Native Vegetation Establishment and Enhancement Guidelines

Section 2. General Planning Considerations

Contents

Species Diversity

Species diversity levels for projects should be based on project goals, the landscapes context, site conditions and budget. 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 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. See also the Xerces Society guide to Interseeding Wildflowers to Diversity Grasslands for Pollinators.

Table 2.1 is a general guide to native diversity levels for a range of project conditions and goals. Recommended 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. For example:

- Site that are more intact (with lower levels of disturbance) should incorporate a larger number of species, while a smaller number of species may be appropriate for more disturbed sites.
- Small lakeshore projects, raingardens, and other projects less than an acre in size can also incorporate smaller numbers of species to create a sense of order and simplify maintenance.
- Species abundance is also important to consider 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 of a few acres in size may be planted in restoration sites with lower diversity levels to provide enhanced habitat for pollinators.

Table 2.1. Recommended Native Plant Diversity Levels

Current Site Conditions	Minimum Recommended Number of Species					
Project Function/Goal:	Soil Stabilitzation	Water Quality	Grassland Bird Nesting	Habitat for Multiple Wildlife Groups	Native Plant Community Resto. (marsh and sedge meadow)	Native Plant Community Resto. (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 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 about potential genetic impacts to species 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:

1) Whether plants will produce viable seed, particularly if they are brought to areas with significantly different climatic conditions
2) Whether the bloom period of plants with longer source distances will correspond with activity of local pollinators.
3) 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-locally adapted sources , decreasing the long-term fitness of the population.
4) 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, a common strategy is to introduce seed from populations within the same ecological subsection to improve the plants' vigor, and to act as genetic steppingstones to link the isolated population to a wider genetic diversity. Another strategy to increase genetic diversity is to obtain seed for a single species from multiple source locations.

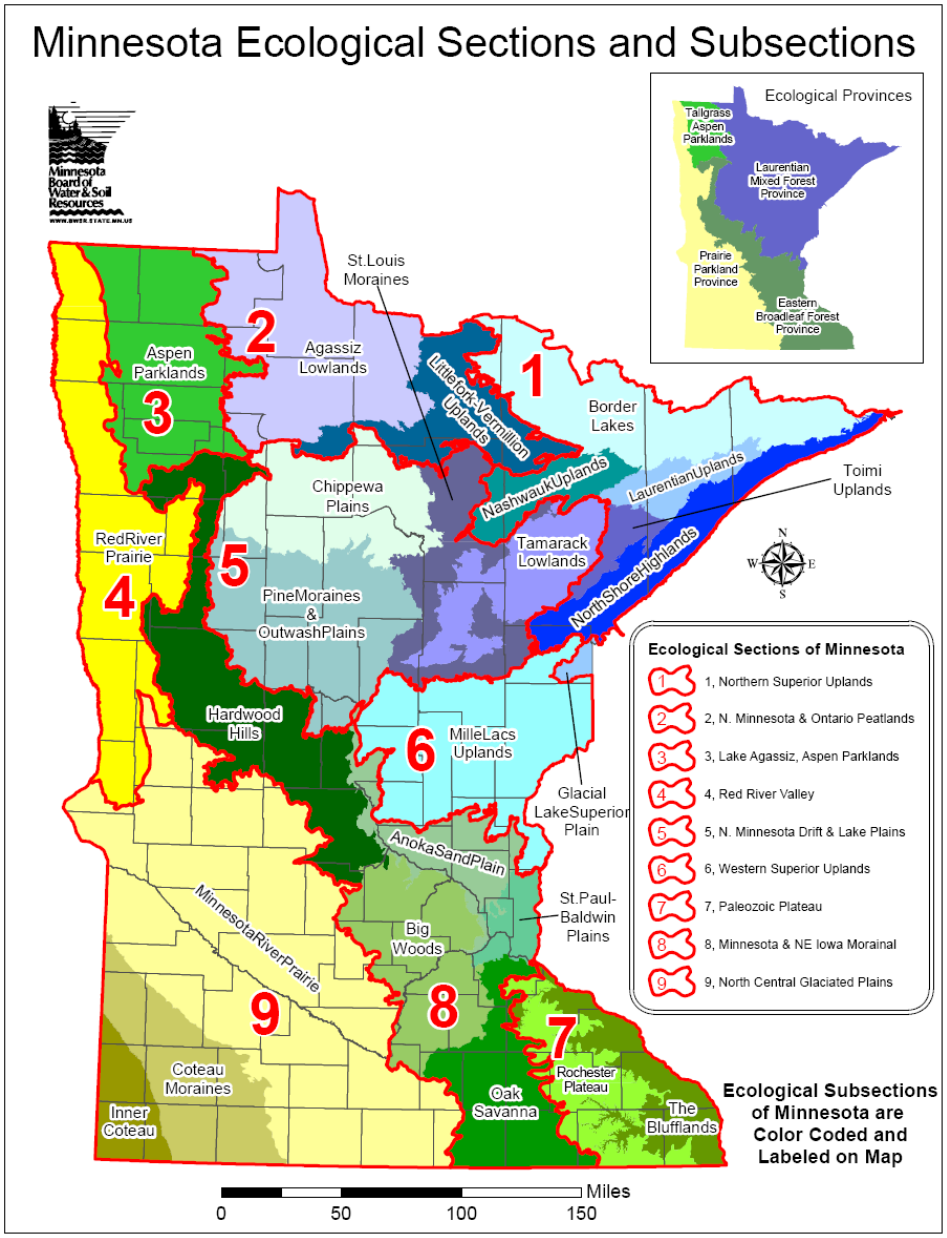
As a general rule, seed and plants should be selected that match site conditions (soils, hydrology, precipitation, elevation, drainage, the angle of slopes, sun/shade and climate) and to have seed that originates from as close to the project site as possible to protect local ecotypes from genetic contamination. Collection sites **to the south of projects** should be utilized when possible due to climate change concerns (see "Climate Change Considerations" below). The map and selection sequence on the following page is recommended when obtaining seed for restoring native plant communities. Note, however, that several other seed source maps may be applicable to forestry projects. The DNR has developed seed zones for Minnesota that are widely used in sourcing seeds for forest projects. Additional source maps developed by the US Forest Service are currently under review and may be incorporated into these guidelines in the future.

