page 59.

Plant: Perennial woody shrubs, multi-stemmed and ranging in heights of 6-15 feet tall (Bell's to 20 feet, Amur to 30 feet). All nonnative bush honeysuckles have hollow stems with a brownish pith (image upper right).

Leaves: Opposite, egg-shaped to lanceolate (*Amur* has lance-shaped with drawn out tips). Other species have rounded to acute leaf tips with tapered, straight or heart-shaped leaf bases. Surfaces range from smooth and hairless on Tatarian to pubescent (hairy) on Amur and Morrow's. Leaf lengths are 1 to 2½ inches.

Flower: Fragrant pairs of tubular flowers approximately ¾ to 1 inch across. Color ranges from cream to white (Amur and Morrow's) or pink (Bell's) fading to yellow. Tatarian produces white, pink or red to crimson not fading to yellow.

Bloom time is mid May to early June.

Fruit and Seed: Most species bright red, Tatarian red to orange. The ¼ inch berries are in clusters of 2-4, mature in late summer and are readily eaten by birds that then disperse the oval, flattened seeds. *Amur honeysuckle fruit can be dark red to purplish, persists into winter and is held on stalks (peduncles) shorter than the leaf stalks (petioles).*

Life History: Vegetative sprouting aids renewal of shrubs. As mentioned above, seed dispersal is mainly by birds.

Habitat: Shade-intolerant plants often found along the forest edges (image upper left). Also found in disturbed, open upland sites such as roadsides, and abandoned pastures or fields.



Management: **Prescribed fire** can be useful to kill seedlings, and drain energy from mature plants. **Mowing (cutting)** can prevent or delay seed production but typically is not considered an eradication method. Monitor the infestation and utilize follow-up treatments of additional mowing and/or herbicide.

For small numbers of plants, **manual methods** including **cutting, digging, or hand pulling** if done repeatedly **and in conjunction** with other treatments can control infestations. Monitor and consider supplemental herbicide treatments. When pulling and digging suspend roots above ground to ensure they dry out. Plants should be disposed of onsite or contained (e.g., bagged) and removed to an approved facility.

Foliar herbicide treatments with formulations of metsulfuron, dicamba, picloram + 2,4-D, triclopyr + 2,4-D, imazapyr or glyphosate at full leaf out during the active growing season.

Cut stem or basal bark applications at any time with 2,4-D, imazapyr, or triclopyr formulations. Additionally, for **cut stem** options include picloram or glyphosate and for **basal bark** treatments options also include aminopyralid.

Top: Honeysuckle in sunlight, on the forest edge.

Center: Honeysuckle leaf and flower color variations.

Bottom: Fruit - Tatarian, Bella or Morrow's and Amur.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|------------|--|---|--|---|------|-------|------|------|----------|
| Burn | Burn | | | | Follow-up with other treatments as necessary. | | | | | |
| | Foliar | | | When fully leafed out and when in fruit. | | | | | | |
| Herbicide | Basal Bark | Any time. | | | | | | | | |
| | Cut stem | Any time except during heavy sap flow. | | | | | | | | |
| Mow | Mow | | Mow frequently to control seedlings. Monitor for follow-up. | | | | | | | |
| | Don't mow | | | | | | | | | |
| Flowering Period | | | | | | | | | | |



Identification:

A native of eastern US, an aggressive, introduced invader in Minnesota.
Plant: Woody perennial, large trees attaining heights ranging from 40-60 feet tall (potentially 80 feet). Bark is dark gray-brown with deep furrows between flat-topped ridges. Vigorous sprouts and young shoots are greenish-colored and have paired spines up to 1 inch long at the base of leaves.
Leaves: Alternate, pinnately compound with 11-19 leaflets creating leaves 3-8 inches long. Oblong leaflets about 3/4 to 2 1/4 inches long by 1/4 to 1 1/4 inches wide. Leaf surfaces are dull dark green to blue-green and paler beneath.
Flower: Before leaves reach full expansion, showy racemes of 3/4 inch long white to creamy white, pea-like flowers appear. Fragrant flowers attract early season pollinators.



Bloom time is June.

Fruit and Seed: Flat pods about 2-4 inches long by 1/2 inch wide turning brown at maturity. Pods contain 4-8 seeds.

Life History: A nitrogen fixing legume that produces a shallow root system. Most reproduction is vegetative, the species sprouts vigorously from roots and stumps. Many stands of trees are clonal stands. It is reported that while black locust produces seed they seldom germinate.

Habitat: Performs well in full sun on well drained soils where there is little competition. Does well in disturbed areas such as roadsides, abandoned fields and woodland sites that are degraded. Has been used in the past for mine soil (spoils) reclamation due to its tough nature and nitrogen fixing capability.

Management:

Mechanical methods such as **cutting** or **mowing** are seldom worth the time or effort since the plants are strong sprouters from root and stump. All of these mechanical methods can have limited effects, but eradication or even good control is unlikely. The same is true of **prescribed fire**.

Basal bark or cut stump herbicide applications with either aminopyralid or clopyralid formulations including bark oil are effective. Other formulations for **cut stump** might include dicamba, glyphosate, imazapyr, triclopyr or combinations of picloram + 2,4-D, triclopyr + 2,4-D, or aminopyralid + triclopyr. Growing season **foliar** applications can be made with the same active ingredients; aminopyralid and clopyralid. Additionally, metsulfuron, picloram + 2,4-D, glyphosate and imazapyr are labeled for use.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|------------|---|-----|------|------|------|------------------------|------|------|----------|--|
| Herbicide | Burn | | | | | | Monitor and follow-up. | | | | |
| | Foliar | When fully leafed out and actively growing. | | | | | | | | | |
| | Basal Bark | Any time. | | | | | | | | | |
| | Cut stem | Any time except during heavy sap flow. | | | | | | | | | |
| | Mow | Mow frequently to control seedlings. | | | | | | | | | |
| | Don't mow | | | | | | | | | | |
| Flowering Period | | | | | | | | | | | |

Restricted

Crown Vetch : *Securigera varia* (L.) Lassen



Synonym: *Coronilla varia* L., also known as purple crown vetch.

Identification: Compare to nonnatives [alfalfa](#), [hairy vetch](#). See page 43.

Compare to native [American vetch](#). See page 50.

Compare to native [Canadian milkvetch](#). See page 50.

Plant: Erect, perennial plant at 1-2 feet tall that forms dense tangled masses of reclining 2-6 feet long stems.

Leaves: Alternate, compound leaves, odd-pinnate with 11-25 oval, smooth-edged leaflets often with a minutely pointed tip. Leaves are stalkless.

Flower: Up to 6 inch long, erect flower stalks support dense umbels or crown-like clusters of 10-25, 5-parted, 1/5-1/2 inch long pinkish flowers.

Bloom time is May to September.

Fruit and Seed: Erect, narrow, multi-segmented, pointy-tipped, angular pods containing up to 12 seeds are clustered at ends of upright stalks. See seed pod images lower left.

Life History: Colonies develop rapidly as plants produce lots of seed and also spread aggressively via vegetative rhizomes. Seed is reported to remain viable for as long as fifteen years. Unattractive, large brown patches in winter and early spring help identify crown vetch infestations.

Habitat: Old fields, pastures and roadsides. Crown vetch has been planted extensively for forage products and along roadsides and steep embankments for erosion control.

Management:

Cutting or mowing will reduce vigor but not eliminate an infestation. Plan to mow several times a season and monitor to time operations with a goal to prevent seed set.

Prescribed fire can be used with other management tactics to encourage stands of native grasses that will compete for resources. However, monitoring is necessary as crown vetch will resprout after burns.



Roadside infestation being held in check by mowing and herbicide applications.

There is a long list of active ingredients applied as a **foliar herbicide** applications. Active ingredients include, but may not be limited to, 2,4-D, aminopyralid, clopyralid, dicamba, glyphosate, metsulfuron-methyl, sulfometuron, picloram and triclopyr. Recommendation is to apply aminopyralid before flower while others are recommended for application during active growing periods.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|-----------|-------|-------------------------------|------|------|--------------------------|-------|------|------|----------|--|
| | Burn | | Late Spring | | | | | | | | |
| Herbicide | Foliar | | During active growth periods. | | | | | | | | |
| | Mow | | Mowing must be repeated | | | | | | | | |
| | Don't mow | | | | | Prevent flower and seed. | | | | | |
| Flowering Period | | | | | | | | | | | |

Restricted

Common buckthorn : *Rhamnus cathartica* L.



Identification: Compare to the native [cherries and wild plum](#) (*Prunus* spp.). See page 51.

Plant: Tall shrub at 20-26 feet with potential to become a small tree reaching 36 feet. Often one to a few stems with diameters up to 5-6 inches and occasionally larger. Light-colored lenticels on shiny gray to brown bark leads to confusion with young native cherries and plums (*Prunus* spp.). Many twigs are terminated by a small **thorn-like spine between dark colored, scale covered buds.**

Leaves: **Sub-opposite**, at times appearing opposite and on fast growing sprouts alternate. Shiny green, 1-2½ inches, oval with tiny teeth on leaf edges. Veins curving to the tip of the leaf (arcuate venation) provide a strong identification characteristic and green leaves persisting into autumn.

Flower: **Dioecious**, male and female flowers on separate plants, small, 4-parted and green.

Bloom time is May to June.



Fruit and Seed: Fruit on female plants only. At maturity a purplish-black, small (¼ inch), berry-like fruit held close to the stem in clusters. Strong identification characteristic are these blackish fruits held close to twigs late into winter. Typically, 3-4 seeds per fruit.

Life History: Reproduction is by seed and dispersal is often aided by birds. Heavy seed production combined with stems and stumps that sprout vigorously when damaged make control difficult.

Habitat: A strong competitor on upland sites in a variety of soil types and moisture regimes. Common buckthorn thrives in the understory, on the forest edge or in full sun often to complete exclusion of other species.

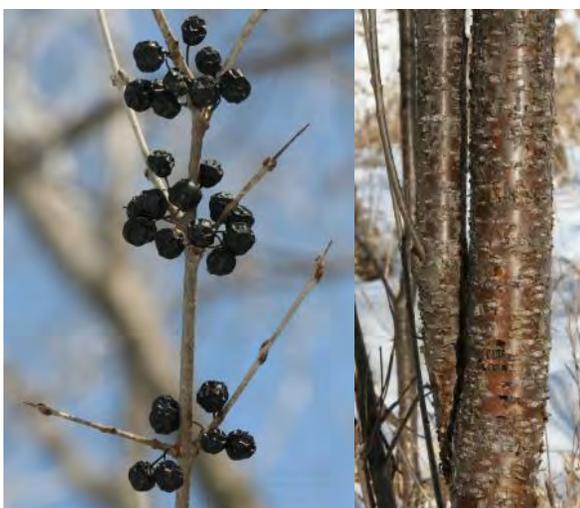
Management:

Keep in mind, if funds and/or time are limited female plants are the fruit producers and should be targeted first. Caution should be exercised to avoid creating large bare patches and/or extensive soil disturbance. Both scenarios lead to soil erosion and create good seed beds for common buckthorn regeneration.

Hand pulling or the mechanical advantage provided by a **weed-wrench** can help control small infestations. **Cutting** of stems must be accompanied by herbicide treatments or resprouting will occur. **Mowing** is typically not an option in sensitive wetland areas, but on upland sites may be a useful tool in seedling and small diameter stem control.

Prescribed fire is used to control seedlings and small diameter stems and if used consistently can drain larger plants of reserves and provide control. However, sprouting will occur and a follow-up herbicide application should be considered.

Herbicide formulations of triclopyr, imazapyr, metsulfuron-methyl, 2,4-D, glyphosate or picloram are used as foliar applications. Herbicides include triclopyr or glyphosate for late autumn into winter applications to basal bark, cut stumps or frill cuts.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|------------|--|--------------------------------------|--|------|------|-------|------|------|----------|--|
| Herbicide | Burn | | | | | | | | | | |
| | Foliar | | | When fully leafed out. During active growth. | | | | | | | |
| | Basal Bark | Any time. | | | | | | | | | |
| | Cut stem | Any time except during heavy sap flow. | | | | | | | | | |
| | Mow | | Mow frequently to control seedlings. | | | | | | | | |
| | Don't mow | | | | | | | | | | |
| Flowering Period | | | | | | | | | | | |

Restricted

Glossy buckthorn : *Frangula alnus* Mill.



Identification: Compare to the native [cherries and wild plum](#) (*Prunus* spp.). See page 51.

Plant: Shrub or small tree at 20 feet in height, often multi-stemmed with prominent light-colored lenticels on dull grayish to dark brown bark. Heartwood may be orange to pinkish and sapwood may be yellowish, both can facilitate identification. **No thorns or spines!** There are no bud scales protecting overwintering buds - referred to as naked buds.

Leaves: **Alternate**, glossy, 2-3 inch length with prominent parallel veins terminating near a smooth edge. Undersides are slightly hairy and dull. Leaves will likely persist longer in autumn than native deciduous shrubs, but they will turn yellow and drop.

Flower: **Monococious**, male and female parts present in flowers. Therefore, all shrubs can fruit. Not showy, small, 5-petaled, yellowish and borne in clusters in the leaf axils.



Bloom time is May to July.

Fruit and Seed: Clustered in leaf axils along the stem, initially reddish maturing to purplish-black in late summer into autumn. Each fruit contains 2-3 seeds, dispersed by birds.

Life History: Reproduction is by seed and while birds disperse the seed, dense thickets suggest many seeds drop close. Shades out native shrubs and forbs creating monocultures in sites that typically support very diverse flora.

Habitat: An invader of wetlands, including sedge meadows, sensitive acidic bogs and calcareous fens. Tolerant of shade, yet will perform well in full sun on upland sites.

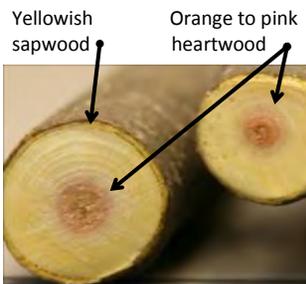
Management:

Caution should be exercised to avoid creating large bare patches and/or extensive soil disturbance. Both scenarios lead to soil erosion and create good habitat for glossy buckthorn regeneration.

Hand pulling or the mechanical advantage provided by a weed-wrench can help control small infestations. **Cutting** of stems must be accompanied by herbicide treatments or resprouting will occur. **Mowing** is typically not an option in sensitive wetland areas, but on upland sites may be a useful tool in seedling and small diameter stem control.

On upland sites **prescribed fire** can be used to control seedlings and small diameter stems and if used consistently can drain larger plants of reserves and provide control. However, sprouting will occur and a follow-up herbicide application should be considered.

Herbicide formulations of triclopyr, imazapyr, metsulfuron-methyl, 2,4-D, glyphosate or picloram are used as foliar applications. Herbicides include triclopyr or glyphosate for late autumn into winter applications to basal bark, cut stumps or frill cuts.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|------------|--|--------------------------------------|--|------|------|--------|--------|--------|----------|--|
| Herbicide | Burn | Yellow | Yellow | Yellow | | | Yellow | Yellow | Yellow | | |
| | Foliar | | | When fully leafed out. During active growth. | | | | | | | |
| Herbicide | Basal Bark | Any time. | | | | | | | | | |
| | Cut stem | Any time except during heavy sap flow. | | | | | | | | | |
| | Mow | | Mow frequently to control seedlings. | | | | | | | | |
| | Don't mow | | | | | | | | | | |
| Flowering Period | | | Red | Red | Red | | | | | | |

Restricted

Garlic mustard : *Alliaria petiolata* (M. Bieb.) Cavara & Grande



Identification:

Plant: Herbaceous, biennial with first year plants being basal rosettes. Second year flowering plants can attain heights of 4 feet and can produce more than one flowering stem.

Leaves: Basal rosettes with coarsely toothed, kidney-shaped foliage remains green through winter. Foliage on flowering stems is alternate, triangular, coarsely toothed and stalked. Foliage has the odor of garlic when crushed.

Flower: Clustered, 4-parted, white flowers are approximately 1/8 inch across.

Bloom time is April to June.

Fruit and Seed: The 1-2 1/2 inch long slender seed pods are very recognizable and contain numerous black, shiny seeds.

Life History: Reproduction is by seed that matures June into July and can be dispersed about 6 inches when pods burst at maturity. Seed remains viable in soil for up to 5 years.

Habitat: An invader of shady, moist forests or woodland settings but also invades oak savannas and disturbed areas in full sun. It is reported that garlic mustard will inhibit the growth of beneficial fungi associated with native plants thus causing a decline in herbaceous cover.

Management: **Biological controls** are under investigation, but none are approved for release at this time. One insect being studied is *Ceutorhynchus scrobicollis*, a crown and stem-mining weevil.

Manual methods include pulling plants in early spring prior to flowering (seed set is almost coincidental with flowering) and cutting plants back to the ground as they bolt for flowering, prior to flower opening. Monitor the site as cutting may need to be repeated. If mature flowers (or seed pods) are present, plants should be disposed of onsite or contained (e.g., bagged) and removed to an approved facility.

Prescribed fire in spring to top-kill basal rosettes and seedlings. Follow-up treatment with **herbicide** is imperative after seedling germination to further slow growth of infestations.

Herbicide applications to foliage with formulations of triclopyr, metsulfuron-methyl, or imazapic. Use glyphosate or 2,4-D after native plants have entered dormancy and garlic mustard is still active.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|------------|------------|------------|------|------|-------|-----------|-----------|-----------|
| Herbicide | Burn | Yellow | Yellow | | | | | | | |
| | Foliar | Dark Blue | | | | | | Dark Blue | Dark Blue | Dark Blue |
| | Cut stem | | | | | | | | | |
| | Mow | Green | Green | | | | | | | |
| | Don't mow | | | Red | Red | Red | Red | Red | Red | Red |
| Flowering Period | | Light Blue | Light Blue | Light Blue | | | | | | |

Restricted

Japanese barberry : *Berberis thunbergii* DC.



Above: *B. thunbergii* in flower late May.

Below left: *B. thunbergii* 'Erecta'

Below right: *B. thunbergii* 'Rose Glow' (top) and *B. thunbergii* 'Sparkle' (bottom)



Identification: Compare to [common barberry](#) (*B. vulgaris*) on page 18.

More images and regulated cultivars [next page](#).

Plant: Perennial woody shrubs, multi-stemmed, typically 3-6 feet tall (potentially to 8 feet tall). Stems are grooved or angular and ranging in color from gray to reddish-brown. Single (possibly 3 branched) ½ inch long spines occur at nodes where leaves attach. Lateral spine branches if present may be very small.

Leaves: Alternate, typically clustered so not appearing alternate. Leaves are simple, narrow near the twig and described as obovate (wider towards the end). The leaf edge or margin is smooth (*B. koreana* and *B. vulgaris* have teeth) and occasionally there is a minute spine tip or point at the ends of leaves.

Flower: Small (¼ to ½ inch) yellowish flowers suspended under the foliage. Therefore not considered showy. Japanese barberry flowers are typically individual but flowers may be in clusters of 2-4 while Korean barberry (*B. koreana*) may have up to 20 flowers per raceme (cluster). See fruit of Korean barberry in upper right-hand image on [next page](#).

Bloom time is May to early June.

Fruit and Seed: Bright red, dry flesh, a true berry that persists into and through winter (image next page, bottom right: fruit at leaf out in April). The ⅓ inch long ellipsoidal berries, like the flowers, will be solitary or in clusters of 2-4.

Life History: Seed production is strong and this special regulation targets species and cultivars producing on average more than 600 seeds. Seed bank viability (longevity) is not well understood; although, a report on *B. thunbergii* 'Beth' states that the seed remain viable up to 10 years. Reproduction can also be vegetative via root sprouts and shrub branches may root if in contact with the ground.

Habitat: Prefers well drained soils in full sun to partial or deep shade. Forest edges, open forests and other woodlands yet also found in old fields, areas of disturbance and can survive in wetland soils.

Management: **Prescribed fire** (or direct flame from a propane torch) can be useful to kill seedlings, and drain energy from mature plants. **Mowing (cutting)** can prevent or delay seed production but typically is not considered an eradication method. Monitor the infestation and utilize follow-up treatments of mowing and/or herbicide.

For small numbers of plants **manual methods** including **cutting, digging, and hand pulling** if done repeatedly **and in conjunction** with other treatments can control infestations. Monitor and consider supplemental herbicide treatments. When pulling and digging suspend roots above ground to ensure they dry out. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

Foliar herbicide treatments with metsulfuron products at full leaf out during the active growing season. Additionally, dicamba + 2,4-D, triclopyr or glyphosate at full leaf out while the plants are fruiting during the growing season.

Cut stem applications at any time with glyphosate or triclopyr formulations can also be useful.

Basal bark treatments at any time with imazapyr or triclopyr products have proven effective.

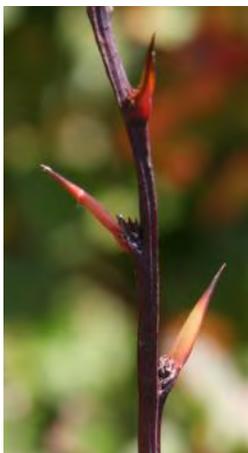
Wild type, single and paired flowers.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|------------|--|--------------------------------------|--|------|------|-------|------|------|----------|--|
| Herbicide | Burn | | | | | | | | | | |
| | Foliar | | | When fully leafed out. During active growth. | | | | | | | |
| Herbicide | Basal Bark | Any time. | | | | | | | | | |
| | Cut stem | Any time except during heavy sap flow. | | | | | | | | | |
| Herbicide | Mow | | Mow frequently to control seedlings. | | | | | | | | |
| | Don't mow | | | | | | | | | | |
| Flowering Period | | | | | | | | | | | |

Restricted

Japanese barberry : *Berberis thunbergii* DC.



Above: 'Tara' (Emerald Carousel®; *B. koreana* × *B. thunbergii* hybrid)

Above left: Grooved, reddish-brown stem, single spines at nodes.

Above center: Foliage and racemes of fruits. Above right: Form



Left: *B. thunbergii*
'Bailone'
Ruby Carousel®

Right: *B. thunbergii*
'Bailtwo'
Burgundy Carousel®



Above: *B. koreana* images for comparison.
Toothy foliage (serrulate margin) and more than 10 rounded fruits per raceme
Inset: Close-up of Korean barberry leaf edge.
Below: Unknown *Berberis* species / cultivar holding fruit at leaf out in April.

Japanese barberry cultivars to be phased out and then prohibited from sale.

These plants average greater than 600 seeds per plant and began a three-year phase-out period in Minnesota beginning January 1, 2015.

- 'Angel Wings' 'Antares' 'Anderson' (Lustre Green™) var. atropurpurea
- 'Crimson Velvet' 'Erecta' 'Gold Ring' 'Inermis' 'Kelleris' 'Kobold'
- 'Marshall Upright' 'Painter's Palette' 'Pow Wow' 'Red Rocket' 'Rose Glow'
- 'Silver Mile' 'Sparkle'
- 'JN Redleaf' (Ruby Jewel™) 'JN Variegated' (Stardust™) 'Monomb' (Cherry Bomb™)
- 'Bailgreen' (Jade Carousel®) 'Bailone' (Ruby Carousel®) 'Bailtwo' (Burgundy Carousel®)
- 'Bailsel' (Golden Carousel®; *B. koreana* × *B. thunbergii* hybrid)
- 'Tara' (Emerald Carousel®; *B. koreana* × *B. thunbergii* hybrid) Wild Type (parent species - green barberry)



Restricted

Multiflora rose : *Rosa multiflora* Thunb.