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 of 175 miles 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 challenges with seed or plant availability, potential solutions are to use species substitutions or to change the project schedule/sequence to match the availability of appropriate seed or plants. **Substitutions or changes in planting schedules should be documented in the project file**.

Figure 2.1 Minnesota Ecological Sections and Subsections



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, tree trenches 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 the project location or characteristics of the species. An example may be an urban rain garden 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, 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 for a year or longer, be absorbed by plants 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 in the soil.

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 hinder native vegetation establishment from seed. Planting temporary cover crops for one or two seasons can allow time for these chemicals to break down in the soil. Investigate prior chemical use and labels to help determine if chemical carryover exists and should be addressed by using temporary cover crops. If in doubt seek consultation from others with applicable experience, such as 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, sedges, rushes, legumes, 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) Include at least 40 seeds per square foot in upland seed mixes
7) Develop diverse seed mixes but ensure that individual species are included at a high enough rate to show up in the planting.
8) Add at least three spring, summer, and fall blooming species in mixes to benefit pollinators.
9) 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.
10) Seed specifications should be used for all projects when ordering seed (see sample specification below)

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. NRCS seed calculators that define mix specifications are used to develop mixes for many conservation projects. A guide to developing site specific seed mixes is also 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 functional groups 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 listed on the BWSR website (https://www.bwsr.state.mn.us/seed-

mixes). 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. Both standard seed mixes that have been in use for many years and experimental pilot mixes are listed on the website. The state seed mixes list each species, percentage within the mix, and application rate. Substitutions 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.

Companion Crops and Temporary Cover

Companion crops are most commonly used to provide additional erosion control. They are particularly beneficial on sites with steep slopes or areas that may have flowing water. Companion crops are used less often for prairie, savanna and wetland mixes, as they can compete with the establishment of native plant seedlings. Companion crops can be removed from mixes when ordering seed, or the rate can be adjusted based on site conditions and project goals.

Temporary covers are typically planted at least a few months before native seed mixes and are often used where chemical residue carryover is a concern for a project or where stabilization is needed prior to the construction of structural practices. When temporary cover is necessary to stabilize project sites prior to the installation of structural conservation practices, pre-construction cover is allowed. Temporary cover is particularly important on steep slopes, streambanks, and other erosion-prone areas.

The table below, adapted from NRCS Technical Note #31, lists recommended species and associated seeding dates and rates. The temporary cover is to remain in place until construction begins. 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. Check with applicable program policy(s) and BWSR's Grants Manual for eligibility and program specific requirements.

Table 2-2. Recommended Temporary Cover Species and Seeding Dates

Cover Crop	Seeding Rate/Acre	Seeding Dates - Statewide
Oats	80 lbs.	April 1 to June 1, August 1 to Sept. 1
Barley	72 lbs.	April 1 to June 1 August 1 to Sept. 1
Spring or Winter Wheat	75 lbs.	April 1 to June 1
Spring or Winter Rye	60 lbs.	April 1 to June 1
Annual Ryegrass	8 lbs.	April 1 to June 1 August 1 to Sept. 1
Proso Millet	12 lbs.	May 15 to June 10
Sorghum/Sudangrass	12 lbs.	May 15 to June 10
Grain Sorghum	10 lbs.	May 15 to June 10

Yellow Tag Seed

Yellow tag seed has a verifiable source that is certified by the Minnesota Crop Improvement Association (MCIA). The certification process consists of several steps including seed source verification, inspection of seed production sites, and seed conditioning and testing. MCIA issues seed labels or certificates to producers whose production has met all certification standards. Certified native seed provides seed buyers with third-party assurance that the genetic identity or source of native grasses and forbs is accurately described on the label. Vendors offering Yellow Tag are encouraged to indicate this status directly on project quotes when applicable. A list of Yellow Tag-certified seed is also available on the MCIA website: www.mncia.org/. Project managers are encouraged to prioritize the use of yellow tag seed for projects due to the verified source. Flexibility regarding the use of yellow tag seed can be granted by project managers when seed from local remnant communities (generation 0 seed) will be used for a project, or the available yellow tag seed is not from a local source. Yellow tag seed may not be available for many grasses and 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 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 identify which plant species are Minnesota designated Noxious Weeds.

The definition of Minnesota Noxious Weeds is similar to that of invasive species, but such weeds are specifically defined by the Minnesota Noxious Weed Law (MN Statutes §§18.75-18.91) "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 MN Statutes §18.78. Additionally, transportation, propagation, or sale of noxious weeds is prohibited except as allowed by MN Statutes §18.82. See the Minnesota Department of Agriculture's Noxious Weed List for description of categories, including the "eradicate," "control," and "specially regulated" plant lists.

In some cases, the DNR's list of invasive plants (both terrestrial and aquatic pages) is used to help with decision making about what non-native species should be prioritized for control or eradication on conservation projects and wetland replacement projects. Figure 2.1 is an example of a seed specification that can be included as part of project bids to address noxious weed issues. Project managers are advised to check with vendors on the composition of the seed mixes to identify the presence of any weed seeds.

See **Appendix A: Prevention of Palmer Amaranth and other Noxious Weeds in Conservation Projects**