Identification:

Plant: Shrub with 6-13 feet long, wide arching canes reaching 6-15 feet tall. Canes armed with stiff, downward curved prickles (thorns) form an impenetrable thicket.

Leaves: Alternate, pinnately compound, 5-11 sharply-toothed leaflets. The oval leaflets are nearly smooth on the topside and are covered with short hairs below. A unique feature are fringed stipules where leaves attach to stems.

Flower: Numerous, showy flowers. Five-parted, fragrant, white to slightly pink, ½-1½ inches across.

Bloom time is May to July.

Fruit and Seed: Numerous rose hips, ¼ inch diameter, bright red to orange-red, hairless or smooth. Hips are on a wide branched structure and persist into winter.

Life History: Plants reproduce by seed and by cane tips with ground contact taking root. The plants are prolific seed producers and seeds are viable in seed banks for up to 20 years.

Habitat: Readily invades disturbed areas such as woodlands, prairies, roadsides, along streams and has become a problem in pastures where the thorns discourage grazing.

Management:

Cutting or mowing frequently during the growing season (3-6 times) for 2-4 years can achieve good control of infestations. **Prescribed fire** in the spring will provide good control of small stems and seedlings.

Herbicide applications to cut stems and to resprout stems with systemic herbicides such as glyphosate have proven successful. As with most species, late season applications of herbicides are effective as plants are moving photosynthates to storage in root systems.



Images clockwise order: Iowa (IA) and Illinois (IL)
 UR: White, five-parted flower (IA, 2009-6-11).
 LR: Wide branched, maturing ¼ in. hips (IL, 2015-10-16).
 LL: Compound leaves (IA). Thorns, stipules and hips (IL).
 UL: Fringed stipules and downward curved thorns (IA).

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|--------|-----------|-----------|-----------|-----------|-----------|-----------|-------|----------|
| Herbicide | Burn | Yellow | Yellow | Yellow | | | | | | |
| | Foliar | | | | Dark Blue | Dark Blue | Dark Blue | Dark Blue | | |
| | Cut stem | | | | | Purple | Purple | Purple | | |
| | Mow | Green | Green | Green | Green | Green | Green | Green | Green | |
| | Don't mow | | | | | | | | | |
| Flowering Period | | | Light Red | Light Red | Light Red | | | | | |

Restricted

Nonnative phragmites or common reed (nonnative subspecies)



Phragmites australis (Cav.) Trin. Ex Steud. subsp. *australis*

Compare to [native phragmites](#) (*P. australis* subsp. *americanus*), Page 60.

Identification:

Plant: A perennial grass reaching heights of 15 feet. Dense stands develop from rhizomatous root systems with live stems and dead stems intermingled. Hollow stems are green in summer and yellow in winter.

Leaves: Dark green, grass-like elongated foliage that is at most 1½ inches wide. Leaf sheaths are typically retained on culms (stems) into winter even if leaves drop from dead culms. *Compare to native phragmites that sheds leaves and leaf sheaths.*

Flower: Bushy panicles of purplish or golden flowers appear in July.

Bloom time is July to September.

Fruit and Seed: Large, dense seed heads become gray-brown. Hairy seeds give heads a fuzzy, fluffed appearance.

Life History: Rhizomes, rhizome fragments, root runners and copious amounts of seed provides common reed a strong competitive edge. It forms such dense stands and thick root systems that all native plants can be forced out. Rhizome segments can break free and coupled with seed production plants readily move into and take over new areas.

Habitat: Shorelines of lakes and rivers as well as pond edges and freshwater marshes. Disturbed areas and roadsides can support common reed very well.

Management: Once established, chemical treatments are recommended as a first step in restoration efforts.

Cutting or mowing will not kill plants or eradicate infestations, but can be effective at slowing the spread.

Prescribed fire after the plant has flowered. Used prior to herbicide treatments, fire (or mowing) removes biomass improving herbicide application to regrowth. Do not burn prior to flowering, as this timing may only encourage growth.

Herbicide applications, aquatic formulations of imazapyr or glyphosate are effective, even on established stands.

Rapid recognition of infestations and treatments soon after increase effectiveness. Late summer/early autumn herbicide applications to foliage or to cut stems are best and repeat treatments in subsequent seasons are likely necessary.



Glumes or seed covers vary in length. Upper and lower glumes are longer on the native subspecies. Best analyzed under a microscope.

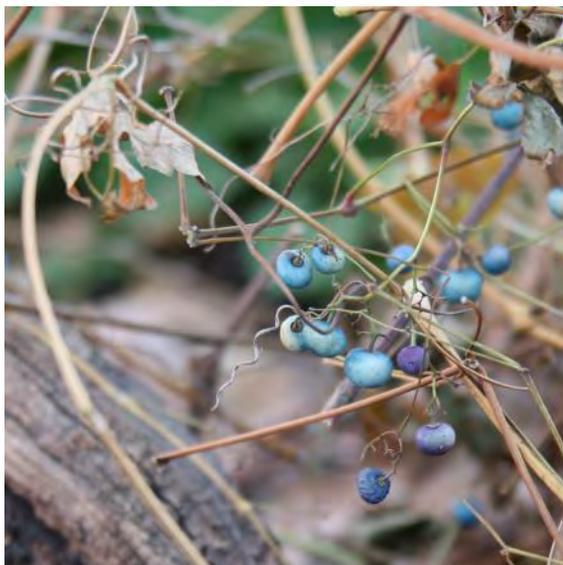
| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-------|-------------------------|------|------|--------------|-------|------|------|----------|
| Herbicide | Burn | | | | | After flower | | | | |
| | Foliar | | | | | After Flower | | | | |
| | Cut stem | | | | | After Flower | | | | |
| | Mow | | Mowing must be repeated | | | | | | | |
| | Don't mow | | | | | | | | | |
| Flowering Period | | | | | | | | | | |

Restricted

Porcelain Berry : *Ampelopsis brevipedunculata* (Maxim) Trautv.



Image by: Paul Kortebein



Family: Vitaceae, same genus as *Vitis* (grapes).

Synonyms: *A. brevipedunculata* (Maxim.) Trautv. var. *maximowiczii* (Regel) Rehder

A. glandulosa (Wall.) Momiy. var. *brevipedunculata* (Maxim.) Momiy.

A. heterophylla (Thunb.) Siebold & Zucc.

A. heterophylla (Thunb.) Siebold & Zucc. var. *brevipedunculata* (Regel) C.L. Li

Identification: Compare to native [riverbank grape](#) (*Vitis riparia*). See page 58.

Plant: Perennial, woody vines that climb trees or structures with assistance of tendrils. Like riverbank grape, tendrils occur opposite leaves. Bark of porcelain berry is gray and retains smoothness with age and the pith is white.

Key differences - Riverbank grape has dark brown bark that peels in narrow, vertical strips.

Leaves: Alternate, simple leaves with a cordate (heart-shaped) base and 3-5 palmate coarsely toothed lobes separated by deep sinuses. Some leaves may resemble wild grape leaves.

Key differences - Riverbank grape has shallow sinuses between 3 distinct palmate, coarsely toothed lobes.

Flower: Inconspicuous, panicles of greenish flowers occur opposite leaves .

Bloom time is June to August.

Fruit and Seed: Shiny, brightly colored berries in hues of blue to purple mature in September and October. Each berry contains 2-4 seeds and seed viability is reported to be 'several' years.

Life History: Water may play a small part in seed movement but predominant means of dispersal is by birds and small mammals that have fed on the colorful berries. Vegetative reproduction is also possible. Vines have strong root systems and will resprout after cutting.

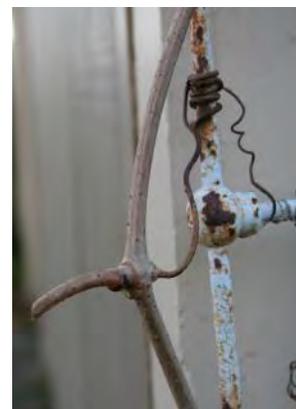
Habitat: When found, typically in riparian (floodplain) areas that are not permanently wet. Full sun to partial shade on forest edges, stream banks, thickets and other such places.

Management:

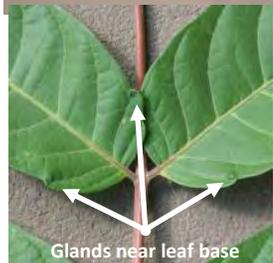
Acceptable control can be attained with **mechanical** methods such as **hand pulling** or **cutting** (possibly **mowing**). However, after cutting, plants will resprout so there should be a plan to monitor and follow up cutting treatments with additional cutting or herbicide treatments.

Follow-up to monitor for new seedlings will also be required.

For large infestations **herbicide** applications are likely the most cost effective approach. Systemic herbicides for woody brush control such as glyphosate and triclopyr have been used effectively as **foliar** or **basal bark / cut stem** treatments.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|-----------|-------|--|------|------|-----------------------------------|----------------------|------|------|----------|--|
| Herbicide | Foliar | | During active growth or cut and treat resprouts. | | | | | | | | |
| | Cut stem | | | | | Basal bark (with oil) or cut stem | | | | | |
| | Mow | | Mowing, when possible, must be repeated | | | | | | | | |
| | Don't mow | | | | | | When seed is present | | | | |
| Flowering Period | | | | | | | | | | | |



Synonyms: *A. glandulosa* Desf. and *Toxicodendron altissimum* Mill.

Identification: Compare to native [sumacs](#) (*Rhus typhina* and *R. glabra*). See page 61.

Plant: Tree, woody perennial plant that can attain heights of 70 feet. Very thick twigs with dime-sized leaf scars aid winter identification. Cutting twigs reveals a soft white pith.

Leaves: Alternate, 1-4 feet long, odd-pinnate compound with 11-25 (up to 40) leaflets. Leaflets are 3-5 inches long by up to 2 inches wide, smooth edged with 1-5 distinct glands (bumps) near leaflet bases. **Key difference:** leaflets are smooth edged, unlike toothy sumac leaflets.

Flower: Clusters of small yellowish-green flowers are showy due to the sheer number of flowers per cluster. Species is predominantly dioecious (male and female flowers on separate trees).

Bloom time is June.

Fruit and Seed: Clusters of 1-1½ inch long twisted samaras develop mid-summer. A pinkish hue develops, then maturing to light tan. Samaras are documented to wind disperse up to 300 feet.

Life History: Trees sprout vigorously from stumps when cut or broken and there is also strong root sprouting potential. Trees in the 12 to 20 year age class produce lots of seed. Seed bank capability is reported to be low, but initial seed viability is high. Allelopathic (chemical) effects prevent germination of other plants near tree-of-heaven.

Habitat: Tolerant of urban stresses including pollution, soil disturbance, nutrient poor soils, drought conditions (once established), compaction, salty roadside soils and prefers full sun.

Management: Prevention is key - early detection and removal is recommended.

Cultural methods like **Cutting** or **mowing** are beneficial but should be followed up with good monitoring. Goal with these methods is to prevent flower and seed.

Prescribed fire, where applicable, can top kill seedlings and or saplings. The goal would be to strengthen the native plant community.

Herbicide applications of glyphosate during July through September are effective when applied to **cut stumps**. Other active ingredients would include triclopyr, dicamba, and imazapyr. Stumps should be cut as low as possible to minimize surface area from which potential resprouts occur.

Hack-and-squirt applications with dicamba, glyphosate, imazapyr, picloram or triclopyr formulations are effective. In addition, **basal bark** treatments with triclopyr or imazapyr active ingredients in oil are also recommended.

At full leaf-out during active growth, **foliar** applications with 2,4-D, glyphosate, imazapyr, picloram or triclopyr are also effective when targeting smaller trees and resprouts.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|-----------|------------------|--|--------------------------------------|------|--|------|-------|------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Foliar | | | | When fully leafed out and active growth. | | | | | |
| Herbicide | Basal Bark | Any time. | | | | | | | | |
| | Cut stem | Any time except during heavy sap flow. | | | | | | | | |
| | Mow | | Mow frequently to control seedlings. | | | | | | | |
| Herbicide | Don't mow | | | | | | | | | |
| | Flowering Period | | | | | | | | | |

Restricted

Queen Anne's Lace (wild carrot) : *Daucus carota* L.



Identification: Compare to nonnative [poison hemlock](#) and [carrot look-alikes](#).

Compare to native [water hemlock](#). See pages 13, 45 and 64.

Plant: Herbaceous, biennial, first year as a basal rosette. Basal leaves are clustered, up to 5 inches long and arch away from a central location. Second year flowering plants attain heights of 3-4 feet on hollow stems that are hairy to sparsely hairy and striped with light colored lines.

Leaves: Alternate, fern-like, finely divided leaves are widely spaced on upper stems and up to 4 inches across by 2 inches wide. Stem and basal leaves are fern-like, finely divided, narrowly lobed described as bipinnate-pinnatifid. Underside of leaves may be slightly hairy along veins. Leaves are attached to stems with sheaths, also a trait of family members.

Flower: Similar to other family members - many small (1/8 inch), 5-petaled, white flowers (florets) make up a flat-topped compound umbel 2-5 inches across. Compound umbels are dense with 20-90 umbellets of which each has 15-60 flowers. Often, outer flower petals are large in comparison to others and a central flower (or flowers) of the compound umbel is purplish (not always present).

Another distinguishing characteristic in this family are bracts beneath flower umbels. Some family members have few if any bracts, wild carrot has very prominent often branched bracts under main umbels and smaller sometimes linear (unbranched) bracts under umbellets making up the larger floral display.

Bloom time is June to September. For about two months various bloom stages within infestations.

Fruit and Seed: Each floret produces 2 seeds (a schizocarp splits into carpels). Seeds are flat and bristly to catch passing fur or clothing. Entire seed clusters may break off plants in winter to roll across the snow distributing seed.

Life History: Infestations spread mainly by seed. Seeds are reported to be viable for as long as seven years. Deep tap roots are difficult to remove and provide strong energy reserve for resprouting.

Habitat: Preferred habitat is dry to moist, disturbed soils in full sunlight. Tolerant of a variety of soils and partial shade

Management:

If performed frequently **cutting** or **mowing** are effective control methods. Same is true for hand pulling, roots and root fragments remaining in the soil may resprout. Monitor infestations and plan on additional treatments.

Prescribed fire as a tool should be used to improve the health of surrounding native vegetation. Wild carrot will likely not outcompete healthy vegetation and will decline on its own.

Foliar herbicide applications to plants at rosette stage with 2,4-D or 2,4-D formulations including dicamba or triclopyr have produced good results. Nonselective herbicides such as glyphosate formulations can also produce results.



Use herbicides wisely, 2,4-D **resistant** wild carrot populations have been identified in Michigan.



| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|-----------|-------|--|------|----------------------|------|-------|------|------|----------|--|
| | Burn | | Stimulate surrounding vegetation | | | | | | | | |
| Herbicide | Foliar | | Target seedlings or rosettes | | | | | | | | |
| | Mow | | Mowing must be repeated to prevent flowering | | | | | | | | |
| | Don't mow | | | | When seed is present | | | | | | |
| Flowering Period | | | | | | | | | | | |



Identification:

Plant: Woody perennial, large shrub or small tree up to 20 feet in height. Mature bark is faint gray developing thin vertical stripes.

Leaves: Opposite, 1-3 inch long simple leaves are three lobed with center lobe extending past shorter side lobes and edges (margins) are doubly toothed. Bright green early in the season and producing brilliant fall colors in hues of red, yellow and gold-orange.

Flower: Fragrant, but not showy, loose clusters of pale yellow to creamy white flowers appear in early spring.

Bloom time is mid May to early June.

Fruit and Seed: Approximately ¾ to 1 inch long, paired, winged seed structures called samaras. The samara pair hang at close to a right angle almost parallel to one another. Initially, seed is very red in color, maturing to a light brown.

Life History: Species is a prolific seed producer. Small animals or birds may spread seeds but wind is likely the force behind most seed dispersal. Species stump sprouts but reproduction by vegetative means is not a strong characteristic.

Habitat: Preferences are to full sun or partial shade in well drained moist soils. However, the species is considered tough and specimens will tolerate dry conditions, salt and pH range of 6.1 to 7.5. A frequent invader of savannas, prairies and open forests where native shrubs, trees and forbs can be displaced.

Management: Prescribed fire will set back plants and may top kill seedlings but plants will likely resprout.

Manual methods including **hand pulling or cutting** can eliminate small infestations of seedlings and saplings while **digging or cutting** larger material can be effective. Monitor and follow up with additional treatments as necessary.

Small plants or resprouting stumps can be treated with **foliar applications** of triclopyr formulations or glyphosate. **Cut stem** treatments with glyphosate or triclopyr are effective as well as **basal bark** treatments with triclopyr.



Specially Regulated is a unique category. See [page 74](#).

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar | |
|------------------|------------|--|--------------------------------------|---|------|------|--------|--------|--------|----------|--|
| Herbicide | Burn | Yellow | Yellow | Yellow | | | Yellow | Yellow | Yellow | | |
| | Foliar | | | When fully leaved out and actively growing. | | | | | | | |
| | Basal Bark | Any time. | | | | | | | | | |
| | Cut stem | Any time except during heavy sap flow. | | | | | | | | | |
| | Mow | | Mow frequently to control seedlings. | | | | | | | | |
| | Don't mow | | | | | | | | | | |
| Flowering Period | | | Red | Red | | | | | | | |



Three knotweeds, often referred to as bamboo, are described here. They are large perennial plants with non-woody stems. Stems are smooth, green with reddish-brown blotches and hollow between swollen nodes where leaves attach. All three have branched flower structures at these leaf attachments holding many small, creamy white to greenish flowers.

Japanese knotweed Identification: *Polygonum cuspidatum* Siebold & Zucc.

Synonyms: *Fallopia japonica* (Houtt.) Ronse Decr. , *Reynoutria japonica* Houtt.

Plant: Height 5-8 feet (10 feet), potentially multiple branches. Typically, only female flowers.

Leaves: Alternate, simple, can be 2 to 7 inches long with a truncate base (mostly straight across). *Tips of leaves are acuminate* (narrowed to an abrupt point) and *undersides of leaves along veins may have brown, fuzzy ridges*.

Flowers: Typically female flowers only. Japanese knotweed has branched *flower structures that are longer than nearby leaves*, those of giant knotweed are shorter than nearby leaves.

Bohemian knotweed Identification :

Polygonum ×bohemicum (J. Chrtek & Chrtková) Zika & Jacobson [*cuspidatum* × *sachalinense*]

Synonym: *Fallopia × bohemica* (Chrtek & Chrtková) J.P. Bailey

Synonym: *Reynoutria × bohemica* Chrtek & Chrtková

Bohemian: an intermediate hybrid with characteristics of both parents, Japanese and Giant.

Plant: Heights from 6 to 16 feet. Typically few, but potentially several branches.

Leaves: Alternate, simple, can be 2 to 12 inches long and width about 2/3 of length. Leaf bases may be straight across (see Japanese) or rounded (heart-shaped like Giant). Leaf tip may be blunt, gradually tapered or pointed. *Few to no hairs on the leaf edges* (margin) and *veins under leaves may have stiff, broad-based, small hairs*.

Flowers: Often perfect flowers (male + female). Male flowers consist of anthers attached to long stamens extending beyond a flower's petals. Structure is branched with variable length.

Giant knotweed Identification : *Polygonum sachalinense* F. Schmidt ex Maxim.

Synonym: *Fallopia sachalinensis* (F. Schmidt ex Maxim.) Ronse Decr.

Synonym: *Reynoutria sachalinensis* (F. Schmidt ex Maxim.) Nakai

Plant: Larger plant attaining heights of 9 to 20 feet. Typically few or no branches.

Leaves: Alternate, simple, can be up to 12 inches across and 6-14 inches long (width about 2/3 of length) with *rounded lobes at the base* (heart-shaped). *Tips of leaves are blunt* and *undersides of leaves may have scattered* (segmented) *hairs* early in the season.

Flowers: Perfect flowers (male + female) and fertile. Branched, flower structures of giant knotweed are compact, *shorter than nearby leaves*.

Bloom time is August to September.

Seeds: Small, black, 3-sided. Reported as not commonly produced on Japanese knotweed.

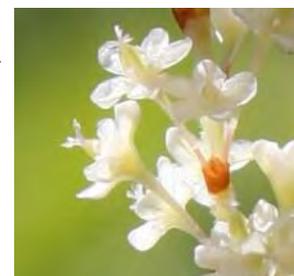


Above: Bohemian knotweed.



Above: Extended male stamens + anthers of Bohemian.

Below: Female flowers of Japanese knotweed.



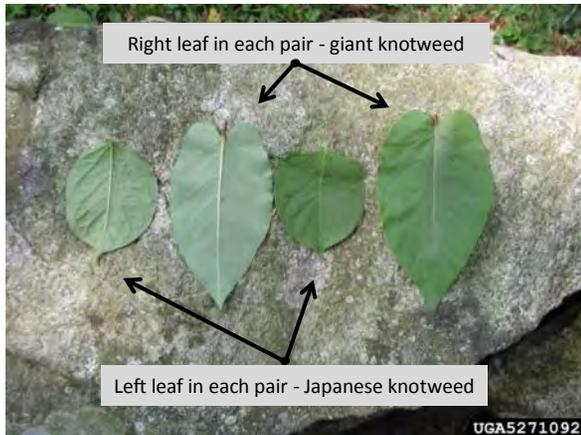
Specially Regulated

Knotweed complex : Japanese and giant



Giant knotweed's compact, erect flower structure and large leaves.

5447655



Right leaf in each pair - giant knotweed

Left leaf in each pair - Japanese knotweed

UGA5271092



UGA5271088

| Common Name | Plant form | Leaves | Leaves, underside | Flowers |
|--|---------------------------------------|---|---|--|
| Japanese knotweed | 5-10 feet multiple branches | 1-4 inches long, 2/3 as wide leaf base - straight across | along veins, scabers brownish, ridges, fuzzy | branched, loose typically female |
| Bohemian knotweed (<i>hybrid</i>) | 6-16 feet, few to several branches | 2-12 inches long, 2/3 as wide leaf base - variable | along veins, short, triangular hairs | branched, variable form female or perfect |
| Giant knotweed | 9-20 feet few or no branches | 7-16 inches long, 2/3 as wide leaf base - heart shaped | along veins, hairs scattered, segmented | branched, compact perfect and fertile |

Life History: It is believed that seed production is limited (especially, *Japanese*) and most reproduction is vegetative. Even small root parts will re-sprout after plants are manually removed or moved. Stem fragments resulting from mowers or other machinery can sprout if nodes are present and in contact with moist soil. Plants uprooted by flooding, digging or other mechanical means will likely re-root if left in contact with moist soil.

Seeds, if produced, are said to be viable four to five years if near the soil surface and up to 15 years if buried.

Habitat: Prefers moist soils in full sun to partial shade. Plants readily inhabit moist roadside ditches, wetlands, and areas along rivers and streams. However, plants will thrive on dry soils.

Management: Most research has been carried out on *Japanese knotweed*.

Develop a four to five year plan. **Prescribed fire** in spring can set plants back and drain some energy while **mowing** can prevent or delay seed production. However, both can stimulate vegetative reproduction, thus potentially increasing stem counts. After treatments, monitor approximately 60 feet beyond original infestations and utilize follow-up treatments of periodic mowing and/or herbicide. Reasoning, root system spread can be up to 60 feet.

Manual methods should not be considered eradication tools. These include **cutting, digging, hand pulling, grazing or tarping** if done repeatedly **and in conjunction** with other treatments may control infestations. Monitor and consider supplemental herbicide treatments. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

Prior to **foliar herbicide** treatments with aminopyralid, glyphosate, imazapyr, triclopyr, or 2,4-D it is recommended that the plants be cut twice when 3 feet tall. Follow those cuttings with a fall **foliar application** when regrowth is 3 feet tall and still actively growing. **Cut stem applications** with glyphosate, triclopyr or triclopyr + 2,4-D can be made at anytime during active growth when the plants are over 3 feet tall. **Stem injection** treatments with glyphosate can be made anytime during active growth periods. See glyphosate's supplemental label for hollow stem injection.

Any management efforts may result in bare ground; therefore, all treatment planning should include revegetation.

Specially Regulated is a unique category. Unadvisable to plant these species within 100 feet of a water body or its designated floodplain. See [page 74](#).

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|---|-----|---|------|------|-------|------|------|----------|
| Herbicide | Inject | | | During active growth, treat when 3' tall. | | | | | | |
| | Foliar | Mow / cut twice - fall treatment. | | | | | | | | |
| | Cut stem | | | During active growth, treat when 3' tall. | | | | | | |
| | Mow | Mowing is not recommended. If used, collect cuttings, monitor and repeat. | | | | | | | | |
| | Don't mow | Follow-up with herbicide treatments at 3 feet of regrowth in fall. | | | | | | | | |
| Flowering Period | | | | | | | | | | |

Specially Regulated

Poison ivy : *Toxicodendron radicans* (L.) Kuntze



Identification: **Common poison ivy** [*T. radicans* (L.) Kuntze subsp. *negundo* (Greene) Gillis] is potentially a larger shrub (up to 10 feet) and possibly a vine in southeastern Minnesota's riparian areas.

While both species are subject to regulation, information provided below focuses on **western poison ivy** [*T. rydbergii* (Small) Green] which is a frequently occurring shrubby plant with an extensive natural range across Minnesota.

Plant: A 1-2 foot **native** shrub with gray to tan bark and little if any branching.

Leaves: Alternate, compound leaves, 3 shiny or dull surfaced leaflets. Leaflet edges are variable from smooth to very coarsely toothed. Lower leaf surfaces are pale and often hairy.

Flower: Small, greenish flowers on erect spikes (panicles). Flower spikes are borne in leaf axils on new or current years growth with male and female flowers on separate plants (dioecious).

Bloom time is June to July.

Fruit and Seed: Creamy white to tannish berry-like drupes, approximately ¼ inch diameter. Drupes mature in August through September and persist through the winter providing a good identification characteristic on female plants.

Life History: Forms dense colonies by seed and through vegetative reproduction from surface or subsurface rhizomes.

Habitat: Invades disturbed areas such as roadsides, trail sides, fencerows, parks and can also be found in prairie (full sun) and forested settings (partial shade).

Specially Regulated is a unique category. Poison ivy, although irritating to humans, is a native plant that benefits wildlife by providing a food source to birds, small mammals and large browsers. See page 74.

Management: **Caution!** Use protective clothing, rubber gloves and long sleeves, contact with the sap (urushiol) from broken plant parts can cause blistering (dermatitis), even during the winter months. **Caution!** Smoke from burning poison ivy can deliver urushiol to airways and lungs. Do not compost as resprouting can occur and urushiol may persist in compost. Urushiol can stay on pets, tools, toys and other objects for long periods to be effectively transferred and cause irritation at a later date.

Grazing, cutting or mowing can inhibit flowering but must be continued in order to deplete energy reserves in the plants and to deplete the seed bank.

Prescribed fire generates potentially harmful smoke, see cautionary note above. So, while prescribed fire can provide control and often does control infestations of poison ivy, this tool should not be the first choice.

Herbicide formulations of triclopyr, 2,4-D, glyphosate, imazapyr or aminocyclopyrachlor applied to foliage or to cut stems are effective. Repeat applications will be required to exhaust seed banks.



Left: Shrub form
Above: Vine form

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|---|-----|------|------|------|-------|------|------|----------|
| Herbicide | Burn | | | | | | | | | |
| | Foliar | | | | | | | | | |
| | Cut stem | | | | | | | | | |
| | Mow | Mow frequently to prevent flower and seed production. | | | | | | | | |
| | Don't mow | | | | | | | | | |
| Flowering Period | | | | | | | | | | |

Nonnative

Alfalfa : *Medicago sativa* L.



Identification: Provided for comparison to crown vetch and purple flowered weeds such as thistles or knapweeds. Return to [crown vetch](#) (page 28).

Return to [knapweed complex](#) (pgs. 15 and 16) or [spotted knapweed](#) (pg. 17).

Return to [Canada](#) or [plumeless thistles](#) (pgs. 19, 20).

Plant: **Fabaceae** family, 4-sided stem supports a 1-3 foot tall plant.

Leaves: Alternate, 3-parted, compound leaves with individual leaflets measuring $\frac{3}{8}$ to $1\frac{3}{8}$ inches long, stipulate (leaf-like appendages where leaves attach to stems).

Key difference - *Thistles and knapweeds have simple leaves not compound.*

Flower: 5-parted, purplish to blue (occasionally cream colored) and approximately $\frac{1}{4}$ to $\frac{1}{2}$ inch long. Alfalfa has a clustered, somewhat conical flower head.

Key difference - *Thistles and knapweeds are disk flowers with ray flowers on the edges.*

Bloom time is June to September.

Fruit and Seed: Coiled pods, mature to a brown color.

Habitat: Introduced to North America for livestock forage and is an agriculture crop. Common in roadside ditches, and similar disturbed areas.



Nonnative

Hairy Vetch : *Vicia villosa* Roth.



Identification: Provided for comparison to crown vetch and purple flowered weeds.

Also compare to [American vetch](#), a Minnesota native. See page 50.

Return to [crown vetch](#) (pg. 28), [knapweeds](#) (pgs. 15, 16, 17) or [thistles](#) (pgs. 19, 20).

Plant: **Fabaceae** family, hairy vetch is a nonnative, short-lived perennial (biennial) with a spreading, viny form and has tendrils that assist climbing nearby plants up to 3 feet.

Leaves: Alternate, compound leaves, pinnately divided. Hairy vetch has 5-10 pairs of leaflets and tendrils are often found terminal on the compound leaves.

Key difference - *Crown vetch has no stipules, no leaf stalk and no tendrils.*

Flower: Hairy vetch has 10-40, 5-parted, pink to purple flowers about $\frac{3}{4}$ inch in length in a one-sided cluster.

Key difference - *Crown vetch has a dense cluster (crown-like) - not one-sided or spike-like.*

Bloom time is May to September.

Fruit and Seed: Pea-like pods, $\frac{1}{2}$ - $\frac{3}{4}$ inch long, that hang.

Key difference - *crown vetch's pods stand erect, they are angled, and multi-segmented.*

Habitat: Old fields, pastures and roadsides.





Above: Calyx tapered both ends, parallel veins.

Below: Curled petals, purplish stamens.



Identification: Provided for comparison to [Dalmatian toadflax](#) on page 7.

Strongly resembles Dalmatian toadflax's gray-green foliage color and form as well as habitat preference.

Plant: Similar to and often confused with bladder-campion (*Silene vulgaris*). Classed as a biennial/perennial that stands as tall as 40 inches. Stems are smooth, pale grayish-green.

Leaves: Opposite, simple leaves have entire margins (no teeth on leaf edges), smooth, waxy and grayish-green.

Key difference - *Leaves of Dalmatian toadflax are alternate on the stem, not opposite.*

Flower: Flowers are five-parted, white with petals that are often rolled. The flower typically has purple tinged stamens extending forward and behind the petals is a smooth bladder-like calyx or cup that will hold the seeds. The calyx is light green, tapers at the ends and has parallel veins.

Key difference - *Flowers are significantly different. Dalmatian toadflax has yellow snapdragon like flowers, while Balkan catchfly has creamy-white, 5-parted flowers.*

Bloom time is May to October.

Fruit and Seed: Held in the calyx or bladder behind the petals. At maturity the bladder turns light tannish-brown and the five tips curl backward.

Habitat: Full sun, dry, disturbed sites such as roadsides, abandoned lots, fields and gravel pits.

Opposite, simple leaves, clasping and blue-gray.



Form, opposite foliage, and plants are blue-gray.



Nonnative

Carrot look-alikes : *Apiaceae* family examples



Caraway



| | | | |
|------------------------|--|---------------------------------|-----------------------|
| Caraway | (<i>Carum carvi</i> L.) | [biennial, 1-4 feet tall forb] | pictures upper left, |
| Burnett saxifrage | (<i>Pimpinella saxifraga</i> L.) | [perennial, 2-3 feet tall forb] | pictures lower left, |
| Japanese hedge parsley | (<i>Torillia japonica</i> [Houtt.] DC.) | [annual, 2-6 feet tall forb] | pictures lower right, |

Identification: Provided for comparison to wild carrot also known as Queen Anne's lace on page 38.

Plant: Herbaceous, life cycles and heights provided above. All examples on this page and including wild carrot are smaller statured members of the family. Compare floral structures, foliage, seeds and in particular bracts (presence or lack of) under the flower umbels and umbellets as defining characteristics.

Leaves: All have alternate foliage. Caraway has compound leaves that are deeply divided into very linear narrow segments. Burnett saxifrage has pinnately compound leaves - basal leaves in particular have oval, toothed leaflets. As leaves ascend the stem they become smaller and deeply lobed (pinnatifid). Of these three plants, Japanese hedge parsley foliage is closest in resemblance to wild carrot and basal leaves are divided in 3-5 parts.

These members of the carrot family have leaves that are smaller near the top of the plant.

Flower: Five-petaled, all are white and all are held as flat or slightly dome-shaped clusters (compound umbels). All have loose, open umbels unlike wild carrots tighter, denser umbel. Caraway has 5-15 umbellets.

Key differences - Wild carrot has obvious, showy, branched bracts beneath umbels. The three plants listed on this page have few if any narrow, linear bracts. Caraway may have up to 4, Burnett saxifrage may have 1 bract while Japanese hedge parsley may have 2 or more narrow bracts at bases of compound umbels and up to 8 tiny bracts under umbellets.

Bloom time is variable - June to September.

Fruit and Seed: All are described as schizocarps splitting at maturity to two carpels (individual seeds). Caraway has elongated ridged seeds at about ¼ inch long, Burnett saxifrage seeds are about ⅛ inch in length, flattened, rounded with slight ridges while seeds of Japanese hedge parsley are about ⅛ inch long and bristly with hooked hairs.

Key difference - Wild carrot seeds are also about ⅛ inch with ridges covered by stiff bristles (not hooked). At maturity wild carrot folds its seed structure into what is often described as a bird's nest.

Habitat: All prefer at least partial shade to full sun with caraway preferring full sun. All take advantage of disturbance to become established and all do well on roadsides. Japanese hedge parsley thrives along woodland edges.



Burnett saxifrage



Japanese hedge parsley





Above: Disturbed woodland edge and ribbed, hairy stems with a clasping leaf attachment.

Below: Bract-like appendages at umbel base and Bracts at umbellet bases. Inset: appendages may not persist.



Identification: Also a member of the Carrot, Parsley family (Apiaceae).
 Provided for comparison to [poison hemlock](#) and [wild carrot](#), pages 13 and 38 respectively.
 Compare to [Carrot look-alikes](#) and [water hemlock](#), pgs. 45, and 64.

Plant: Herbaceous biennial that stands as tall as 5 feet (2-5 feet). Stems are hollow, ribbed, and mostly green with fine hairs, especially along the ribs.

Key difference - *Poison hemlock stems are smooth and spotted purple, not hairy or ridged.*

Leaves: Alternate, doubly pinnately compound leaves are smooth and shiny on the upper surface

with short hairs below. Vein patterns are more pronounced than on poison hemlock.

Key difference - *poison hemlock leaves have no hairs and venation is not as pronounced.*

Flower: Structure of the inflorescence is a compound umbel. Each umbel is comprised of 4-15 umbellets each with 3-10 white, 5-parted, florets.

Bloom time is April to June.

Fruit and Seed: Like other carrot family members, compound umbels of 2-parted seeds. In this species the styles persist resulting in a "beaked" seed (a pointed tip). Seed matures to 3/8 inch long and develops a dark brown color.

Habitat: Part shade to full sun, moist soils, disturbed sites such as roadsides, abandoned lots, fields and gravel pits.

Grooved rachis.

Doubly, pinnately compound leaves with distinct venation.



Above: Hollow, ribbed stem with fine hairs.



Above: Seedlings.



A single umbellet of 2-parted, beaked seeds.

Nonnative

Musk or nodding thistle : *Carduus nutans* L.



Identification: Provided for comparison to [Canada](#) and [plumeless](#) thistles on pages 19 and 20.

Compare to native [swamp thistle](#) (*Cirsium muticum*). See page 62.

Compare to nonnatives [alfalfa](#) and [hairy vetch](#). See page 43.

Plant: Herbaceous, biennial thistle, basal rosette in its first season. Second season, mature flowering stalks 1-7 feet tall.

Leaves: Rosettes can be twenty inches or more in diameter with rosette foliage deeply lobed, a light colored midrib and leaf edges that are light colored and spiny. Foliage on flowering stalks is alternate with spiny wings from leaf bases onto the stem and both surfaces are without hairs. Compare to [plumeless thistle](#) foliage that is hairy below.

Flower: Large at 1½-3 inches wide and deep pinks to purple. Composite flowers are solitary on branch ends, often nodding with large dark-colored spiny bracts beneath. Compare to [plumeless thistle's](#) flowers that are ½ to 1½ inches wide with short spiny bracts and winged, spiny stems.

Bloom time is June to August.

Fruit and Seed: Seeds are tufted with feathery plumes that are easily wind dispersed and most are deposited within 160 feet of plants. Do not mow after seed has developed as this strongly aids dispersal.

Life History: Plants have thick taproots but no rhizomes; thus, musk thistle is not clonal. Seed production is high with individual plants producing thousands of seed which can persist in seed banks up to 10 years.

Habitat: Infestations are found on dry to moist soils in woodlands, waste areas, roadsides, ditches and stream banks.

Management:

Cutting taproots 1-2 inches below ground is effective but time consuming for large numbers of plants. **Mowing** should be timed at flower bud stage to prevent seed production and should be repeated 2-3 times per season to be effective. Care should be taken to avoid spreading seed with hay or straw and with mowing and vehicle movement through infestations.

Prescribed fire can be used to encourage stands of native grasses that will outcompete thistle. However, monitoring is needed to check for thistle that germinates in bare soil soon after burns are completed.

Herbicide applications timed at the early bolting phase are foliar applications of 2,4-D ester or dicamba formulations. For foliar applications at the budding to flower stage or fall applications to basal rosettes turn to formulations of aminopyralid, clopyralid, metsulfuron-methyl or triclopyr.

| | | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec.-Mar |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|--------|-----------|-----------|----------|
| Herbicide | Burn | Yellow | Yellow | Yellow | | | Yellow | Yellow | Yellow | |
| | Foliar | Dark Blue | Dark Blue | Dark Blue | | | | Dark Blue | Dark Blue | |
| | Cut stem | | | | | | | | | |
| | Mow | | Green | Green | | | | | | |
| | Don't mow | | | | Red | Red | Red | Red | Red | |
| Flowering Period | | | | Light Red | Light Red | Light Red | | | | |



Identification: *Provided for comparison to [leafy spurge](#) on page 21.*

Plant: Yellow rocket (a.k.a. winter cress, garden yellowrocket) was introduced from Eurasia and is common in Minnesota. A biennial plant (also described as perennial) that forms a basal rosette its first year. Subsequent growing seasons, flower stalks are erect at 8 to 36 inches tall, typically multi-branched and terminated by clusters of bright yellow flowers.

Leaves: Basal leaves and some stem leaves are pinnately lobed to deeply toothed and up to 6 inches in length. Often the terminal end of leaves is a larger rounded lobe in addition to 1-4 lesser side lobes. Leaves near the top of the plant are alternate, typically smaller, oval and often stalkless.

Key difference - *Leaves of leafy spurge are simple (not lobed) and narrowly linear at 1-4 inches in length.*

Flower: Crowded, rounded clusters of bright yellow stalked flowers. Flower clusters are terminal to branch ends. Individual flowers range from 1/8 to 1/2 inch wide and have 4 bright yellow petals. As flower clusters elongate, flowers are produced above with seed pods produced below.

Key difference - *Leafy spurge has greenish-yellow flowers without petals. The greenish-yellow bracts beneath the true flowers provide the appearance of a petaled flower. Confusion occurs due to overlap in bloom periods.*

Bloom time is April to June.

Fruit and Seed: Slender pods develop along stems as flower clusters stretch upwards. The roundish pods are approximately 1 inch long, upward curved and contain small brown seeds at maturity.

Habitat: Considered a weed of lawns, gardens and agricultural fields. Often along roadsides and other disturbed sites. An infestation of yellow rocket indicates a disturbed site on which ground cover of native forbs and grasses is thin.



Minnesota Native

American bittersweet : *Celastrus scandens* L.



Oriental bittersweet, yellowish husks, fruit in leaf axils

American bittersweet, orange husks and bright red arils

Identification: Provided for comparison to [Oriental bittersweet](#) on page 11.

Plant: Woody vine, twining, no tendrils or aerial roots to assist in climbing.
Leaves: Alternate, elliptic to oblong or obovate, typically twice as long as wide. At bud break, leaf edges unroll in a scroll-like fashion.

Flower: Terminal panicles of numerous 5-parted flowers. Dioecious plants (male and female) producing small, rather inconspicuous whitish flowers.

Key difference - terminal panicles. Flower location is observable on early growth.

Bloom time is May to June.

Fruit and Seed: Like the flowers, **terminal** panicles. **Orange** colored husks covering bright red 3-parted arils (fleshy, berry-like fruits) containing 1-2 seeds each. Fruits persist into late winter.

Key differences - terminal clusters, orange colored husks, bright red 3-parted arils.

Habitat: Typically found in rich soil, full to partial sun often along roadsides and woodland edges.



Terminally clustered fruits, orange husks and bright red arils.



Foliage typically twice as long as wide. Oriental tends toward oval. Note the drawn out leaf tip.



Staminate (male) flowers with yellow pollen.



Pistillate (female) flowers clustered at branch ends

Minnesota Native

Canadian Milkvetch : *Astragalus canadensis* L.



Identification: Provided for comparison to [crown vetch](#) on page 28.

Plant: **Fabaceae** family, 1-3 feet tall perennial with ridged, pubescent stems.

Leaves: Alternate, odd-pinnate, compound leaves with 21-31 oblong leaflets, about 1½ inches long. Leaves measure 5 to 9 inches long and there are no tendrils.

Key difference - *crown vetch* has 11-25 oval leaflets.

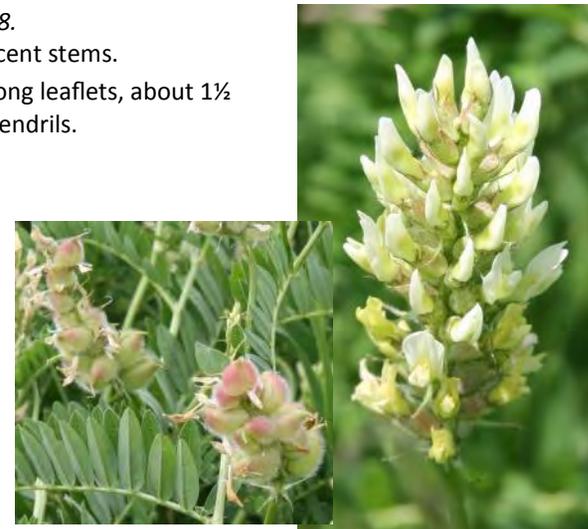
Flower: 5-parted, cream colored and approximately ¾ inch long. Milkvetch has a tall, spike-like, clustered, conical flower head with as many as 75 flowers.

Key difference - *Crown vetch* has a purple to pink short, dense cluster (*crown-like*).

Bloom time is June to September.

Fruit and Seed: Thickened, fuzzy, 2-parted pods with a pointed tip, mature to a brown color.

Habitat: Used for livestock forage and as an agriculture crop. Common in roadside ditches, and similar disturbed areas.



Minnesota Native

American vetch : *Vicia americana* Muhl. Ex Willd.



Identification: Provided for comparison to [crown vetch](#) and purple flowered weeds.

Also compare to [alfalfa](#) and [hairy vetch](#), nonnative family members.

Plant: **Fabaceae** family, American vetch is a native perennial with a spreading, viny form and typically has tendrils that assist in climbing nearby plants up to 3 feet.

Leaves: Alternate, compound leaves, pinnately divided. American vetch has 4-8 pairs of leaflets and tendrils terminal on the compound leaves. American vetch has toothed stipules at the base of its compound leaves.

Key difference - *Crown vetch* has no stipules, no leaf stalks and no tendrils.

Flower: American vetch has 2-9 flowers in a one-sided cluster. Flowers are 5-parted, pink to purple and about ¾ inch in length.

Key difference - *Crown vetch* has a dense crown-like flower cluster.

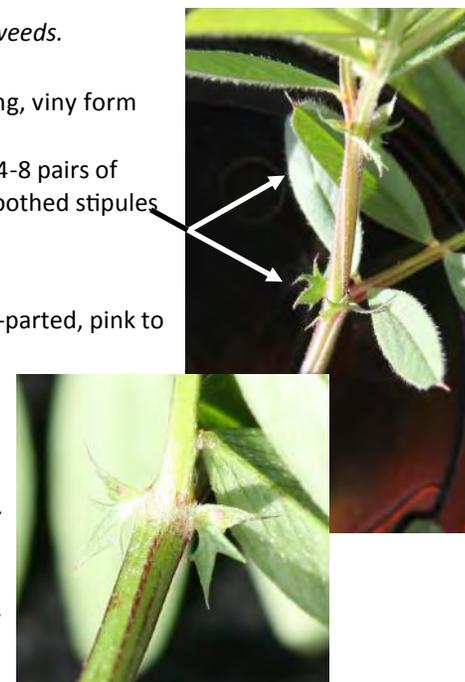
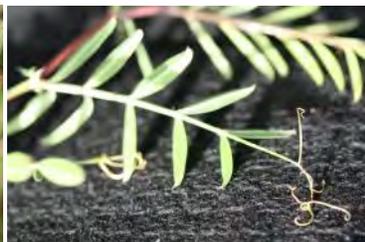
Bloom time is May to September.

Fruit and Seed: Pea-like pods that hang.

American vetch's pods are about 1 inch long. Similar to [hairy vetches](#) pea-like pod.

Key difference - *crown vetch's* pods stand erect, they are angled, and multi-segmented.

Habitat: Old fields, pastures and roadsides.





Black cherry (*P. serotina* Ehrh.) Pin cherry (*P. pensylvanica* L. f.)
 Choke cherry (*P. virginiana* L.) American plum (*P. americana* Marshall)

Identification: *Provided for comparison to [common](#) and [glossy](#) buckthorn on pages 29 and 30.*

Plant: Plums, chokecherry and fire or pin cherry are small sized trees. Black cherry may be a small tree, but reaches medium to large tree status. All have smooth, gray to brown bark that is often shiny and lenticled. Couple that bark and American plum's thorn-like twigs and it is no surprise that these species are frequently confused with buckthorn.

Leaves: Alternate, elliptic to oblong or ovate, typically finely toothed with acuminate or drawn out leaf tips.

Key difference - *Prunus species have glands on the leaf petioles. Additionally, arcuate venation of common buckthorn.*

Flower: Numerous 5-parted, white, fragrant flowers are fairly showy or obvious. Cherries have panicles of white fragrant flowers while the plum's white flowers are clustered along the stem. In Minnesota American plum (wild plum) is one of the earliest trees to bloom, typically small groups of trees clumped along forest edges.