Purple Loosestrife

Figure 2.2. Seed Specifications Example

Note: The following specifications are included in this bid package to help ensure the quality and success of the restoration or conservation 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.
- All seed that is supplied for projects must be labeled according to the requirements of the Minnesota Seed Law, section 21.82:
    - Each species in the mix should be listed on the label along with the origin of seed to provide verification of original (generation 0) seed source. The smallest known geographic area (township, county, ecotype region, state, etc.) shall be identified. Each species should also show the source lot and the percentage of pure seed, germination, and hard (dormant) seed.
    - The label should also include the percentage of other crop, weed seed, inert matter for the mixture and a listing of the restricted and prohibited weed seeds by name and number per lb. Seed labelers are required to determine if any amaranth contaminants in the lot are Palmer amaranth using a genetic test.
- Seed must be cleaned to an extent sufficient to allow its passage through appropriate seeding equipment.
- All wild harvest mixes must be tested and labeled and list the origin, and percentages of pure seed, germination, hard (dormant) seed, for each species that is more than 5% and percentages of other crop, weed seed, inert matter, and restricted and prohibited noxious weeds by name and number per lb in the mixture. Any Amaranth species in wild harvest mixes must be identified and have the same genetic testing required for seed that is produced. Unless otherwise requested, small, large, and cover crop seeds should be packaged separately.
- Seed source standards for individual conservation programs must be followed. For Minnesota Board of Water and Soil Resources (BWSR) funded projects the seed zone map and source sequence in BWSR's Native Vegetation Establishment and Enhancement Guidelines must be followed for obtaining seed. Yellow tag seed should be prioritized to have a verified source for seed.
- All seed delivered to sites must have a complete label and include information about individual component seed lots. Project managers will save the seed tags as part of project record keeping. Installers must allow MDA staff to take seed samples if they arrive for a random inspection.
- Project contracts provided to landowners must state that if it can be determined that seed labelers or 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

Remnant prairie in Goodhue County

Intact native plant communities such as remnant prairies, savanna and calcareous fens are now uncommon in the Minnesota landscape and those that remain 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 avoid abrupt transitions between plant communities and to promote plant and animal dispersal.

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 should not be used within one-quarter mile of these areas 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 or genetic diversity is needed to address inbreeding depression). The DNR 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.

Climate Change Impacts and Projections

The effects of a changing climate, such as more frequent 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 "Principles for Restoring Resilient, Functional Landscapes and Maintaining Ecological Diversity" outline key strategies for increasing the resilience of our remnant and reconstructed plant communities to climate change impacts and other landscape stressors. 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. More information on climate change is provided on the "Our Minnesota Climate" website and in BWSR's Climate Change Trends and Action Plan.

It is challenging to predict the effects of climate change on remnant and restored native plant communities, and impacts will vary across different regions of the state. It is likely that longer and wetter 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 types of changes create challenges for management of existing plant communities as well as site preparation and seed and plant selection when planning restorations. Maintaining and restoring native plant diversity across landscapes will be important in maintaining resilience of ecosystems.

Moving plants and seed for climate change (assisted migration) is a topic of significant debate among ecologists. One concern about moving plants and seed relatively long distances is that introducing plants from too far away can pose risks to the genetic fitness of existing populations. 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, selecting seed and plants from sources located just to the south of projects is advisable due to the risks of a warming climate. Plant species that are at the southern edge of their range and at risk of population declines due to climate change may need special consideration and planning by conservation professionals to determine strategies to support their populations. Moving plant species beyond the specified 175-mile maximum range is discouraged, except in connection with research efforts designed to assess the species' suitability and compatibility with native species.

Climate Change Considerations for Plant Selection and Management

General Considerations:

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 for restoration projects should be selected for overall resiliency to stressors. High diversity levels, as well as early, mid and late successional species, should be provided in seed mixes.

4) Plants that bloom in spring, summer and fall and that represent a wide range of plant Genus should be incorporated into seed mixes and other plantings to support a wide range of pollinator and other insect species. It is also important that plantings be protected from pesticide exposure.

5) 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.

6) The need for adapted management of restored and native plant communities is increasing due to invasive species, herbivores, extreme precipitation and other stressors. Management strategies 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.

Adaptation and Resiliency Considerations:

7) 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).

8) In urban landscapes, select species that are adapted to higher temperatures as well as increased salt concentrations and air pollution. In many cases this will include species from dry and mesic prairie and savanna plant communities. Trees and shrubs can play an important role in mitigating urban heat islands.

9) 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.

10) 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.

Mitigation Considerations:

11) 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.

12) In agricultural landscapes, cover crops, perennial vegetation, and no-till or strip tilling can play important roles in sequestering carbon in the soil while also protecting water quality.