Key difference - *5-parted, white, fragrant flowers are fairly showy or obvious.*

Bloom time is May to June.

Fruit and Seed: Choke and black cherries panicles (loose, hanging clusters) of black fruit are readily taken by birds. Pin or fire cherry fruits mature to a bright red. Plums have a ¾-1 inch, reddish to purplish fruit that contains a large seed.

Key difference - *birds eat fruits of cherries and plums after ripening. Buckthorn fruits remain on shrubs into late winter.*

Habitat: Typically found in rich soil, full to partial sun often along roadsides and woodland edges.

Above: Mature, bright red, solitary or paired fruit and foliage of pin cherry.

Below: Flower of black cherry and maturing fruit of chokecherry.



Below: Thorns of wild plum on dead branches. Wild plum flowers and fruit.



Hooked stem hairs early spring (May).



Male flowers, 3-lobed, opposite leaves.

Identification: Provided for comparison to [Japanese hops](#) on page 10.

Plant: Herbaceous, perennial vine, rhizomatous (spreads by rhizomes). Leaf petioles and annual stems with stout hooked hairs. Image at left is of developing, hooked hairs in May.

Leaves: Opposite, for the most part 3 lobed (up to 5 lobes), higher on the vine leaves may be unlobed. Typically, a cordate (heart shaped) base to the leaf and leaves nearly as broad as long.

Key difference - 3 (maybe 5) lobed leaves, higher on the vine leaves may be unlobed.

Flower: Inconspicuous, wind pollinated and dioecious (male and female) plants.

Bloom time is July to August.

Fruit and Seed: Fruiting structure is cone like, comprised of papery bladders covering individual seeds. Fragrant when crushed. Fruit persists into late winter (see image at right).

Key difference - native common hops fruit structure is fragrant when crushed.

Habitat: Moist soils, disturbed sites in woodlots and along fencerows.



Opposite leaves.



Winter fruit, fragrant.



Fruit, 3-lobed and un-lobed leaves.



Male flowers, 3-lobed, opposite leaves.



Female flowers, 3-lobed, and un-lobed opposite leaves.



5-lobed, 3-lobed, opposite leaves.



Synonym: Common cow-parsnip (*Heracleum lanatum* Michx.)

Identification: Provided for comparison to [giant hogweed](#) on page 8.

Plant: Perennial, single-stemmed large plants at 3-10 feet tall. Fuzzy stems are hollow and described as foul smelling. **Key difference - hogweed has purplish stems with coarse hairs.**

Leaves: Alternate, compound, 3-parted with toothed, palmate leaflets. The petiole or leaf stalk has an enlarged base that clasps the stem.

Key difference - hogweed has strongly dissected leaves up to 5 feet wide.

Flower: 8-30 small, white, 5-parted flowers with notched petals, in a 4-8 inch flat umbel, 8-30 umbellets. *Cow parsnips outer flower petals are often larger, irregular, and notched.*

Bloom time is June to July.

Fruit and Seed: Many flattened fruits that when dry split into 2 seeds. See left-hand image.

Habitat: Often found in rich, moist soils along streams or river bottoms in full to partial sun.

Caution: Although to a lesser extent, cow parsnip can cause blistering rashes similar to giant hogweed. Again, plant sap reacting with sunlight - phytophotodermatitis.



Clasping, 3-parted leaf, fuzzy stems.



Outer flowers, larger, notched and irregular.



Wild cucumber (*Echinocystis lobata*) and bur cucumber (*Sicyos angulatus*).

Identification: Provided for comparison to [Japanese hops](#) on page 10.

Compare to native [common hops](#). See page 52.

Plant: Annual vines (non woody) with tendrils, often found covering shrubs and small trees to approximately 20 feet.

Leaves: Simple, alternate, 3-5 triangular lobed wild cucumber leaves have small teeth along the leaf edge. Bur cucumber differs with its 3-5 shallowly lobed leaves having hairy undersides as well as sticky hairs on its stems.

Flower: Wild cucumber has creamy white flowers with 6 strap-like petals. These are male flowers. One rarely noticed female flower is at the end of the flower spike. Bur cucumber has 5-petaled greenish-white male flowers clustered and separate from the female flowers clustered elsewhere on the plant.

Bloom time is July to September.

Fruit and Seed: Solitary, prickly bladders distinguish wild cucumber from bur's grouped, up to 10, prickly pods.

Habitat: Can be found growing side-by-side. Plants can be found in partial shade to full sun along the edge of the woods or in thickets or open areas with moist soils.



Above: Bur cucumber foliage and flowers.

Below: Bur cucumber foliage and prickly seed structure.



Key difference - Both cucumber species have prickly seed structures. Below: Wild cucumber



Above: Wild cucumber hanging on a fence in winter

Key difference - cucumber vines have tendrils.



Above: Bladder-like seed pod remaining in winter, seeds dispersed.

Below: Wild cucumber foliage and flowers.



Minnesota Native

Fireweed : *Chamerion angustifolium* (L.) Holub ssp. *angustifolium*



Synonym: *Epilobium angustifolium* L.

Identification: Provided for comparison to [purple loosestrife](#) on page 23.

Plant: Perennial, erect, rounded, single stems reaching 2-6 feet tall. **Key difference** - rounded stem, not 4-6 sided.

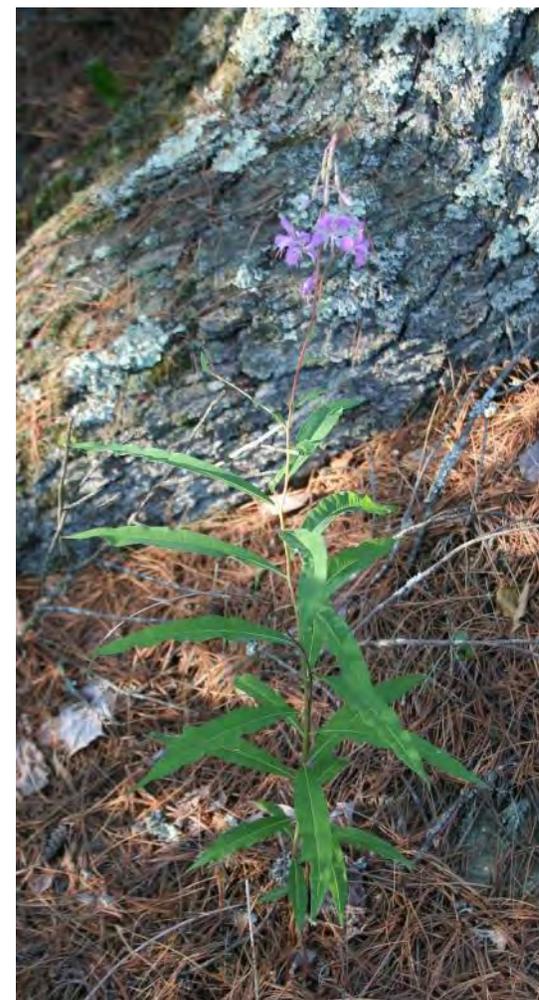
Leaves: Alternate, crowded leaves that are lance-like and stalkless. **Key difference** - alternate (not opposite).

Flower: Four-parted, colors range from pink to purple. The flowers are showy at $\frac{3}{4}$ to $1\frac{1}{2}$ inches wide and arranged along a tall terminal spike. **Key difference** - Fireweed has four-parted flowers (purple loosestrife has 5-parted flowers).

Bloom time is June to August.

Fruit and Seed: Long, slender capsules or pods that split to release small seeds with long tufted hairs.

Habitat: Often present following burns on moist soils at forest edges or in clearings.





Golden alexander [*Z. aurea* (L.) W.D.J. Koch] and heart-leaved golden alexander [*Z. aptera* (A. Gray) Fernald].

Identification: Provided for comparison to [wild parsnip](#) on page 25.

Plant: Herbaceous, perennial reaching 1-2 feet tall.

Key difference - golden alexanders smooth, shiny stems compared to the grooved stem of wild parsnip.

Leaves: Alternate 2-3 inch stem leaves, mostly 3-parted with finely toothed edges. Basal leaves of heart-leaved golden alexanders are simple and oval (heart-shaped) while those of golden alexanders are compound like upper stem leaves.

Key difference - the basal leaves of wild parsnip are pinnately compound with 5-15 leaflets.

Flower: Terminal panicles of numerous 5-parted, yellow flowers.

Bloom time is May to July.

Fruit and Seed: Similar to wild parsnips. Ridged - when mature appears dry and splits into 2 parts.

Key difference - wild parsnip seeds are typically larger and flatter.

Habitat: Moderately moist to wet - sandy, loamy soils, full sun to shade.



Z. aptera heart-shaped basal leaves.

Ridged seed, few if any bracts.





Pyramidal inflorescence of Canada goldenrod

Identification: *Provided for comparison to [common tansy](#) on page 24.*
 In particular, compare common tansy to stiff goldenrod (*Solidago rigida* L.).

Plant: Perennial plants, often clumped, typically erect, single stems. Species typically ranges in height from 1-4 feet while species may reach heights of 7 feet.
Leaves: Alternate, simple, depending on species leaves are lance shaped, may or may not be toothed and may or may not be hairy.
Key difference - *tansy foliage is pinnately divided, toothed and aromatic when crushed.*
Flower: Yellow ray flowers typically arranged in branched clusters. Depending on species the inflorescence may be pyramidal, flat-topped or one-sided.
Key difference - *goldenrod flowers have ray petals surrounding central, disk-like florets.*
Bloom time is late July through September.



Ray petals of stiff goldenrod

Fruit and Seed: Dry, light seeds often tufted with light-colored to brownish hairs easily carried by wind.

Key difference - *Tansy seed is not tufted and persists into winter in the flower heads.*

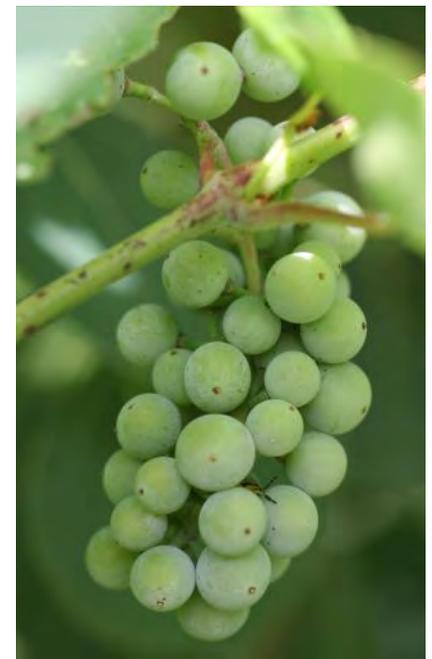
Habitat: goldenrod species thrive in a variety of sites. They can be found in dry to wet prairies, dry to moist forests and on a variety of roadsides. Partial to full sun.



Flat-topped inflorescence of stiff goldenrod



One-sided inflorescence of gray goldenrod



Identification: *Provided for comparison to [porcelain berry](#) on page 36.*

Plant: Perennial, woody, vines climbing into trees and structures or spreading over low growing vegetation. Height can be variable and up to 80 feet. Tendrils opposite some leaves assist climbing and support. Stems of grape vines can attain diameters of 7-8 inches with bark maturing to dark brown and shredding from stems in narrow strips.

Key difference - *Porcelain berry's bark does not shed in vertical strips.*

Leaves: Alternate, simple, cordate (heart-shaped) leaves are sharply toothed and palmately lobed, often three distinct lobes. Leaves may be up to 6 inches long and 4 across. Upper leaf surface is typically dark green and smooth while underside may be whitish. There may or may not be hairs along the major veins.

Key difference - *Porcelain berry's leaves are often deeply divided by sinuses.*

Flower: Often dioecious, male and female flowers on separate plants, occasionally flowers are perfect (all reproductive parts). Hanging panicles of greenish-yellow, 5-parted flowers are not showy. Most are held opposite a leaf.

Bloom time is May to late June.

Fruit and Seed: Green berries (grapes), covered by a whitish film (glaucous), that mature to a purple color. Berries contain 1 to 4 seeds.

Key difference - *Porcelain berry has shiny, berries in hues of blue/purple.*

Habitat: Grapes prefer full sun but will tolerate partial shade. Preference is moist soils and as the name implies, riverbank grapes are often found in river bottoms climbing into trees where there is good sunlight at forest edges and in openings.



Above and below: June 13 - flowers, leaves and tendrils of grape on the Anoka sandplain.





Above: Landscape use of northern bush honeysuckle.
Yellow tubular flowers, and serrated, lance shaped foliage.

Below:
Left 2 images - fly honeysuckle foliage, fruit and flower.
Second from right - rounded foliage of vining hairy honeysuckle
and extreme right is red flower, fused foliage of wild honeysuckle.



Northern bush honeysuckle [shrub] (*Diervilla lonicera* Mill.) - pictures upper right and left, fly honeysuckle [shrub] (*Lonicera canadensis* Marsh.) - pictures lower left, swamp fly honeysuckle [shrub] (*L. oblongifolia* [Goldie] Hook.) - not pictured, mountain fly honeysuckle [shrub] (*L. villosa* [Michx.] J. A. Schultes) - not pictured, hairy honeysuckle [vine] (*L. hirsuta* Eat.) - picture second from lower right, wild honeysuckle [vine] (*L. dioica* L.) - picture lower right.

Identification: Provided for comparison to [Asian bush honeysuckles](#) on page 26.

Plant: Shrubs range in heights up to 3 feet for northern bush honeysuckle on up to 6 feet for fly honeysuckles. Twining vines may be sprawling, standing weakly or climbing to heights of 9-15 feet (hairy and wild) on up to 24 feet for the uncommon grape honeysuckle.

Key difference - Native bush honeysuckles have solid piths, typically white. Vine forms have hollow stems, white piths.

Leaves: Opposite. It is difficult to generalize leaf types and shapes for these species. Bush honeysuckle has lance-shaped leaves with a long tip, serrated and ciliated margins with hairs possibly present on surfaces or mid-veins. Fly honeysuckles have elliptical to oblong shapes with blunt or acute tips. Vining honeysuckles tend to have rounded or ovate leaves except terminal leaf pairs tend to be fused (see image at right).

Key difference - Northern bush honeysuckle has serrated, lance shaped foliage. Vining honeysuckles tend to have rounded foliage with the terminal pair fused.

Flower: Tubular. Northern bush honeysuckles have a yellow flower (image left) while wild honeysuckles are red (image lower right). Others, like fly honeysuckle, vary from pale yellow to white.

Bloom time is typically May to July. Northern bush honeysuckle as late as September.

Fruit and Seed: Typically berry-like, typically red except for bush honeysuckles beaked, capsule with sepals attached.

Habitat: Woodland habitats with some species tolerant of deeper shade while others require partial sun. Swamp fly and mountain fly honeysuckles are typically found in moist soils such as forested swamps or bogs.



Above: northern bush honeysuckles beaked, capsule fruit.

Below: Vining honeysuckles fused terminal leaves.



Minnesota Native

Native phragmites : *Phragmites australis* ssp. *americanus* Saltonstall



Introduced

Native

Left: Introduced - diffuse fungal spots and leaf sheaths intact on yellow winter stems.

Right: Native - sharply defined fungal spots may be present on some stems and note the maroon to pink color.

Images 2012/12/04.



Introduced

Native

Left: Introduced - green stems at the nodes.

Right: Native - maroon to pink color at the stem nodes.

Images: 2009/08/18



Introduced

Native

Above: Introduced - larger, grayish, fuzzy seed head.

Right: Native - smaller, golden, some fuzziness to seed heads.

Complete nomenclature from USDA GRIN: *Phragmites australis* (Cav.) Trin. ex Steud. subsp. *americanus* Saltonstall

Identification: *Provided for comparison to [nonnative phragmites](#) on page 35.*

Plant: Perennial grass. Stand density can be similar to introduced common reed but, stands often have other native plants interspersed. In comparison to introduced form, native plants are typically shorter and foliage appears yellowish.

Leaves: Summer leaves are yellowish. Leaves and leaf sheaths will drop from plants in winter leaving bare reddish stems (photo at left). Ligule length determined under a dissecting microscope is diagnostic, typically > 1.0mm.

Flower: Approximately 3-4 months after spring growth begins.

Bloom time is June-September.

Fruit and Seed: Plumes are sparse and likely not persistent through winter. Glume lengths are diagnostic and as with ligules a dissecting microscope is useful for measurement and comparison.

Habitat: Native phragmites occurs near water sources such as rivers, streams, shorelines of ponds and lakes as well as within wetland systems including wet roadside ditches.



Native

Native phragmites seed heads tend to be less dense, less fuzzy and typically not as large.



Native

Introduced

Left foreground: Introduced - dark green foliage with larger, grayish, seed heads.

Right background: Native - yellowish foliage with smaller, golden, seed heads.



Native

Native phragmites has maroon stems at the nodes or segment joints.

Image 2009/11/02



Staghorn sumac

Height can exceed the 25-30 feet shown here.



Staghorn sumac [shrub] (*R. typhina* L.) - pictures left.
Smooth sumac [shrub] (*R. glabra* L.) - pictures right,

Identification: Provided for comparison to [tree-of-heaven](#) on page 37.

Plant: Shrubs ranging in heights up to 18 feet for smooth sumac and staghorn sumac considered a shrub or small tree at heights up to 36 feet (or taller). Both smooth and staghorn sumac develop clonal, multi-stemmed, colonies. The names are indicative of the hairiness of the plants. Smooth sumac has smooth bark, fruits and foliage while staghorn has very fuzzy twigs, fruit and leaf parts.

Key difference - *Tree-of-heaven* has smooth twigs similar to smooth sumac, but twigs and small branches of *tree-of-heaven* are very stout with very large leaf scars.

Leaves: Alternate, odd pinnate compound. Smooth sumac has 9-23 hairless, sessile (no stalk) leaflets while staghorn sumac has 13-27 hairy, sessile leaflets. In particular the petioles (stalks that leaflets attach to) of staghorn sumac are fuzzy as is the mid-vein on the underside of the leaflet. Both species have serrated (toothed) leaflet edges. Leaflet color of the sumacs is darker green on top surface and pale green, almost whitish, on the bottom.

Key difference - *Tree-of-heaven* has 11-25 or more smooth leaflets that have smooth edges and glands near leaf bases. Leaf color is a consistent green top and bottom.

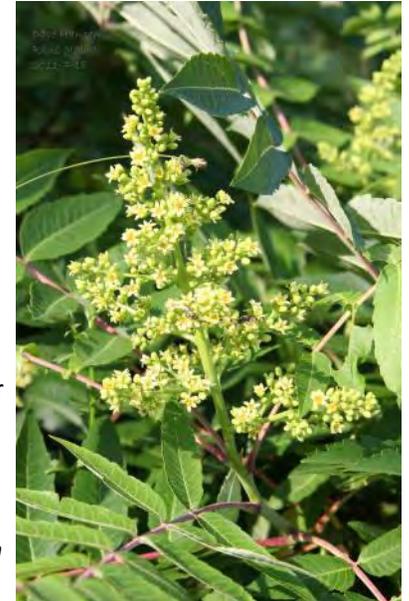
Flower: Dioecious species, male and female flowers on separate plants. Pyramidal multi-branched, stalks of greenish, 5-parted flowers. Many ¼ inch greenish flowers are somewhat showy as they are held on terminal, pyramidal structures that can be up to 15 inches tall by 9 inches wide.

Bloom time is typically late June into July.

Fruit and Seed: The pyramidal structure of female flowers will be replaced by red fruits called drupes, each contains a single seed. Individual fruits of smooth sumac are covered by very short red hairs while those of staghorn are covered by very noticeable fuzzy, reddish hairs. Fruits of both species while rounded are slightly flattened and will hold on through winter and potentially into the following summer.

Key difference - *Tree-of-heaven*, clusters of slightly twisted, single-seeded samaras.

Habitat: Both sumac species prefer full sun. Both are found along forest edges and in forest openings. However, they may also be found near lakes or rivers or even on the drier extremes of rocky outcrops, prairie and savanna habitats. Sumacs are a common sight along dry roadsides.



Above: Greenish male flowers of smooth sumac. July 18, BWCAW.
Below: Smooth sumac fruit October 15th near Mankato.



Staghorn sumac



Smooth sumac





Identification: Provided for comparison to nonnative thistles; [Canada](#) and [plumeless](#) thistle on pages 19, 20.

See also: [BWSR Featured Plant: Minnesota's Thistles](#), Publication date 2013-3-6.

Plant: Biennial, mature plants from 2-7 feet tall with multiple-branches terminated by many heads. Stems are not spiny but woolly, especially lower portions of the plant.

Leaves: Alternate, deeply divided leaves have lance-like or oblong segments that are described as softly spiny.

Flower: Purples to pinks typically not white. Composite flowers are 1½ inches wide held together by whitish, woolly, non-spiny bracts that have a visible light-colored dorsal (central) ridge.

Bloom time is July to October.

Fruit and Seed: Tufted seed matures and is wind-dispersed late summer into autumn.

Habitat: Swamps, bogs and areas like wet meadows, moist woods and thickets.

Key difference - Woolly, non-spiny bracts with a light colored dorsal ridge.

Key difference - Deeply divided foliage that is softly spiny. Stems are hairy or woolly, not spiny.





Woodbine, palmately compound leaves.

Virginia creeper [*Parthenocissus quinquefolia* (L.) Planch.] and woodbine [*P. vitacea* (Knerr) Hitchc.], synonym: *P. inserta* (Kerner) K. Fritsch.

Identification: Provided for comparison to [Japanese hops](#) on page 10.

Compare to native [common hops](#) on page 52.

Plant: Woody, perennial vines, with tendrils that assist climbing into trees and onto structures (Virginia creeper and woodbine) or sprawling on the forest floor (woodbine). Virginia creeper may develop aerial roots while woodbine does not. Tendrils of Virginia creeper develop adhesive disks while tendrils of woodbine usually attach by wrapping around an object, seldom developing adhesive disks.

Leaves: Alternate, palmately compound with 4-5 leaflets (typically 5). Leaflet bases are tapered and the leaf edges are toothed (possibly doubly toothed).

Key difference - *Leaves of Japanese hops are simple not palmately compound.*

Flower: Both species have greenish flowers held on compound cymes (branched, flat-topped structures with terminal flowers opening first). Virginia creeper's structure has a central axis while woodbine's does not.

Bloom time is June to July.

Fruit and Seed: Fruits are berries, bluish at maturity and held on red structures.

Key difference - *Japanese hops does not produce berries.*

Habitat: Virginia creeper is often found in forest interiors where it climbs high into the canopy. Woodbine on the other hand will sprawl over the ground, on fences, rock piles unless it encounters a structure or tree suitable for climbing.

Full sun to partial shade of the forest, moist soils, along fencerows or found growing on disturbed sites where animals and birds have dropped the seeds.



Woodbine climbing a fence post.



Virginia creeper, aerial roots holding onto elm bark.

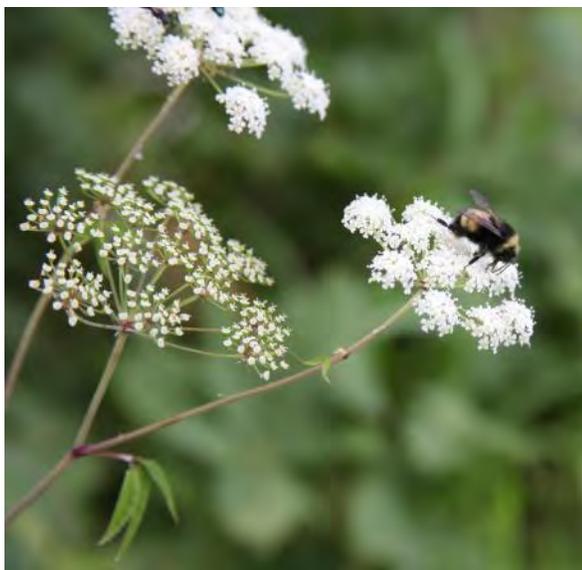
Welby Smith describes the flower petals as "Boat-shaped."



Fall foliage and blue berries.



Adhesive disks at tendril ends.



United States Dept. of Agriculture fact sheet states: "the most violently toxic plant that grows in North America."

Caution All plant parts (foliage, seeds, stems, roots) are **poisonous to humans** and livestock. **Caution** Reported that toxin can be absorbed through bare skin! Wear appropriate PPE - gloves, long sleeves, and long pants.

Identification: *Provided for comparison to [wild carrot](#) on page 38. Also, compare to [poison hemlock](#) on page 13.*

Plant: Herbaceous, biennial (short-lived perennial), first year as a basal rosette and second year water hemlock is a lightly branched, 3-6 feet tall, plant. Stems are smooth (no hairs), hollow (lower portion), appear ridged due to veins and are light green or pinkish or reddish purple.

Key difference - wild carrot stems are hollow and sparingly hairy to hairy. Stems are not spotted, see poison hemlock.

Leaves: Alternate, generally triangular in form. Compound leaves are pinnate or doubly pinnate with 3-7 leaflets. Leaflets are not fern-like. Leaflets are 1-4 inches long by ½- 1¼ inches wide. Leaflets are toothed and veins appear to terminate in the notch between teeth - not at the tip. Petiole to stem attachments are partially covered by a sheath.

Flower: Petals are notched at the tip and narrowed at the base. Flowers are five-petaled, white and held as flat or slightly dome-shaped, loose, open compound umbels. Each umbel is comprised of 10-20 domed umbellets each holding 12-15 flowers. Main branches (rays) of umbels are not subtended by bracts. Secondary branches of umbellets have lanceolate bracts with scarious (thin, dry, membranous) margins.

Key differences - wild carrot has obvious, showy, branched bracts beneath flower umbels and umbellets.

Bloom time is variable - June to August.

Fruit and Seed: Seeds are schizocarps splitting at maturity to two carpels (individual seeds). Seeds are ⅛ inch long and angular. There are no hairs.

Key difference - Wild carrot seeds are also about ⅛ inch with ridges covered by stiff bristles. At maturity wild carrot folds its seed structure into what is often described as a bird's nest.

Habitat: Partial shade is tolerated but preference is full sun with wet to moist fertile soils with organic material. Often found in wet meadows and pastures and other similar sites like moist to wet roadside ditches. Prefers more moisture than poison hemlock and typically, does not compete or occur with poison hemlock.



Identification: Provided for comparison to [poison hemlock](#) and [wild carrot](#), pages 13 and 38 respectively. Compare to [Carrot look-alikes](#), [wild chervil](#) and [water hemlock](#), pgs. 45, 46, and 64.

Plant: Perennial, herbaceous plant reaching heights of 1-2 (3) feet. Stems are pale green, hollow and typically covered with fine hairs. Plants are often unbranched except near the top.

Leaves: Alternate, narrow and finely divided - single or double pinnate - very fern like. Stem leaves are sessile (no leaf stalk) and near top of plants, typically smaller. Leaflets are longest at the middle of the rachis and shorter near the tip and base.

Flower: Terminal branched flower structures (compound corymb) of numerous 5-parted flower heads. Each flower head consists of 5 ray florets and 5 disk florets. Florets are typically whitish to pale cream. White flowers on a flat-topped structure brings about confusion with the carrot family.

Key difference - terminal **branched** panicles or compound corymb versus carrot families compound umbels.

Bloom time is June to September.

Fruit and Seed: Like the flowers, terminal panicles. Florets are replaced by seeds (achenes) lacking hairs. Roots are rhizomatous - thus colonies can be formed.

Habitat: Mesic to dry soils, full to partial sun often in prairies, along roadsides and woodland edges.



Leaf Bases to ----- > Leaf Tips



Typical form with flowers terminal to branches. Branches may be few.

Images of pinnately, compound foliage. Very finely divided, very fern-like.

Top leaf - sessile stem leaf. Bottom leaf - petioled basal leaf.

End of season, dry flower structure. Historically used in architectural modeling as trees.

Citations / Resources:

Prohibited: Eradicate

- Black swallow-wort:** *Cynanchum louiseae* Kartesz & Gandhi Page 4
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
<https://www.invasive.org/weedcd/pdfs/wgw/blackswallowwort.pdf>
<http://www.invasive.org/browse/subinfo.cfm?sub=3398>
- Common teasel:** *Dipsacus fullonum* L. Page 5
Image citations – Bugwood.org:
Flowering head close-up - David Cappaert, Michigan State University,
Flower group, basal rosettes, seed head - Steve Dewey, Utah State University.
Identification and management:
<http://www.illinoiswildflowers.info/weeds/plants/teasel.htm>
<http://www.fs.fed.us/database/feis/plants/forb/dipspp/all.html>
<http://www.invasiveplantatlas.org/subject.html?sub=3018>
- Cutleaf teasel:** *Dipsacus laciniatus* L. Page 6
Image citations: Dave Hanson and Tina Markeson, MnDOT.
Identification and management:
<http://dnr.wi.gov/topic/Invasives/fact/CutLeavedTeasel.html>
<http://www.invasiveplantatlas.org/subject.html?sub=5545>
http://www.missouriplants.com/Whiteopp/Dipsacus_laciniatus_page.html
- Dalmatian toadflax:** *Linaria dalmatica* (L.) Mill. Page 7
Image citation: all images - Dave Hanson, MnDOT
Identification and management: <http://www.cwma.org/Dalmatian.html>
http://wiki.bugwood.org/HPIPM:Dalmatian_toadflax
<http://www.invasiveplantatlas.org/subject.html?sub=5939>
<https://www.cabi.org/isc/datasheet/30827>
- Giant hogweed:** *Heracleum mantegazzianum* Sommier & Levier Page 8
Image citations – Bugwood.org:
Flower - Leslie J. Mehrhoff, University of Connecticut,
Flower and pen - USDA APHIS PPQ Archive, USDA APHIS PPQ,
Leaf - Donna R. Ellis, University of Connecticut,
Foliage to human - Thomas B. Denholm, New Jersey Department of Agriculture.
Identification and management:
<http://www.invasiveplantatlas.org/subject.html?sub=4536>
<http://dnr.wi.gov/topic/Invasives/fact/GiantHogweed.html>
- Grecian foxglove:** *Digitalis lanata* Ehrh. Page 9
Image citations: Dave Hanson and Tina Markeson, MnDOT,
Identification and management:
<http://www.minnesotawildflowers.info/flower/grecian-foxglove>
<http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/foxglove.aspx>

- Japanese hops:** *Humulus japonicus* Siebold & Zucc. Page 10
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
https://science.nature.nps.gov/...NPS_Field_Guide_JapaneseHop.pdf
<http://dnr.wi.gov/topic/Invasives/fact/JapaneseHops.html>
- Oriental bittersweet:** *Celastrus orbiculatus* Thunb. Page 11
Image citations: Ken Graeve and Dave Hanson, MnDOT.
Identification and management: <https://www.cabi.org/isc/datasheet/12009>
<https://www.invasive.org/weedcd/pdfs/wgw/orientalbittersweet.pdf>
<http://dnr.wi.gov/topic/Invasives/fact/OrientalBittersweet.html>
<http://www.invasive.org/browse/subinfo.cfm?sub=3012>
- Palmer amaranth:** *Amaranthus palmeri* S. Watson Page 12
Foliage images: Aaron Hager, University of Illinois at Urbana-Champaign.
Image citations from Bugwood.org:
Leaf/petiole and plant form - Ross Recker, University of Wisconsin - Madison,
Female seed spike and thick stem - Rebekah D. Wallace, University of Georgia.
Identification and management:
Becker, Roger. University of Minnesota. Herbicide recommendations. Email.
<http://www.ksre.ksu.edu/bookstore/pubs/s80.pdf>
<http://www.extension.org/pages/65209/palmer-amaranth-amaranthus-palmeri>
<http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/palmeramaranth.aspx>
<http://www.weeds.iastate.edu/mgmt/2014/Palmer%20amaranthICMv2.0.pdf>
- Poison hemlock:** *Conium maculatum* L. Page 13
Image citation: all images - Dave Hanson, MnDOT.
Identification: <https://gobotany.newenglandwild.org/species/conium/maculatum/>
http://www.illinoiswildflowers.info/weeds/plants/poison_hemlock.htm
- Yellow starthistle:** *Centaurea solstitialis* L. Page 14
Image citations – Bugwood.org: Bolting stage - Cindy Roche,
Flower up-close - Peggy Greb, USDA Agricultural Research Service,
Mature foliage, basal rosette - Steve Dewey, Utah State University.
Identification and management:
<https://www.invasive.org/weedcd/pdfs/wgw/yellowstarthistle.pdf>
<http://www.invasive.org/browse/subinfo.cfm?sub=4390>
https://www.fs.fed.us/foresthealth/technology/pdfs/...Biocontrol_Yellow_Starthistle.pdf
- Knapweed complex:** Page 15-16
Identification and management: <http://wiki.bugwood.org/Archive:Knapweed>
<http://www.ag.ndsu.edu/pubs/plantsci/weeds/w1146.pdf>
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- Brown knapweed:** *Centaurea jacea* L. Page 15-16
Image citations – Bugwood.org:
Flower - Rob Routledge, Sault College; Flower side view - Cindy Roche.
Foliage and form - Bruce Ackley, The Ohio State University,
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http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250066298
<http://www.invasiveplantatlas.org/subject.html?sub=5278>
<http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artmar06/bj-knapweed.html>

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Meadow knapweed: *Centaurea moncktonii* C. E. Britton Page 15-16
Image citation: all images - Tom Jacobson, MnDOT.
Identification and management:
http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250068128
<http://www.mda.state.mn.us/en/plants/pestmanagement/weedcontrol/noxiouslist/meadowkw.aspx>

Diffuse knapweed: *Centaurea moncktonii* C. E. Britton Page 15-16
Image citation: Steve Dewey, Utah State University, Bugwood.org
K. George Beck and James Sebastian, Colorado State University, Bugwood.org
Identification and management:
<http://www.cwma.org/DiffuseKnapweed.html>

Russian knapweed: *Acroptilon repens* (L.) DC. Page 15-16
Currently not listed in Minnesota.
Identification and management:
<http://extension.colostate.edu/topic-areas/natural-resources/russian-knapweed-3-111/>

Prohibited: Control

Spotted knapweed: *Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek Page 17
Image citation:
Flower top/side views, basal rosette, rosette foliage - Dave Hanson, MnDOT.
Image citations – Bugwood.org: Foliage - James H. Miller, USDA Forest Service.
Images and good identification write-up: Minnesota wildflowers
<http://www.minnesotawildflowers.info/flower/spotted-knapweed>
Discussion and management considerations:
http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250068126
<http://dnr.wi.gov/topic/Invasives/fact/SpottedKnapweed.html>
http://wiki.bugwood.org/Centaurea_stoebe_ssp_micranthos
<http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/spottedknapweed.aspx>

Barberry, common: *Berberis vulgaris* L. Page 18
Image citations: Bugwood.org: Leslie J. Mehrhoff, University of Connecticut.
Identification and management:
<https://gobotany.newenglandwild.org/species/berberis/vulgaris/>
<https://gobotany.newenglandwild.org/dkey/berberis/> (dichotomous key)
Japanese Barberry control information:
[https://mipncontroldatabase.wisc.edu/search?name=Berberis thunbergii#plants](https://mipncontroldatabase.wisc.edu/search?name=Berberis_thunbergii#plants)

Canada thistle: *Cirsium arvense* (L.) Scop. Page 19
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
<http://www.minnesotawildflowers.info/flower/canada-thistle>
<http://dnr.wi.gov/topic/Invasives/fact/CanadaThistle.html>

Plumeless thistle: *Carduus acanthoides* L. Page 20
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
<http://www.minnesotawildflowers.info/flower/plumeless-thistle>
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Leafy spurge: *Euphorbia esula* L. Page 21
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
<http://www.minnesotawildflowers.info/flower/leafy-spurge>
<http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/leafyspurge.aspx>

Narrowleaf bittercress: *Cardamine impatiens* L. Page 22
Image citations – Bugwood.org: Leslie J. Mehrhoff, University of Connecticut.
Identification and management:
<http://www.minnesotawildflowers.info/flower/narrow-leaf-bittercress>
<http://www.invasive.org/browse/subinfo.cfm?sub=11539>

Purple loosestrife: *Lythrum salicaria* L. and *Lythrum virgatum* L. Page 23
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
<http://www.minnesotawildflowers.info/flower/purple-loosestrife>
Write-up on identification and control options:
<https://www.invasive.org/weedcd/pdfs/wgw/purpleloosestrife.pdf>
<http://wiki.bugwood.org/Archive:Loosestrife>
<http://dnr.wi.gov/topic/Invasives/fact/PurpleLoosestrife.html>
<http://www.dnr.state.mn.us/invasives/aquaticplants/purpleloosestrife/index.html>

Common tansy: *Tanacetum vulgare* L. Page 24
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
<http://www.minnesotawildflowers.info/flower/common-tansy>
Identification and management:
<http://dnr.wi.gov/topic/Invasives/fact/Tansy.html>
<http://www.fs.fed.us/database/feis/plants/forb/tanvul/all.html>

Wild parsnip: *Pastinaca sativa* L. Page 25
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
<http://www.minnesotawildflowers.info/flower/wild-parsnip>
Identification and management:
<http://dnr.wi.gov/topic/Invasives/fact/WildParsnip.html>
http://wiki.bugwood.org/Pastinaca_sativa

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Restricted Noxious weeds:

- Asian bush honeysuckles:** *Lonicera* spp. Page 26
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
Dirr, Michael. 2009. *Manual of Woody Landscape Plants* (full citation page 69)
Smith, Welby R. 2008. *Trees and shrubs of Minnesota: the complete guide to species identification*. Minneapolis, MN: University of Minnesota Press.
- Black locust:** *Robinia pseudoacacia* L. Page 27
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
Dirr, Michael. 2009. *Manual of Woody Landscape Plants* (full citation page 69)
<http://mipncontroldatabase.wisc.edu/>
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_015112.pdf
- Crown vetch:** *Securigera varia* (L.) Lassen Page 28
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
http://www.illinoiswildflowers.info/weeds/plants/crown_vetch.htm
<http://mipncontroldatabase.wisc.edu/>
- Common buckthorn:** *Rhamnus cathartica* L. Page 29
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
<http://dnr.wi.gov/topic/Invasives/fact/CommonBuckthorn.html>
http://wiki.bugwood.org/Rhamnus_cathartica
- Glossy buckthorn (and all cultivars):** *Frangula alnus* Mill. Page 30
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
<http://dnr.wi.gov/topic/Invasives/fact/GlossyBuckthorn.html>
http://wiki.bugwood.org/Frangula_alnus
<http://www.fs.fed.us/database/feis/plants/shrub/fraaln/all.html>
- Garlic mustard:** *Alliaria petiolata* (M. Bieb.) Cavara & Grande Page 31
Image citation: all images - Dave Hanson, MnDOT.
Images and good identification write-up: Minnesota wildflowers
<http://www.minnesotawildflowers.info/flower/garlic-mustard>
Management:
http://www.ipm.msu.edu/invasive_species/garlic_mustard
- Japanese barberry:** *Berberis thunbergii* DC. Page 32- 33
Image citation: all images - Dave Hanson, MnDOT.
Identification and Management: <http://www.mipn.org/control.html>
Dirr, Michael. 2009. *Manual of Woody Landscape Plants* (full citation page 69)
<http://dnr.wi.gov/topic/Invasives/fact/JapaneseBarberry.html>
Seed viability: <http://www.invasive.org/weedcd/pdfs/srs/2008/barberry.pdf>

- Multiflora rose:** *Rosa multiflora* Thunb. Page 34
Image citation: all images - Dave Hanson, MnDOT.
Identification and Management:
<http://dnr.wi.gov/topic/Invasives/fact/MultifloraRose.html>
http://wiki.bugwood.org/Rosa_multiflora#MANAGEMENT.2FMONITORING
- Nonnative phragmites:** *Phragmites australis* (Cav.) Trin. Ex Steud. Page 35
Image citations: Ken Graeve and Dave Hanson, MnDOT.
Identification and Management:
<http://dnr.wi.gov/topic/Invasives/fact/Phragmites.html>
http://www.nmca.org/PHRAG_FIELD_GUIDE.pdf
<https://www.invasive.org/weedcd/pdfs/wgw/commonreed.pdf>
- Porcelain berry:** *Ampelopsis brevipedunculata* (Maxim.) Trautv. Page 36
Image citations: Foliage image - Paul Kortebein.
Other images - Dave Hanson, MnDOT.
Identification and management:
<https://www.nps.gov/plants/alien/pubs/midatlantic/ambr.htm>
- Tree-of-Heaven:** *Ailanthus altissima* (Mill.) Swingle Page 37
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
<https://www.invasive.org/weedcd/pdfs/wgw/treeofheaven.pdf>
<http://www.ecolandscaping.org/05/invasive-plants/tree-of-heaven-an-...-fact-sheet>
<http://mipncontroldatabase.wisc.edu/>
- Wild carrot:** *Daucus carota* L. Page 38
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
<https://www.minnesotawildflowers.info/flower/queen-annes-lace>
[Controlling Wild Carrot in Hay fields and Pastures](http://www.invasive.org/weedcd/pdfs/wgw/treeofheaven.pdf)
[Controlling wild carrot](http://www.invasive.org/weedcd/pdfs/wgw/treeofheaven.pdf)

Specially Regulated Plants:

- Amur maple:** *Acer ginnala* Maxim. Page 39
Image citation: all images - Dave Hanson, MnDOT.
Identification and management:
<http://www.invasiveplantatlas.org/subject.html?sub=3965>
<http://dnr.wi.gov/topic/Invasives/fact/AmurMaple.html>

Citations / Resources continued:

Specially Regulated Plants:

Knotweed, Japanese: *Polygonum cuspidatum* Siebold & Zucc. Page 40-41
Image citation: all images - Dave Hanson, MnDOT.
Identification and Management:
<http://www.mipn.org/control.html>
<http://dnr.wi.gov/topic/Invasives/fact/JapaneseKnotweed.html>
<http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/invasive-knotweeds/japanese-knotweed.aspx>

Knotweed, giant: *Polygonum sachalinense* F. Schmidt ex Maxim. Page 40-41
Image citation: all images -
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org
Identification and Management:
<http://www.mipn.org/control.html>
<http://dnr.wi.gov/topic/Invasives/fact/GiantKnotweed.html>
<http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/invasive-knotweeds.aspx>

Knotweed, Bohemian: *Polygonum xbohemicum* (J. Chrtek & Chrtkova) Zika & Jacobson
Image citations: Dave Hanson, MnDOT and
see citations for Japanese and giant knotweeds, pages 40-41.
Identification and management:
https://www.for.gov.bc.ca/hra/publications/invasive_plants/Knotweed_key_BC_2007.pdf
<http://www.kingcounty.gov/s.../weed-identification/invasive-knotweeds/bohemian-knotweed.aspx>
Download Montana State university Guide:
[Biology, Ecology and management of the Knotweed complex \(*Polygonum* species\)](#)

Poison ivy: western [*Toxicodendron rydbergii* (Small) Green] Page 42
common [*T. radicans* (L.) Kuntze ssp. *negundo* (Greene) Gillis]
Image citation: all images - Dave Hanson, MnDOT.
Identification and Management:
http://www.nps.gov/public_health/info/factsheets/fs_pivy.htm
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Web links verified January, 2018.

Miscellaneous images: Dave Hanson, MnDOT
Cover photo: Oriental bittersweet in Winona, County on October 26, 2017..
Photos page 2: Dalmatian toadflax, Japanese hops and garlic mustard.
Photos page 3: field thistle, cow parsnip and stiff golden rod.

Page 69: Dave Hanson, MnDOT
Biological control images including: spotted knapweed root weevil, loose-strife beetle, leafy spurge flea beetle and spotted knapweed seedhead weevil.

Miscellaneous image: MnDOT
Page 69: herbicide application.

Miscellaneous images: Ken Graeve, MnDOT
Page 69: mowing and prescribed fire.

Nonnative Plants:

Alfalfa: *Medicago sativa* L. Page 43
Image citations – Bugwood.org:
Foliage - Gerald Holmes, Valent USA Corporation,
Flower - Keith Weller, USDA Agricultural Research Service.
Identification:
<http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=4213>

Hairy vetch : *Vicia villosa* Roth Page 43
Image citation: all images - Dave Hanson, MnDOT.
Identification:
<http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=5382>
<http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=Coronilla%20varia>

Balkan catchfly: *Silene csereii* Baumgarten Page 44
Image citation: Dave Hanson and Ken Graeve, MnDOT.
Identification:
<http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=5045>
<http://www.minnesotawildflowers.info/flower/balkan-catchfly>

Carrot look-alikes: Various species of carrot family members Page 45
Image citation: all images - Dave Hanson, MnDOT.
Identification:
<https://www.minnesotawildflowers.info/flower/caraway>
<https://www.minnesotawildflowers.info/flower/burnet-saxifrage>
<http://www.invasiveplantatlas.org/subject.html?sub=12275>
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Chervil, wild: *Anthriscus sylvestris* (L.) Hoffm. Page 45
Image citation: all images - Dave Hanson, MnDOT.
Identification:
<https://www.minnesotawildflowers.info/flower/wild-chervil>

Musk or nodding thistle: *Carduus nutans* L. Page 46
Image citation: all images - Dave Hanson, MnDOT.
Other images and good identification write-up: Missouri Plants
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Yellow rocket: *Barbarea vulgaris* W. T. Aiton. Page 47
Image citation: Dave Hanson and Tina Markeson, MnDOT.
Identification:
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American bittersweet: *Celastrus scandens* L. Page 48

Image citation: all images - Dave Hanson, MnDOT.

Identification:

<http://dendro.cnre.vt.edu/dendrology/syllabus/factsheet.cfm?ID=913>

American vetch: *Vicia americana* Muhl. Ex Willd. Page 49

Image citation: all images - Dave Hanson, MnDOT.

Identification:

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Canadian milkvetch: *Astragalus canadensis* L. Page 49

Image citation: all images - Dave Hanson, MnDOT.

Identification:

http://www.illinoiswildflowers.info/prairie/plantx/can_milkvetchx.htm

<https://www.minnesotawildflowers.info/flower/canada-milkvetch>

Cherries and wild plum: *Prunus* spp. Page 50

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://wisflora.herbarium.wisc.edu/imagelib/index.php>

Genera: Prunus

Common hops: *Humulus lupulus* L. Page 51

Image citation: all images - Dave Hanson, MnDOT.

Identification:

http://www.hort.purdue.edu/newcrop/duke_energy/humulus_lupulus.html

Cow-parsnip: *Heracleum lanatum* Michx. Page 52

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/flower/common-cow-parsnip>

Cucumbers, wild and bur: *Echinocystis lobata* Michx. and *Sicyos angulatus* L. Page 53

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/flower/wild-cucumber>

<http://www.minnesotawildflowers.info/flower/bur-cucumber>

Fireweed: *Chamerion angustifolium* (L.) Holub ssp. *angustifolium* Page 54

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/flower/fireweed>

Golden alexanders: *Zizia aurea* (L.) W.D.J. Koch and *Z. aptera* (A. Gray) Fernald Page 55

Image citation: all images - Dave Hanson, MnDOT.

Identification:

<http://www.minnesotawildflowers.info/flower/golden-alexanders>

<http://www.minnesotawildflowers.info/flower/heart-leaved-alexanders>

Goldenrods: *Solidago* spp. Page 56

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/>

Search plant name: solidago

Grape, riverbank: *Vitis riparia* Michx. Page 57

Image citations: all images - Dave Hanson, MnDOT.

Identification:

Smith, Welby R. 2008. *Trees and shrubs of Minnesota*. (full citation page 69).

Native honeysuckles: *Diervilla lonicera* Mill. and *Lonicera* spp. Page 58

Image citation: all images - Dave Hanson, MnDOT.

Identification:

Smith, Welby R. 2008. *Trees and shrubs of Minnesota*. (full citation page 69).

Native phragmites: *Phragmites australis* (Cav.) Trin. ex Steud. ssp. *americanus* Saltonstall Page 59

Image citations: Ken Graeve and Dave Hanson, MnDOT.

Identification: <http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?451454>

https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmctn11494.pdf

<http://greatlakesphragmites.net/basics/native-vs-invasive/>

Sumac, Staghorn and Smooth: *Rhus typhina* L. and *R. glabra* L. Page 60

Image citation: all images - Dave Hanson, MnDOT.

Identification:

Smith, Welby R. 2008. *Trees and shrubs of Minnesota*. (full citation page 69).

Swamp thistle: *Cirsium muticum* Michx. Page 61

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/flower/swamp-thistle>

Virginia creeper and woodbine: *Parthenocissus* spp. Page 62

Image citation: all images - Dave Hanson, MnDOT.

Identification:

Smith, Welby R. 2008. *Trees and shrubs of Minnesota*. (full citation page 69).

Water hemlock: *Cicuta maculata* L. Page 63

Image citation: all images - Dave Hanson, MnDOT.

Identification:

http://www.illinoiswildflowers.info/wetland/plants/water_hemlock.htm

Yarrow, Common: *Achillea millefolium* L. Page 61

Image citation: all images - Dave Hanson, MnDOT.

Identification:

<https://www.minnesotawildflowers.info/flower/common-yarrow>

<http://www.illinoiswildflowers.info/weeds/plants/yarrow.htm>

Additional Book and Web Resources:

Black Merel R., Emmet J. Judziewicz. 2009. *Wildflowers of Wisconsin and the Great Lakes Region: a comprehensive field guide*. Univ of Wisconsin Press. 275 pages.

Dirr, Michael. 2009. *Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation and uses*. Champaign, Ill: Stipes Pub.

Invasive.org – images at Bugwood. Online. <http://www.invasive.org/species/forbs.cfm>
Factsheets. Online. [Weeds Gone Wild: Alien Plant Invaders of Natural Areas](http://www.invasive.org/weedcd/html/wgw.htm).

Midwest Invasive Plant Network. Online. <http://www.mipn.org/>
Education, identification, control and management.

Minnesota Department of Agriculture. Online.
- [Noxious weed list](#) and Fact sheets - [Noxious weed law](#)
- [Biological control](#) - [Pest management](#)

Minnesota Department of Transportation. 2011. *Herbicide Options for Vegetation Control on Mn/DOT Rights-of-Way*. Internal Document.
[herbicidepreseasonables.pdf](#)

Mortenson, Carol. 2003. *Noxious Weeds of Minnesota*. Leech Lake Division of Resources Management.

PCA Alien Plant Working Group. 2010. *Least Wanted: Alien Plant Invaders of Natural Areas*. Factsheets. Online. <https://www.invasive.org/weedcd/html/wgw.htm>

Sarver, Matthew. et al. 2008. *Mistaken Identity? Invasive plants and their native look-alikes*. online. http://www.nybg.org/files/scientists/rnaczi/Mistaken_Identity_Final.pdf 12/2012.

Smith, Welby R. 2008. *Trees and shrubs of Minnesota: the complete guide to species identification*. Minneapolis, MN: University of Minnesota Press.

USDA Plants Database. <https://plants.usda.gov/java/>. United States Department of Agriculture, Natural Resources Conservation Service.

Wisconsin DNR. 2010. *A field Guide to Terrestrial Invasive Plants in Wisconsin*. Ed. Thomas Boos, Kelly Kearns, Courtney LeClair, Brandon Panke, Bryn Scrivner, and Bernadette Williams.

Wisconsin Department of Natural Resources factsheets:
Online. [Terrestrial Invasive Species: List, Factsheets, Images](#)



Biological Controls

Mowing or Other Mechanical Means

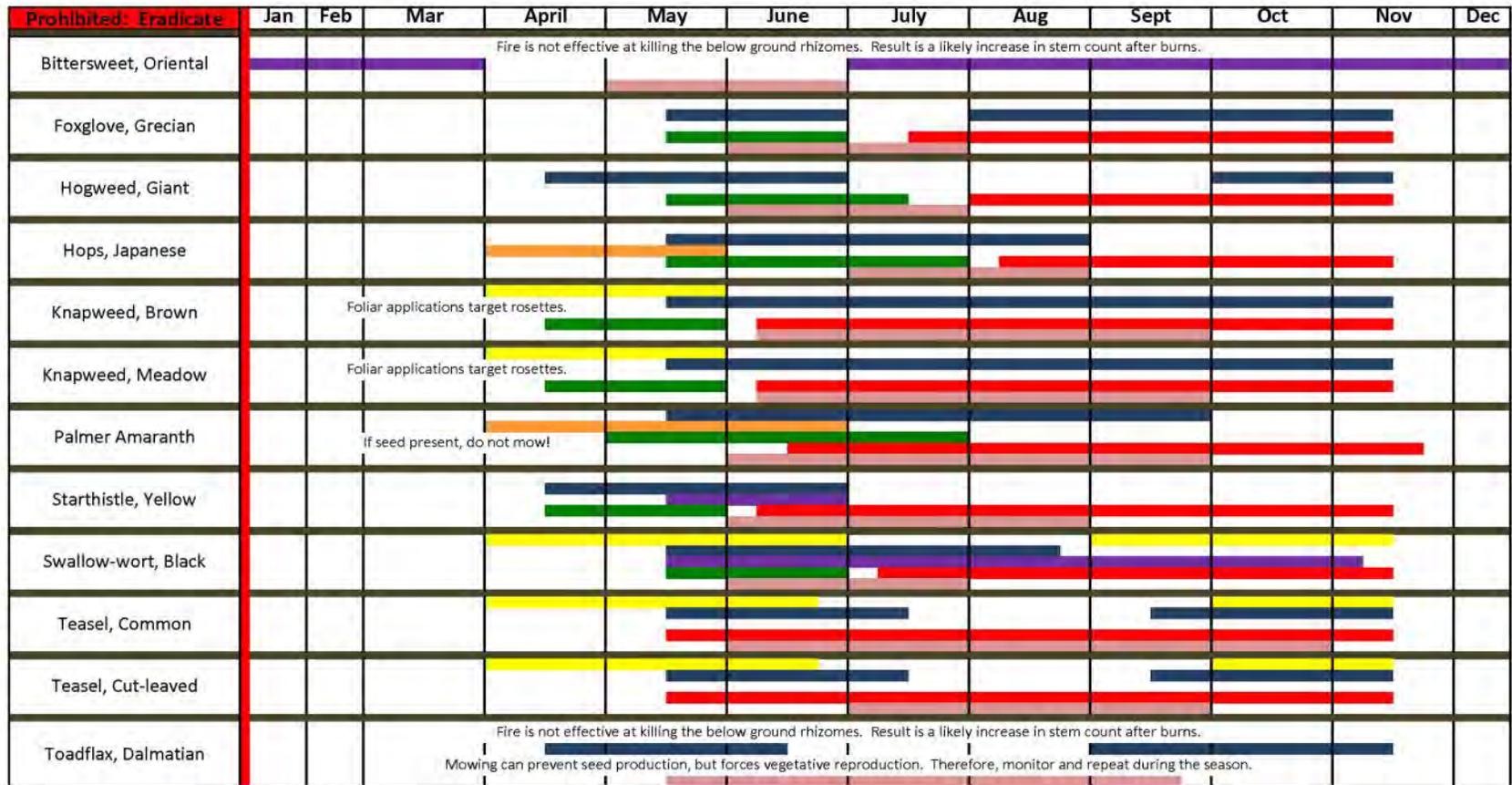
Herbicide

Prescribed Fire

Management tactics can take many forms and should be based on predefined vegetation management goals.

Suggested timing of management tactics or control options can be found in graphical form on the following two pages.
Timings are based on recommendations described in the many resources listed on the previous pages.

Suggested Timing of Control Options for
Minnesota Noxious Weed Species (2016)



N:_Programs\Roadside_Veg_Mngt\Pesticide\Herbicide-options-calendar\2016-Herbicide_tables-cheat-sheets\2016_Management-calendar.xlsx

djh (March, 2016).

Suggested Timing of Control Options for
Minnesota Noxious Weed Species (2016)

| Prohibited: Control | Jan | Feb | Mar | April | May | June | July | Aug | Sept | Oct | Nov | Dec |
|-------------------------------|------------|------------|------------|--------------|------------|-------------|-------------|------------|-------------|------------|------------|------------|
| Bittercress, Narrowleaf | | | | | | | | | | | | |
| Knapweed, Spotted | | | | | | | | | | | | |
| Loosestrife, Purple | | | | | | | | | | | | |
| Parsnip, Wild | | | | | | | | | | | | |
| Spurge, Leafy | | | | | | | | | | | | |
| Tansy, Common | | | | | | | | | | | | |
| Thistle, Canada | | | | | | | | | | | | |
| Thistle, Plumeless | | | | | | | | | | | | |
| Restricted | Jan | Feb | Mar | April | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Buckthorn, Glossy | | | | | | | | | | | | |
| Buckthorn, Common | | | | | | | | | | | | |
| Mustard, Garlic | | | | | | | | | | | | |
| Nonnative Phragmites | | | | | | | | | | | | |
| Rose, Multiflora | | | | | | | | | | | | |
| Specially Regulated | Jan | Feb | Mar | April | May | June | July | Aug | Sept | Oct | Nov | Dec |
| Barberry, Japanese | | | | | | | | | | | | |
| Knotweed, Japanese or giant | | | | | | | | | | | | |
| Poison Ivy, Common or Western | | | | | | | | | | | | |

N:_Programs\Roadside_Veg_Mngt\Pesticide\Herbicide-options-calendar\2016-Herbicide_tables-cheat-sheets\2016_Management-calendar.xlsx

dih (March, 2016).

Definitions of the noxious weed categories from the Minnesota Department of Agriculture web page:

<http://www.mda.state.mn.us/en/plants/pestmanagement/weedcontrol/noxiouslist.aspx>

State Prohibited Noxious Weeds

Prohibited noxious weeds are annual, biennial, or perennial plants that the commissioner designates as having the potential or are known to be detrimental to human or animal health, the environment, public roads, crops, livestock or other property. There are two regulatory listings for prohibited noxious weeds in Minnesota:

1. **Eradicate List:** Prohibited noxious weeds that are listed to be eradicated are plants that are not currently known to be present in Minnesota or are not widely established. These species must be eradicated, meaning all of the above and below ground parts of the plant must be destroyed, as required by Minnesota Statutes, Section 18.78. Additionally, no transportation, propagation, or sale of these plants is allowed. Measures must also be taken to prevent and exclude these species from being introduced into Minnesota.
2. **Controlled List:** Prohibited noxious weeds listed to be controlled are plants established throughout Minnesota or regions of the state. Species on this list must be controlled, meaning efforts must be made to prevent the spread, maturation and dispersal of any propagating parts, thereby reducing established populations and preventing reproduction and spread as required by Minnesota Statutes, Section 18.78. Additionally, transportation, propagation, or sale of these plants is prohibited.

Restricted Noxious Weeds

Restricted noxious weeds are plants that are widely distributed in Minnesota and are detrimental to human or animal health, the environment, public roads, crops, livestock or other property, but whose only feasible means of control is to prevent their spread by prohibiting the importation, sale, and transportation of their propagating parts in the state except as allowed by Minnesota Statutes, Section 18.82. Plants designated as Restricted Noxious Weeds may be reclassified if effective means of control are developed.

Specially Regulated Plants

Specially regulated plants are plants that may be native species or have demonstrated economic value, but also have the potential to cause harm in non-controlled environments. Plants designated as specially regulated have been determined to pose ecological, economical, or human or animal health concerns. Plant specific management plans and or rules that define the use and management requirements for these plants will be developed by the Minnesota Department of Agriculture for each plant designated as specially regulated. Measures must also be taken to minimize the potential for harm caused by these plants.

Amur maple: Sellers shall affix a label that advises buyers to only plant Amur maple and its cultivars in landscapes where the seedlings will be controlled by mowing or other means. Amur maple should be planted at least 100 yards from natural areas. [Return](#) to Amur maple.

Knotweeds, giant and Japanese: Any person, corporation, business or other retail entity distributing Japanese and/or giant knotweeds for sale within the state, must have information directly affixed to the plant or container packaging that it is being sold with, indicating that it is inadvisable to plant this species within 100 feet of a water body or its designated flood plain as defined by Minnesota Statute 103F.111, Subdivision 4. [Return](#) to knotweeds.

Poison ivy: Must be eradicated or controlled for public safety along rights-of-ways, trails, public accesses, business properties open to the public or on parts of lands where public access for business or commerce is granted. Must also be eradicated or controlled along property borders when requested by adjoining landowners. [Return](#) to poison ivy.

Minnesota Noxious Weeds

<http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf>



This book has two parts; part 1 (index pg. 2) contains terrestrial noxious weeds and part 2 (index pg. 3) contains look-alike plants.

For example, compare:

Left: Noxious weed, Oriental bitterweet (*Celastrus orbiculatus*) that has flowers and fruits in leaf axils along its vine (white arrows).

Right: Native plant, American bitterweet (*Celastrus scandens*) has flowers and fruits only at the terminus of branches.



Index on page 2 contains terrestrial noxious weeds listed under:

Minnesota Noxious Weed Law:
Find more information at:

[Minnesota Department of Agriculture.](#)

Index on page 3 contains a list of terrestrial nonnative and native species often mistaken for the associated noxious weeds.

These terrestrial plant descriptions are provided in an effort to prevent mistaken identities.

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Reference herein to any specific commercial products, process, or service by tradename, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favoring by MnDOT and the State of Minnesota.

Scientific names (genus and species) were sourced from : [USDA Plants Database](#)

Minnesota Noxious Weeds

<http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf>

The index on page 2 contains
terrestrial noxious weeds listed under
Minnesota Noxious Weed Law

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January, 2018



CITY OF BROOKLYN PARK FORESTRY

1. PURPOSE

The purpose of this administrative policy is to outline policies and procedures for public and private forestry, in new and existing areas.

2. APPLICABILITY

This administrative policy is applicable to all public and private forestry.

DEFINITION(S)

- Private forestry means trees on privately owned property.
- Public forestry means trees on public easements (public right-of-way and public use), parks and public buildings grounds.
- Street trees are public forestry that are in public right-of-way on the boulevard or median.
- Park and public ground trees are public forestry that are in parks or other public land used primarily for recreation or other active public purposes.
- Park and public ground natural areas are located in parks or other public land used secondarily for recreation or other limited public purposes.

POLICY

- A. The primary purpose of public and private forestry shall be to provide protection from climatic extremes and improve the environment, such as:
- Provide shade and wind protection
 - Improve air quality by capturing pollution particles and reducing carbon dioxide
 - Improve water quality of rivers and streams
 - Provide food and shelter for wildlife
- B. The secondary purpose of public and private forestry shall be to provide aesthetics and other intangibles such as:
- Streetscapes, parks and private properties beautification
 - Provide privacy and aid in reduction of noise and glare
 - Help in reducing stress levels and possibly crime levels

C. STREET TREE SPECIES/LOCATION STANDARDS

1. Street tree species and location shall be as approved by the Operations & Maintenance Department/Park Maintenance Division.
2. Street tree species shall be from the following list and be a minimum trunk diameter of two (2) inches measured six (6) inches above grade (**no coniferous trees allowed**):

Shade Trees

Bi-Color Oak (swamp white oak)
Ironwood/Hop Horn Beam
Ginko (no female) slow growing
Hackberry
Honey Locust
Linden
Red Maple
Sugar Maple
River Birch
Red Oak
Burr Oak
Pin Oak
American Basswood
Other as Approved by City Forester

Ornamental Trees

Amur Maple (single stem)
Japanese Lilac Tree
Service Berry (Tree Farm)
Newport Plum
Pink Spire Crabapple
Red Splendor Crabapple
Prairiefire Crabapple
Other as Approved by City Forester

3. Street trees generally are not installed in boulevards or medians, but may be installed in locations as follows:
 - a. Arterial or major collector street designated entryway medians as approved by the City Council
 - b. Special development projects area street medians and possibly boulevards as approved by the City Council
 - c. Cul-de-sacs and entrance medians in **association maintained** developments as approved by the City Council
 - d. Replacement in areas with existing street trees as location standards allow; replacements are normally planted in the front yard, not in the boulevard
 - e. Planting by private property owners with Operations & Maintenance Department/Park Maintenance Division's permission and meeting street-tree species/location standards as listed in section C
4. **Street tree specific location standards (when allowed) shall be as follows:**
 - a. The boulevard (planting area) must be eight (8) feet or more in width.
 - b. The planting site must be located as follows:
 - 30 feet or more from street curb intersections as per City Code Section 364.7
 - 10-20 feet from curb on collector and arterial streets;

preferably 15 feet

- 5-12 feet from curb on local streets; preferably 10 feet
- 10 feet or more from any sewer or water line, fire hydrant or driveway as per City Code Section 93.25
- 5 feet or more from any gas, electric, telephone, cable TV or other under ground utility
- 3 feet or more from any sidewalk or trail
- 2 feet or more from any public right-of-way
- 18 foot maximum height of tree at maturity, if within 18 feet of a **Distribution Power Line**
- 25 foot clear zone (no plantings) on either side of a **Transmission Power Line**

D. PRIVATE TREE SPECIES/LOCATION RECOMMENDATIONS

1. Private property tree species are recommended to be chosen from the section C. street tree list or the following additional tree list (keeping in mind that a variety of tree species is best for a healthy urban forest):

Coniferous Trees

- Balsam Fir
- Pine
- White Spruce (Black Hills Spruce)
- Other species allowed if recommended by a qualified arborist and approved by City Forester.

2. Private property tree location standards are recommended or required as follows in addition to zoning code, development agreement or conditional use permit requirements:

- a. The planting site should be located as follows:

- 30 feet or more from street curb intersections as per City Code Section 364.7
- 10 feet or more from any sewer or water line
- 18 foot maximum height of tree at maturity, if within 18 feet of a **Distribution Power Line**
- 25 foot clear zone (no plantings) on either side of a **Transmission Power Line**
- 5 feet or more from a fire hydrant, gas or electric underground utility, driveway or property line as per City Code Section 93.25
- 3 feet or more from any sidewalk or trail
- 1 1/2 feet or more from any public right-of-way
- 20 feet or more from any building (shade tree)
- 15 feet or more from any building (ornamental tree)

3. The developer, contractor or individual private property owner must call for Gopher State One-Call utility locates.

E. COST/FUNDING RELATED ISSUES

1. Costs for new public forestry installations shall be determined on a case by case basis, with funding by the City or developer or a combination of City, developer, donations or grant funding.
2. Costs for public forestry maintenance, diseased or other removal, replacement and fill-in shall be borne by the City general fund, as each adopted annual budget allows.
3. Costs for private forestry installation, maintenance, diseased or other removal and replacement, shall be borne 100% by developer or private property owner.

ADMINISTRATIVE PROCEDURES

A. Installation of public and private trees.

1. The Operations & Maintenance Department shall maintain public and private forestry specifications and installation requirements.
2. The Community Development Department and Operations & Maintenance Department shall maintain the City Code ordinances and other development policies to provide for private forestry and project specific public forestry.
3. The Community Development Department and Operations & Maintenance Department shall coordinate the development agreement requirements and ensure that new construction forestry is installed as per the agreement.
4. Public forestry street trees shall be installed as per this general policy and as per development agreements and specific special project plans and specifications as approved by the City Council.
5. Public forestry street trees installed by private property owners after initial development, shall be by permission and direction of the Operations & Maintenance Department/Park Maintenance Division.
6. Other public forestry (trees on parks and other public grounds) shall be installed as per park and public building development grounds or as directed by the Operations & Maintenance Department/Park Maintenance Division.
7. Private forestry trees shall be installed by developers and individual property owners per development agreement, City Code ordinances and this policy.

B. Maintenance of public and private trees.

1. The Operations & Maintenance Department will develop an annual 5-year Capital Improvement Plan program related to this policy.

2. The Operations & Maintenance Department/Park Maintenance Division is responsible for the related annual public forestry operations and maintenance budgets and for annual review/development of methods that could control, contain or reduce costs.
3. Private forestry maintenance and replacement is the responsibility of the private property owner.
4. Public and private forestry maintenance shall be in conformance with City Code Chapter 97, Grass, Weed, and Tree Regulations as well as policies O&M 3.15 - Public Easement Maintenance, O&M 5.25 Emerald Ash Borer Preparedness and Management Plan, O&M 5.30 – Park Facilities Maintenance and O&M 5.40 Arterial/Collector Street (Roadway) Median and Boulevard Landscaping.

Cross-Referenced: Resolution #2011-128

**CITY OF BROOKLYN PARK
EMERALD ASH BORER (EAB) PREPAREDNESS AND MANAGEMENT PLAN**

I. INTRODUCTION

The Emerald Ash Borer (EAB) is a non-native insect that was introduced to North America from Asia. It was first discovered in the Detroit, Michigan/Windsor Ontario area in 2002, arriving likely in wood crating for packaged freight that was transported here via ship or airplane. Despite eradication and suppression efforts, EAB has killed over 20 million Ash trees throughout the U.S. and Canada. In May of 2009, EAB was identified for the first time in Minnesota and in August of 2017, EAB was found for the first time in Brooklyn Park.

EAB is a beetle that is smaller than a dime. The adult does very little damage; however, this is not the case with the larvae (immature stage) that feed on the inner bark of ash trees. Over a couple of years of feeding off of the tree the larvae will completely disrupt the feeding of nutrients to the tree and eventually kill the tree. All species of ash trees are susceptible and it is hard to detect presence of EAB, therefore it can be present for years before an infestation is confirmed.

Currently, the City has approximately 5,000 ash trees on public property, it is estimated that there could be three times as many privately owned ash trees. An undertaking as large as the infestation of EAB will bring about many issues that are difficult to predict and articulate at this time. However, they will need attention as they come more into focus. The most notable of these issues will be the additional funding, personnel and equipment needed to deal with the infestation.

II. PURPOSE

The purpose of this policy is to outline policies and operational procedures to mitigate the disruption to the urban forest caused by the infestation of the Emerald Ash Borer (EAB). Taking a proactive approach, this policy provides the framework for implementation of an EAB Preparedness and Management Plan (Plan), enabling the City to address public and private needs in an efficient and effective manner.

III. APPLICABILITY

This policy is applicable to all public and private properties in the City of Brooklyn Park where such EAB infested trees may negatively or generally threaten the health of the urban forest overall.

Definitions

Easement. Specific areas granted as public by property deeds for specific use for streets, storm water conveyance, utilities (public or private), sidewalks and trails, etc.

Right of Way (ROW). An area granted as a public easement by property deeds for general use for streets, storm water conveyance, utilities (public or private), sidewalks and trails, etc.

Tree. Any woody plant, having a single woody trunk and a potential diameter of two inches or more.

Private Trees. Trees located on privately owned property including but not limited to: residential, commercial, industrial, and other publicly owned property.

Public Trees. Trees located on City owned public property including but not limited to: Parks and open space; public building grounds; street boulevards, medians, and other public rights of way.

IV. **POLICY**

Administration of the Plan

The Park & Building Maintenance Manager and the Park Maintenance Division, through the Operations and Maintenance Department, will be responsible for implementation and follow up on the provisions of the Plan. The Operations and Maintenance Department will work closely with the Recreation and Parks Department including the Golf Course Division on the implementation of the Plan. The Plan is subject to change should county, state, or federal rules dictate.

Communications

The Mayor, City Council, City Manager, Director of Operations & Maintenance Director, and Recreation & Parks Director will receive periodic updates through normal channels. All media relations will follow the City's communications policy.

PREPAREDNESS

Ash Wood Quarantine

After the discovery of EAB in St. Paul in 2009, The Minnesota Department of Agriculture (MDA) issued quarantine on the movement of ash wood in the Counties of Hennepin, Ramsey, and Houston. This quarantine has and is being expanded as new EAB is found in other Counties in the State. Wood from ash trees in quarantined Counties may not be transported outside of the quarantine boundary.

Ordinances and Policies

The City has ordinances and policies related to forestry activities, including, City Ordinance Chapter 97: Grass, Weed, and Tree Regulations, Operations & Maintenance Department Administrative Policies #5.20: Forestry; #5.25: Emerald Ash Borer Preparedness and Management Plan; and #3.15: Public Easement Maintenance, all of which guide forestry operations within the city.

Staff Training and Licensing

The Operations & Maintenance Department currently has certified tree inspectors, licensed pesticide applicators, and certified arborists. The Golf Course Division, within the Recreation & Parks Department also have licensed pesticide applicators all of which must attend training annually or bi-annually to retain their license or certification.

MANAGEMENT AND CONTROL

Pesticide Treatments

Pesticides known to control EAB are commercially available. Many of these pesticides are restricted use and must be applied by a certified pesticide applicator. Pesticide treatments on a large scale basis may be cost prohibitive, due to the fact that treatments to each tree are needed annually or bi-annually for the life of the tree. While the immediate cost of chemically treating is cheaper than removal and re-planting, it is delaying the inevitable tree loss in the community.

Policy Impact: Treating a tree costs approximately \$100.00-\$150.00 per tree for a two year treatment. To treat all public trees in the city using an average one time cost of \$125.00 would be \$625,000. The treatment of individual trees, in the case of a homeowner with one special tree, or for high profile trees in the public landscape is a viable alternative to prolong the life of the tree(s) and preserve the overall tree canopy for a longer period of time. It is unknown how long treatments will extend the life of the affected trees.

Tree Removal

North American communities have not successfully eradicated EAB once it has been found. EAB typically increases in population and eventually infests and kills all varieties of ash trees. Symptoms are slow to appear and once EAB is found it is estimated that it has already been present in the tree for 3-5

years. Infected ash trees typically succumb to the disease and are subsequently removed and disposed of. Typically trees in natural areas are left to die and are not removed unless they pose a hazard.

Policy Impact: Staff currently estimates the cost to remove and dispose of an average tree including stump removal to be approximately \$800.00 per tree. At this cost it would take approximately \$3,760,800 to remove all of the ash trees on city property including boulevard trees and trees on Edinburgh golf course.

Reforestation

The future expected loss of several thousand boulevard, park and open space ash trees will require a massive reforestation effort. The benefits trees provide is broadly understood and includes cleaning our air, cooling our atmosphere, saving energy through shade and wind breaks, and making Brooklyn Park a greener, safer and more pleasant city. Therefore, developing a plan for re-planting the trees lost to EAB may be one of the most important policy decisions within this Plan.

Tree planting is currently guided by O&M Policy #5.20: Forestry; and O&M Policy #3.15: Public Easement Maintenance. Thus, with the impending loss of thousands of trees, consideration should be given to whether these guidelines should be reviewed and modified.

Policy Impact: As a pro-active measure, several years ago staff discontinued the planting of ash trees on city owned property. It is estimated that the cost to replant a new tree is between \$200.00 and \$500.00 per tree. This cost is dependent on the initial size of the tree and using an average cost of \$350.00 per tree, it would cost \$1,179,150 to replace the 3,369 publically owned boulevard street ash trees. Additionally, it would cost \$262,500 to replace the 750 Ash trees on Edinburgh USA Golf Course.

Wood Disposal and Utilization

The probable loss of thousands of ash trees creates several challenges for the City in regards to the disposal of the wood for both city trees, as well as private trees removed by commercial tree services and residents. In the early stages of an infestation, care to slow down the spread of EAB is paramount not only to Brooklyn Park, but to other surrounding communities and the State.

May 2 - September 30 is considered EAB's Active Period. This is the most critical period for removal, trimming and movement of ash trees. This is the time where adult beetles emerge from trees, begin feeding on foliage, move to other trees, and lay their eggs. During these months it is best to leave these trees standing and not chance the possible spread of EAB by not transporting infested wood to other areas.

October 1 - May 1 is considered to be EAB's Dormant Period. Ash trees can be removed, trimmed and transported so long as they are promptly chipped to the required dimensions of 1"x1"x1". Chipping to this small size will effectively kill any EAB larvae.

ATTACHMENTS

1. EAB Preparedness and Management Progress to Date
2. 2018-2019 EAB Preparedness and Management Work Plan

Cross – Referenced: City Council Resolution # 2011-158

EAB Preparedness and Management Progress to Date

Ordinances and Policies

In 2014, City Ordinance Chapter 97: Grass, Weed, and Tree Regulations, was revised to address trees impacted by EAB. Administrative Policies #5.20: Forestry (established 4/1/2000 last revised 11/1/2016); #5.25 Emerald Ash Borer Preparedness and Management Plan (established 10/18/2011, last revised 5/7/2018); and Policy #3.15: Public Easement Maintenance (established 8/1/1997 last revised 8/1/2011) all guide forestry operations within the City.

Monitoring

Monitoring the infestation is the first step to managing it. In 2010, the Minnesota Department of Agriculture (MDA) placed several purple traps in ash trees located in Brooklyn Park. These traps assisted the MDA in watching for the spread of EAB. No EAB was found in the traps in 2010. Since the first find in the State in 2009, the City's Forestry Division has been monitoring trees for EAB and responding to calls from residents with questions about EAB. In August 2017, EAB was identified for the first time in the central part of Brooklyn Park, across the street from Edinburgh USA Golf Course.

Inventory collection

In 2010, Operations & Maintenance Division staff began a GPS/GIS inventory of all trees maintained by the City, by having this data, staff can more accurately estimate the future cost associated with managing EAB. The inventory continues to be an on-going project with data currently being collected on over 16,836 trees on City owned property of which 4,701 were ash trees. Staff will also be using this data to keep an inventory of critical trees identified to be proactively managed and treated, to ensure reapplication treatments are done each year and recorded for effectiveness.

Pesticide Treatments

In 2014, the City began a pro-active approach to treating higher quality ash trees located on public property. These treatments were primarily in parks and on the Government Campus. Trees that are treated need to be re-treated every two years. Trees treated by year: 2014 (5 trees), 2015 (207 trees), 2016 (142 trees), 2017 (208 trees), 2018 (502 trees of which 232 were at Edinburgh USA). In 2018 The City entered into a three- year agreement with Rainbow Tree Care for pesticide treatments on both public and private property.

Tree Removal

In 2014, the City began pro-actively removing lower quality ash trees located on public property and boulevards. Trees removed by year: 2014 (10 trees), 2015 (17 trees), 2016 (19 trees), 2017 (156 trees of which 103 were located on Edinburgh USA golf course (holes 1 -9).

Reforestation

The City's reforestation program is supported by the Annual Tree Sale. This program was started in 2007 in response to the devastating wind storm that hit the city in 2005, resulting in the loss of many public and private trees. The primary goal of this program is to provide residents the opportunity to plant trees on private property at a reasonable cost. Since 2007, over 1,720 trees have been planted on private property, with an additional 550 on public property. In 2018, 88 additional trees were planted on public property,

EAB Program Funding

By City Council Resolution No. 2011-158, the Council authorized an appropriation of \$150,000 from within the Heritage Fund for fiscal year 2012 to begin funding for the EAB program. However, because of budget constraints, it was not implemented until 2016. Since then, \$150,000 has been appropriated each year in the Capital Improvement Program.

2018-19 EAB Preparedness and Management Work Plan (Plan)

1. Ordinances and Policies

- Update Chapter 97 of the City Code to comply with current recommendations from the Minnesota Department of Agriculture (MDA).

2. Monitoring

- Staff will continue to monitor for the spread of EAB and report new finds to the MDA as they are found.

3. Inventory collection

- Continue with the tree inventory of all public trees.
- Begin to inventory private trees as site visits allow.

4. Pesticide Treatments

- Continue to treat identified high profile public ash trees in parks and public building properties.
- Begin a treatment program at Edinburgh USA golf course and Brookland Golf Park.
- Keep GIS records of all pesticide applications to ensure tracking of treatments and health of ash trees.
- Determine if a treatment plan should be designed for public boulevard ash trees.
- Determine, if City should play a role in assisting with a cost share program for resident to treat a City owned boulevard tree.
- Continue to ensure staff training and licensure for application of pesticide treatments for EAB.

5. Tree Removal

- Continue to proactively remove public ash trees that are in decline on street boulevards, active parks and public building sites, the exception is wooded natural areas within park system. The trees in these areas will be left to decompose unless they pose a hazard to park users, in which case they will be felled and left.
- Consult with Golf Course Architect about proactively removing ash trees as needed on the back nine holes at Edinburgh USA golf course.

6. Reforestation

- As the budget permits, all publicly owned ash trees, that are removed, should be replaced with non-host species that will enhance the planting site, are appropriate for the planting site, and add to the diversity and general health of the urban forest. Trees will be planted in accordance with Operations & Maintenance Department best practices. New plantings will be budget based and prioritized by staff.
- Tree replacements on private property are subject to Operations & Maintenance Policy Number O&M 5.20, and are to be totally funded by the owner.

7. Funding

- Staff will continue to review the EAB Management program and make annual recommendations to the City Council through the annual budget process. Staff will also pursue grants and state funding to minimize the impact to the city.

8. Tree Contractor Licensing

- Staff will evaluate the practice of Licensing Tree Contractors to work within the City Limits. The City does not currently license Tree Contractors. The Minnesota Department of Agriculture (MDA) currently requires all persons or companies who provide tree care services to register and pay an annual fee to the MDA. Thus, licensing is already being done at the State level.

9. Private Trees

- Consider entering into a contract with a private tree removal company to provide pre-bid costs for residents to use for removal and/or treatment options if they choose.

NATURAL RESOURCE INVENTORY

As a natural resource-based regional park, the protection and enhancement of natural resources are as important as the recreation offerings. The natural resources provide the setting to support nature-based recreation including unique, high quality user experiences that help connect people to nature. A summary of the natural resources at Mississippi Gateway Regional Park are included in Table 12.

Table 12: Natural Resource Inventory

Source: Three Rivers Park District

| GENERAL | |
|------------------------|---|
| Glacial History | About 75,000 years ago, the Wisconsin Age glacial period began. This glacial period had a significant effect on the landscape and waterways of Minnesota. During this glacial period, and as recent as 14,000 years ago, the Des Moines Lobe of the Laurentide Ice Sheet covered a significant portion of Minnesota – including Hennepin County. When this lobe retreated it left behind rolling hills, nutrient rich soil and a vast system of lakes and rivers – including the Mississippi River. |
| Topography | Mississippi Gateway Regional Park’s topography is typical of the river corridor in this area. The historic riverbank is present throughout the park creating a natural wooded bluff line through the southern two-thirds of the East Unit - including slopes between 12-18% and some greater than 18%. The parkland above and below the bluff is relatively flat with very subtle slope pitching toward the river and southern park area (lowest area within the park). The northern third of the East Unit is flat with the bluff landform occurring right at the river’s edge and rising over the recreation pool. The West Unit is also relatively flat and slopes to a central wetland complex. |

| VEGETATION RESOURCES | | | | |
|---|--|------------------|------------------|--------------|
| Minnesota Land Cover Classification System | The Minnesota Land Cover Classification System categories the landscape by land cover showing areas of development as well as natural areas by plant community type (Figure 14). | | | |
| | MLCCS | East Unit | West Unit | Total |
| | Artificial Surfaces | 7.4 | 8.3 | 15.7 |
| | Planted or Cultivated Vegetation | 8.5 | 1.8 | 10.3 |
| | Forests | 62.3 | 16.9 | 79.2 |
| | Woodland | 31.6 | 20.2 | 51.8 |
| | Shrubland | 0 | 1.0 | 1.0 |
| | Herbaceous | 53.4 | 46.2 | 99.6 |
| | Water | 7.3 | 2.1 | 9.4 |
| | Total Acres | 170.5 | 96.5 | 267 |
| Minnesota County Biological Survey | The Minnesota County Biological Survey maps the distribution and status of the state’s rare and native flora, fauna and plant communities. The Minnesota County Biological Survey identifies 52 acres of Silver Maple (Virginia Creeper) Floodplain Forest as well as areas of moderate biological significance within Mississippi Gateway Regional Park. These areas are located in the southern area of the East Unit (Figure 15). | | | |
| Cottonwood Reintroduction | Three Rivers is working with partners to reintroduce cottonwoods in the park as research indicates that they are not naturally reproducing at the historic rate and are an appropriate species for this site given its location within the Mississippi River floodplain. | | | |
| Invasive Species | The park is home to many common invasive species found within the Twin Cities including but not limited to: buckthorn, smooth brome grass, Canadian thistle, garlic mustard, reed canary grass and birds foot trefoil. Active management efforts are underway within the East Unit to reduce invasive species and progress has been made - however, the West Unit has not been actively managed and there are portions that are almost entirely invasive species. If they were removed, there would be little plant material, habitat and screening from neighbors left. | | | |

| OVERALL ECOLOGICAL VALUE HEALTH | |
|--|---|
| MnDNR Regional Significant Ecological Areas | The Regional Significant Ecological Area identifies areas within the Twin Cities with ecologically significant terrestrial and wetland areas. Areas within Mississippi Gateway Regional Park are classified as Moderate and High (Figure 16). Unfortunately, this data set does not identify why the areas are regionally significant. Based on the location of the identified areas, those classified as High appear to be within the Mississippi River floodplain, undeveloped areas and native plant communities and the areas classified as Moderate appear to be undeveloped upland. |
| Additional Information | <ul style="list-style-type: none"> • Within a MnDNR Ecological Corridor; • Within the Mississippi River Flyway; and • Within the MnDNR’s Mississippi River Critical Area. |

| WILDLIFE RESOURCES | | | |
|--|---------------------------------|--------------------------|----------------------------|
| Rare, Endangered, and Threatened Wildlife* | Common Name | Scientific Name | Status |
| | Blandings Turtle | Emydoidea blandingii | Threatened |
| | Long-bearded Hawkweed | Hieracium longipilum | Non-Threatened |
| | Black Sandshell | Ligumia recta | Species of Special Concern |
| | Round Pigtoe | Pleurobema sintoxia | Threatened |
| | Colonial Waterbird Nesting Site | N/A | -- |
| | Bald Eagle | Haliaeetus leucocephalus | Species of Special Concern |
| | Peregrine Falcon | Falco peregrinus | Threatened |
| No rare, endangered and threatened wildlife are anticipated to be significantly impacted by the proposed park plan. As with all park projects, design and construction best management processes, such as avoiding construction during the nesting season, will be implemented to avoid or minimize any potential impacts. | | | |

*Rare, Endangered, and Threatened Plant Communities lists rare Minnesota plant communities located within or immediately adjacent to Mississippi Gateway Regional Park that are documented in the Natural Heritage System.

| WATER RESOURCES | | | | |
|-------------------------------|---|------------------|------------------|--------------|
| Mississippi River | <ul style="list-style-type: none"> • Located on west bank of Mississippi River at Coon Rapids Dam; • 2,080 feet of shoreline on the recreation pool (north of dam) and 6,500 feet of shoreline south of dam; and • The Mississippi River is an impaired water as listed by the Minnesota Pollution Control Agency due to mercury and PCB within fish tissue. | | | |
| Wetland | Areas designated as wetlands are shown on Figure 17. | | | |
| | Wetland Type | East Unit | West Unit | Total |
| | Type 1: Seasonally Flooded Basins | 66.3 | 23.3 | 89.6 |
| | Type 3: Shallow Marshes | 18.6 | 0.1 | 18.7 |
| | Type 4: Deep Marshes | 1.0 | 0.9 | 1.9 |
| | Type 5: Open Water | 0.4 | 1.1 | 1.5 |
| | Type 6: Shrub Swamps | 33.1 | 34.1 | 67.2 |
| | Total Acres | 119.4 | 59.5 | 178.9 |
| Ponds/Creek | <ul style="list-style-type: none"> • An unnamed creek runs through both East and West Units and discharges into the Mississippi River at the southern portion of the East Unit. • There are several small ponds in the West and East Units that are all connected via the unnamed stream and adjacent wetlands with the exception of the pond in the very southern portion of the East Unit which is only connected via surface water during times of flooding. | | | |
| Additional Information | <ul style="list-style-type: none"> • The park is located within the West Mississippi Watershed (Mississippi and Northwest/Riverside Subwatersheds). | | | |

Figure 14: Minnesota Land Cover Classification System

Source: Three Rivers Park District, MnDNR

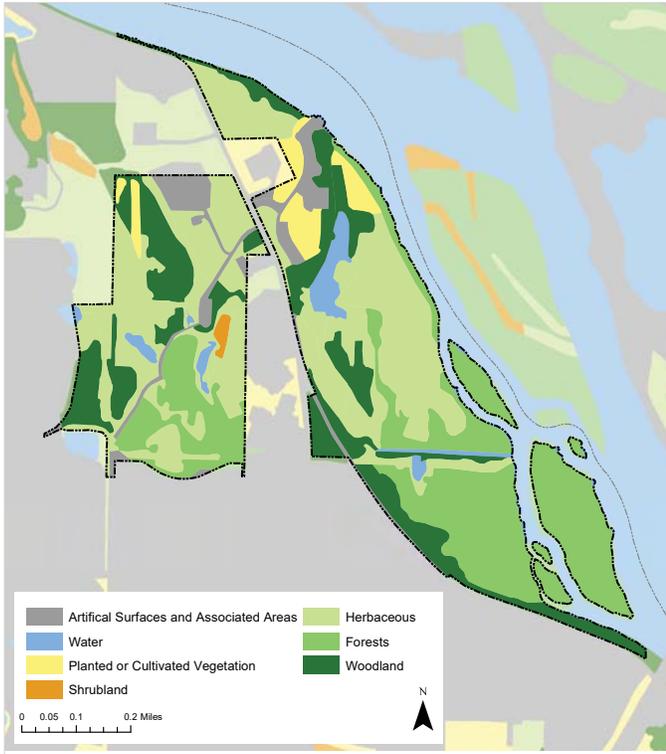


Figure 15: Minnesota County Biological Survey

Source: Three Rivers Park District, MnDNR

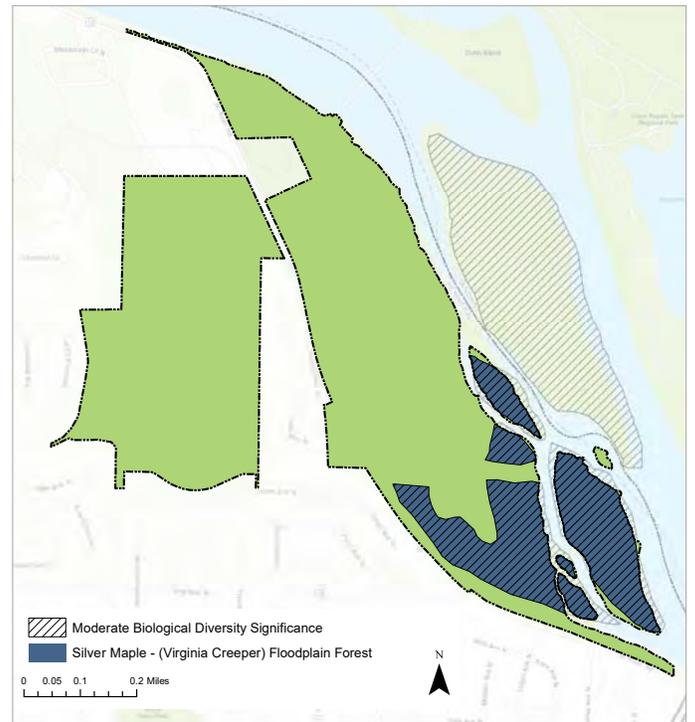


Figure 16: Regionally Significant Ecological Areas

Source: Three Rivers Park District, MnDNR

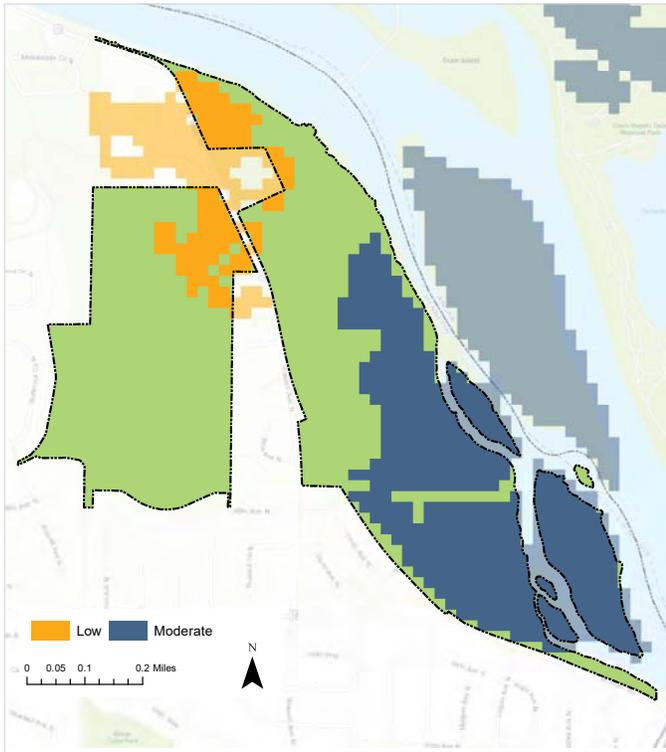
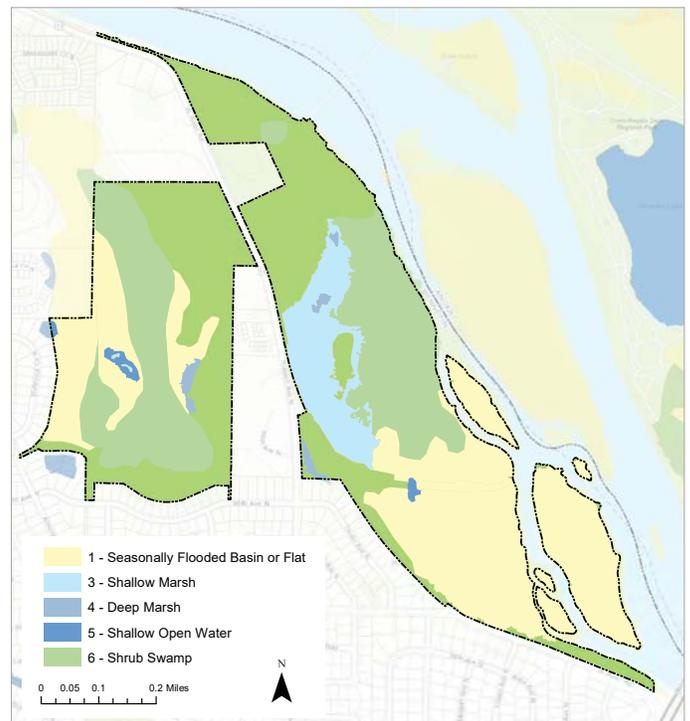


Figure 17: Wetlands

Source: Three Rivers Park District, MnDNR



**CITY OF BROOKLYN PARK
EMERALD ASH BORER (EAB) PREPAREDNESS AND MANAGEMENT PLAN**

I. INTRODUCTION

The Emerald Ash Borer (EAB) is a non-native insect that was introduced to North America from Asia. It was first discovered in the Detroit, Michigan/Windsor Ontario area in 2002, arriving likely in wood crating for packaged freight that was transported here via ship or airplane. Despite eradication and suppression efforts, EAB has killed over 20 million Ash trees throughout the U.S. and Canada. In May of 2009, EAB was identified for the first time in Minnesota and in August of 2017, EAB was found for the first time in Brooklyn Park.

EAB is a beetle that is smaller than a dime. The adult does very little damage; however, this is not the case with the larvae (immature stage) that feed on the inner bark of ash trees. Over a couple of years of feeding off of the tree the larvae will completely disrupt the feeding of nutrients to the tree and eventually kill the tree. All species of ash trees are susceptible and it is hard to detect presence of EAB, therefore it can be present for years before an infestation is confirmed.

Currently, the City has approximately 5,000 ash trees on public property, it is estimated that there could be three times as many privately owned ash trees. An undertaking as large as the infestation of EAB will bring about many issues that are difficult to predict and articulate at this time. However, they will need attention as they come more into focus. The most notable of these issues will be the additional funding, personnel and equipment needed to deal with the infestation.

II. PURPOSE

The purpose of this policy is to outline policies and operational procedures to mitigate the disruption to the urban forest caused by the infestation of the Emerald Ash Borer (EAB). Taking a proactive approach, this policy provides the framework for implementation of an EAB Preparedness and Management Plan (Plan), enabling the City to address public and private needs in an efficient and effective manner.

III. APPLICABILITY

This policy is applicable to all public and private properties in the City of Brooklyn Park where such EAB infested trees may negatively or generally threaten the health of the urban forest overall.

Definitions

Easement. Specific areas granted as public by property deeds for specific use for streets, storm water conveyance, utilities (public or private), sidewalks and trails, etc.

Right of Way (ROW). An area granted as a public easement by property deeds for general use for streets, storm water conveyance, utilities (public or private), sidewalks and trails, etc.

Tree. Any woody plant, having a single woody trunk and a potential diameter of two inches or more.

Private Trees. Trees located on privately owned property including but not limited to: residential, commercial, industrial, and other publicly owned property.

Public Trees. Trees located on City owned public property including but not limited to: Parks and open space; public building grounds; street boulevards, medians, and other public rights of way.

IV. **POLICY**

Administration of the Plan

The Park & Building Maintenance Manager and the Park Maintenance Division, through the Operations and Maintenance Department, will be responsible for implementation and follow up on the provisions of the Plan. The Operations and Maintenance Department will work closely with the Recreation and Parks Department including the Golf Course Division on the implementation of the Plan. The Plan is subject to change should county, state, or federal rules dictate.

Communications

The Mayor, City Council, City Manager, Director of Operations & Maintenance Director, and Recreation & Parks Director will receive periodic updates through normal channels. All media relations will follow the City's communications policy.

PREPAREDNESS

Ash Wood Quarantine

After the discovery of EAB in St. Paul in 2009, The Minnesota Department of Agriculture (MDA) issued quarantine on the movement of ash wood in the Counties of Hennepin, Ramsey, and Houston. This quarantine has and is being expanded as new EAB is found in other Counties in the State. Wood from ash trees in quarantined Counties may not be transported outside of the quarantine boundary.

Ordinances and Policies

The City has ordinances and policies related to forestry activities, including, City Ordinance Chapter 97: Grass, Weed, and Tree Regulations, Operations & Maintenance Department Administrative Policies #5.20: Forestry; #5.25: Emerald Ash Borer Preparedness and Management Plan; and #3.15: Public Easement Maintenance, all of which guide forestry operations within the city.

Staff Training and Licensing

The Operations & Maintenance Department currently has certified tree inspectors, licensed pesticide applicators, and certified arborists. The Golf Course Division, within the Recreation & Parks Department also have licensed pesticide applicators all of which must attend training annually or bi-annually to retain their license or certification.

MANAGEMENT AND CONTROL

Pesticide Treatments

Pesticides known to control EAB are commercially available. Many of these pesticides are restricted use and must be applied by a certified pesticide applicator. Pesticide treatments on a large scale basis may be cost prohibitive, due to the fact that treatments to each tree are needed annually or bi-annually for the life of the tree. While the immediate cost of chemically treating is cheaper than removal and re-planting, it is delaying the inevitable tree loss in the community.

Policy Impact: Treating a tree costs approximately \$100.00-\$150.00 per tree for a two year treatment. To treat all public trees in the city using an average one time cost of \$125.00 would be \$625,000. The treatment of individual trees, in the case of a homeowner with one special tree, or for high profile trees in the public landscape is a viable alternative to prolong the life of the tree(s) and preserve the overall tree canopy for a longer period of time. It is unknown how long treatments will extend the life of the affected trees.

Tree Removal

North American communities have not successfully eradicated EAB once it has been found. EAB typically increases in population and eventually infests and kills all varieties of ash trees. Symptoms are slow to appear and once EAB is found it is estimated that it has already been present in the tree for 3-5

years. Infected ash trees typically succumb to the disease and are subsequently removed and disposed of. Typically trees in natural areas are left to die and are not removed unless they pose a hazard.

Policy Impact: Staff currently estimates the cost to remove and dispose of an average tree including stump removal to be approximately \$800.00 per tree. At this cost it would take approximately \$3,760,800 to remove all of the ash trees on city property including boulevard trees and trees on Edinburgh golf course.

Reforestation

The future expected loss of several thousand boulevard, park and open space ash trees will require a massive reforestation effort. The benefits trees provide is broadly understood and includes cleaning our air, cooling our atmosphere, saving energy through shade and wind breaks, and making Brooklyn Park a greener, safer and more pleasant city. Therefore, developing a plan for re-planting the trees lost to EAB may be one of the most important policy decisions within this Plan.

Tree planting is currently guided by O&M Policy #5.20: Forestry; and O&M Policy #3.15: Public Easement Maintenance. Thus, with the impending loss of thousands of trees, consideration should be given to whether these guidelines should be reviewed and modified.

Policy Impact: As a pro-active measure, several years ago staff discontinued the planting of ash trees on city owned property. It is estimated that the cost to replant a new tree is between \$200.00 and \$500.00 per tree. This cost is dependent on the initial size of the tree and using an average cost of \$350.00 per tree, it would cost \$1,179,150 to replace the 3,369 publically owned boulevard street ash trees. Additionally, it would cost \$262,500 to replace the 750 Ash trees on Edinburgh USA Golf Course.

Wood Disposal and Utilization

The probable loss of thousands of ash trees creates several challenges for the City in regards to the disposal of the wood for both city trees, as well as private trees removed by commercial tree services and residents. In the early stages of an infestation, care to slow down the spread of EAB is paramount not only to Brooklyn Park, but to other surrounding communities and the State.

May 2 - September 30 is considered EAB's Active Period. This is the most critical period for removal, trimming and movement of ash trees. This is the time where adult beetles emerge from trees, begin feeding on foliage, move to other trees, and lay their eggs. During these months it is best to leave these trees standing and not chance the possible spread of EAB by not transporting infested wood to other areas.

October 1 - May 1 is considered to be EAB's Dormant Period. Ash trees can be removed, trimmed and transported so long as they are promptly chipped to the required dimensions of 1"x1"x1". Chipping to this small size will effectively kill any EAB larvae.

ATTACHMENTS

1. EAB Preparedness and Management Progress to Date
2. 2018-2019 EAB Preparedness and Management Work Plan

Cross – Referenced: City Council Resolution # 2011-158

EAB Preparedness and Management Progress to Date

Ordinances and Policies

In 2014, City Ordinance Chapter 97: Grass, Weed, and Tree Regulations, was revised to address trees impacted by EAB. Administrative Policies #5.20: Forestry (established 4/1/2000 last revised 11/1/2016); #5.25 Emerald Ash Borer Preparedness and Management Plan (established 10/18/2011, last revised 5/7/2018); and Policy #3.15: Public Easement Maintenance (established 8/1/1997 last revised 8/1/2011) all guide forestry operations within the City.

Monitoring

Monitoring the infestation is the first step to managing it. In 2010, the Minnesota Department of Agriculture (MDA) placed several purple traps in ash trees located in Brooklyn Park. These traps assisted the MDA in watching for the spread of EAB. No EAB was found in the traps in 2010. Since the first find in the State in 2009, the City's Forestry Division has been monitoring trees for EAB and responding to calls from residents with questions about EAB. In August 2017, EAB was identified for the first time in the central part of Brooklyn Park, across the street from Edinburgh USA Golf Course.

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Policy Number: O&M 5.25-Attachment 1

Established: 10/18/2011

Last Revision: 10/2/2018

Page 2

EAB Program Funding

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2018-19 EAB Preparedness and Management Work Plan (Plan)

1. Ordinances and Policies

- Update Chapter 97 of the City Code to comply with current recommendations from the Minnesota Department of Agriculture (MDA).

2. Monitoring

- Staff will continue to monitor for the spread of EAB and report new finds to the MDA as they are found.

3. Inventory collection

- Continue with the tree inventory of all public trees.
- Begin to inventory private trees as site visits allow.

4. Pesticide Treatments

- Continue to treat identified high profile public ash trees in parks and public building properties.
- Begin a treatment program at Edinburgh USA golf course and Brookland Golf Park.
- Keep GIS records of all pesticide applications to ensure tracking of treatments and health of ash trees.
- Determine if a treatment plan should be designed for public boulevard ash trees.
- Determine, if City should play a role in assisting with a cost share program for resident to treat a City owned boulevard tree.
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- Tree replacements on private property are subject to Operations & Maintenance Policy Number O&M 5.20, and are to be totally funded by the owner.

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- Staff will continue to review the EAB Management program and make annual recommendations to the City Council through the annual budget process. Staff will also pursue grants and state funding to minimize the impact to the city.

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9. Private Trees

- Consider entering into a contract with a private tree removal company to provide pre-bid costs for residents to use for removal and/or treatment options if they choose.

CITY OF BROOKLYN PARK FORESTRY

1. PURPOSE

The purpose of this administrative policy is to outline policies and procedures for public and private forestry, in new and existing areas.

2. APPLICABILITY

This administrative policy is applicable to all public and private forestry.

DEFINITION(S)

- Private forestry means trees on privately owned property.
- Public forestry means trees on public easements (public right-of-way and public use), parks and public buildings grounds.
- Street trees are public forestry that are in public right-of-way on the boulevard or median.
- Park and public ground trees are public forestry that are in parks or other public land used primarily for recreation or other active public purposes.
- Park and public ground natural areas are located in parks or other public land used secondarily for recreation or other limited public purposes.

POLICY

A. The primary purpose of public and private forestry shall be to provide protection from climatic extremes and improve the environment, such as:

- Provide shade and wind protection
- Improve air quality by capturing pollution particles and reducing carbon dioxide
- Improve water quality of rivers and streams
- Provide food and shelter for wildlife

B. The secondary purpose of public and private forestry shall be to provide aesthetics and other intangibles such as:

- Streetscapes, parks and private properties beautification
- Provide privacy and aid in reduction of noise and glare
- Help in reducing stress levels and possibly crime levels

C. STREET TREE SPECIES/LOCATION STANDARDS

1. Street tree species and location shall be as approved by the Operations & Maintenance Department/Park Maintenance Division.

2. Street tree species shall be from the following list and be a minimum trunk diameter of two (2) inches measured six (6) inches above grade (**no coniferous trees allowed**):

Shade Trees

Bi-Color Oak (swamp white oak)
Ironwood/Hop Horn Beam
Ginko (no female) slow growing
Hackberry
Honey Locust
Linden
Red Maple
Sugar Maple
River Birch
Red Oak
Burr Oak
Pin Oak
American Basswood
Other as Approved by City Forester

Ornamental Trees

Amur Maple (single stem)
Japanese Lilac Tree
Service Berry (Tree Farm)
Newport Plum
Pink Spire Crabapple
Red Splendor Crabapple
Prairiefire Crabapple
Other as Approved by City Forester

3. Street trees generally are not installed in boulevards or medians, but may be installed in locations as follows:
- Arterial or major collector street designated entryway medians as approved by the City Council
 - Special development projects area street medians and possibly boulevards as approved by the City Council
 - Cul-de-sacs and entrance medians in **association maintained** developments as approved by the City Council
 - Replacement in areas with existing street trees as location standards allow; replacements are normally planted in the front yard, not in the boulevard
 - Planting by private property owners with Operations & Maintenance Department/Park Maintenance Division's permission and meeting street-tree species/location standards as listed in section C

4. **Street tree specific location standards (when allowed) shall be as follows:**

- The boulevard (planting area) must be eight (8) feet or more in width.
- The planting site must be located as follows:
 - 30 feet or more from street curb intersections as per City Code Section 364.7
 - 10-20 feet from curb on collector and arterial streets; preferably 15 feet
 - 5-12 feet from curb on local streets; preferably 10 feet
 - 10 feet or more from any sewer or water line, fire hydrant or driveway as per City Code Section 93.25
 - 5 feet or more from any gas, electric, telephone, cable TV or other under ground utility
 - 3 feet or more from any sidewalk or trail
 - 2 feet or more from any public right-of-way
 - 18 foot maximum height of tree at maturity, if within 18 feet of a **Distribution Power Line**

- 25 foot clear zone (no plantings) on either side of a **Transmission Power Line**

D. PRIVATE TREE SPECIES/LOCATION RECOMMENDATIONS

1. Private property tree species are recommended to be chosen from the section C. street tree list or the following additional tree list (keeping in mind that a variety of tree species is best for a healthy urban forest):

Coniferous Trees

- Balsam Fir
- Pine
- White Spruce (Black Hills Spruce)
- Other species allowed if recommended by a qualified arborist and approved by City Forester.

2. Private property tree location standards are recommended or required as follows in addition to zoning code, development agreement or conditional use permit requirements:

- a. The planting site should be located as follows:

- 30 feet or more from street curb intersections as per City Code Section 364.7
- 10 feet or more from any sewer or water line
- 18 foot maximum height of tree at maturity, if within 18 feet of a **Distribution Power Line**
- 25 foot clear zone (no plantings) on either side of a **Transmission Power Line**
- 5 feet or more from a fire hydrant, gas or electric underground utility, driveway or property line as per City Code Section 93.25
- 3 feet or more from any sidewalk or trail
- 1 1/2 feet or more from any public right-of-way
- 20 feet or more from any building (shade tree)
- 15 feet or more from any building (ornamental tree)

3. The developer, contractor or individual private property owner must call for Gopher State One-Call utility locates.

E. COST/FUNDING RELATED ISSUES

1. Costs for new public forestry installations shall be determined on a case by case basis, with funding by the City or developer or a combination of City, developer, donations or grant funding.
2. Costs for public forestry maintenance, diseased or other removal, replacement and fill-in shall be borne by the City general fund, as each adopted annual budget allows.
3. Costs for private forestry installation, maintenance, diseased or other removal and replacement, shall be borne 100% by developer or private property owner.

ADMINISTRATIVE PROCEDURES

- A. Installation of public and private trees.

1. The Operations & Maintenance Department shall maintain public and private forestry specifications and installation requirements.
2. The Community Development Department and Operations & Maintenance Department shall maintain the City Code ordinances and other development policies to provide for private forestry and project specific public forestry.
3. The Community Development Department and Operations & Maintenance Department shall coordinate the development agreement requirements and ensure that new construction forestry is installed as per the agreement.
4. Public forestry street trees shall be installed as per this general policy and as per development agreements and specific special project plans and specifications as approved by the City Council.
5. Public forestry street trees installed by private property owners after initial development, shall be by permission and direction of the Operations & Maintenance Department/Park Maintenance Division.
6. Other public forestry (trees on parks and other public grounds) shall be installed as per park and public building development grounds or as directed by the Operations & Maintenance Department/Park Maintenance Division.
7. Private forestry trees shall be installed by developers and individual property owners per development agreement, City Code ordinances and this policy.

B. Maintenance of public and private trees.

1. The Operations & Maintenance Department will develop an annual 5-year Capital Improvement Plan program related to this policy.
2. The Operations & Maintenance Department/Park Maintenance Division is responsible for the related annual public forestry operations and maintenance budgets and for annual review/development of methods that could control, contain or reduce costs.
3. Private forestry maintenance and replacement is the responsibility of the private property owner.
4. Public and private forestry maintenance shall be in conformance with City Code Chapter 97, Grass, Weed, and Tree Regulations as well as policies O&M 3.15 - Public Easement Maintenance, O&M 5.25 Emerald Ash Borer Preparedness and Management Plan, O&M 5.30 – Park Facilities Maintenance and O&M 5.40 Arterial/Collector Street (Roadway) Median and Boulevard Landscaping.

Cross-Referenced: Resolution #2011-128

NATURAL RESOURCE INVENTORY

As a natural resource-based regional park, the protection and enhancement of natural resources are as important as the recreation offerings. The natural resources provide the setting to support nature-based recreation including unique, high quality user experiences that help connect people to nature. A summary of the natural resources at Mississippi Gateway Regional Park are included in Table 12.

GENERAL

Glacial History About 75,000 years ago, the Wisconsin Age glacial period began. This glacial period had a significant effect on the landscape and waterways of Minnesota. During this glacial period, and as recent as 14,000 years ago, the Des Moines Lobe of the Laurentide Ice Sheet covered a significant portion of Minnesota – including Hennepin County. When this lobe retreated it left behind rolling hills, nutrient rich soil and a vast system of lakes and rivers – including the Mississippi River.

Topography Mississippi Gateway Regional Park's topography is typical of the river corridor in this area. The historic riverbank is present throughout the park creating a natural wooded bluff line through the southern two-thirds of the East Unit - including slopes between 12-18% and some greater than 18%. The parkland above and below the bluff is relatively flat with very subtle slope pitching toward the river and southern park area (lowest area within the park).

The northern third of the East Unit is flat with the bluff landform occurring right at the river's edge and rising over the recreation pool.

The West Unit is also relatively flat and slopes to a central wetland complex.

OVERALL ECOLOGICAL VALUE | HEALTH

MnDNR Regional Significant Ecological Areas The Regional Significant Ecological Area identifies areas within the Twin Cities with ecologically significant terrestrial and wetland areas. Areas within Mississippi Gateway Regional Park are classified as Moderate and High (**Figure 16**). Unfortunately, this data set does not identify why the areas are regionally significant. Based on the location of the identified areas, those classified as High appear to be within the Mississippi River floodplain, undeveloped areas and native plant communities and the areas classified as Moderate appear to be undeveloped upland.

Additional Information Within a MnDNR Ecological Corridor;
Within the Mississippi River Flyway; and
Within the MnDNR's Mississippi River Critical Area.

WILDLIFE RESOURCES

| Rare, Endangered, and Threatened Wildlife* | Common Name | Scientific Name | Status |
|--|---------------------------------|--------------------------|----------------------------|
| | Blandings Turtle | Emydoidea blandingii | Threatened |
| | Long-bearded Hawkweed | Hieracium longipilum | Non-Threatened |
| | Black Sandshell | Ligumia recta | Species of Special Concern |
| | Round Pigtoe | Pleurobema sintoxia | Threatened |
| | Colonial Waterbird Nesting Site | N/A | -- |
| | Bald Eagle | Haliaeetus leucocephalus | Species of Special Concern |
| | Peregrine Falcon | Falco peregrinus | Threatened |

No rare, endangered and threatened wildlife are anticipated to be significantly impacted by the proposed park plan. As with all park projects, design and construction best management processes, such as avoiding construction during the nesting season, will be implemented to avoid or minimize any potential impacts.

WATER RESOURCES

Mississippi River Located on west bank of Mississippi River at Coon Rapids Dam; 2,080 feet of shoreline on the recreation pool (north of dam) and 6,500 feet of shoreline south of dam; and The Mississippi River is an impaired water as listed by the Minnesota Pollution Control Agency due to mercury and PCB within fish tissue.

Wetland Areas designated as wetlands are shown on **Figure 17**.

| Wetland Type | East Unit | West Unit | Total |
|-----------------------------------|--------------|-------------|--------------|
| Type 1: Seasonally Flooded Basins | 66.3 | 23.3 | 89.6 |
| Type 3: Shallow Marshes | 18.6 | 0.1 | 18.7 |
| Type 4: Deep Marshes | 1.0 | 0.9 | 1.9 |
| Type 5: Open Water | 0.4 | 1.1 | 1.5 |
| Type 6: Shrub Swamps | 33.1 | 34.1 | 67.2 |
| Total Acres | 119.4 | 59.5 | 178.9 |

Ponds/Creek An unnamed creek runs through both East and West Units and discharges into the Mississippi River at the southern portion of the East Unit. There are several small ponds in the West and East Units that are all connected via the unnamed stream and adjacent wetlands with the exception of the pond in the very southern portion of the East Unit which is only connected via surface water during times of flooding.

Additional Information The park is located within the West Mississippi Watershed (Mississippi and Northwest/Riverside Subwatersheds).

VEGETATION RESOURCES

Minnesota Land Cover Classification System The Minnesota Land Cover Classification System categories the landscape by land cover showing areas of development as well as natural areas by plant community type (**Figure 14**).

| MLCCS | East Unit | West Unit | Total |
|----------------------------------|-----------|-----------|-------|
| Artificial Surfaces | 7.4 | 8.3 | 15.7 |
| Planted or Cultivated Vegetation | 8.5 | 1.8 | 10.3 |
| Forests | 62.3 | 16.9 | 79.2 |
| Woodland | 31.6 | 20.2 | 51.8 |
| Shrubland | 0 | 1.0 | 1.0 |
| Herbaceous | 53.4 | 46.2 | 99.6 |
| Water | 7.3 | 2.1 | 9.4 |
| Total Acres | 170.5 | 96.5 | 267 |

Minnesota County Biological Survey The Minnesota County Biological Survey maps the distribution and status of the state's rare and native flora, fauna and plant communities. The Minnesota County Biological Survey identifies 52 acres of Silver Maple (Virginia Creeper) Floodplain Forest as well as areas of moderate biological significance within Mississippi Gateway Regional Park. These areas are located in the southern area of the East Unit (Figure 15).

Cottonwood Reintroduction Three Rivers is working with partners to reintroduce cottonwoods in the park as research indicates that they are not naturally reproducing at the historic rate and are an appropriate species for this site given its location within the Mississippi River floodplain.

Invasive Species The park is home to many common invasive species found within the Twin Cities including but not limited to: buckthorn, smooth brome grass, Canadian thistle, garlic mustard, reed canary grass and birds foot trefoil. Active management efforts are underway within the East Unit to reduce invasive species and progress has been made - however, the West Unit has not been actively managed and there are portions that are almost entirely invasive species. If they were removed, there would be little plant material, habitat and screening from neighbors left.

