North Carolina Pollinator Toolkit

Prepared by the North Carolina Botanical Garden

University of North Carolina at Chapel Hill

April 2019

ACKNOWLEDGEMENTS

The North Carolina Pollinator Toolkit was developed by the North Carolina Botanical Garden at the University of North Carolina at Chapel Hill in collaboration with multiple partners, including the North Carolina Wildlife Resources Commission, the Rural Advancement Foundation International (RAFI-USA), the North Carolina Wildlife Federation, the U.S. Fish & Wildlife Service, Fresh Energy, and Audubon North Carolina. Funding for development of the North Carolina Pollinator Toolkit was provided by the Burt's Bees Greater Good Foundation.

This document can be found on the North Carolina Botanical Garden website at http://ncbg.unc.edu and North Carolina Pollinator Conservation Alliance website, http://ncpollinatoralliance.org/.

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I. INTRODUCTION

The North Carolina Pollinator Toolkit has been developed with the goal of reversing the decline of pollinator species and other beneficial insects, including bees (both native bees and European honeybees), butterflies, moths, flies, beetles, and wasps. There are nearly 500 species of bees, more than 2,200 species of moths, and over 170 species of butterflies native to the state of North Carolina (Asher and Pickering 2014, Discoverlife.org). Some of these pollinator species are considered threatened or endangered due to habitat loss and fragmentation, pesticide use, and exposure to disease and parasites. The conservation and protection of healthy pollinator populations is crucial to maintaining ecosystem health and resilience, in addition to protecting our agricultural economies and our food supply. The planting of pollinator habitat is one important action to support healthy pollinator populations by providing and enhancing food supplies and nesting habitat. In addition to attracting and supporting pollinator species, pollinator habitat supports agriculturally beneficial predatory insects that can help control crop pests and also provides food (seeds and insects) and shelter for birds and other wildlife.

The purpose of this toolkit is to provide a comprehensive, "one stop shop" for the residents of North Carolina to help promote the enhancement of pollinator habitats. Specifically, this toolkit provides guidance to select appropriate species and seed mixes for various types of projects located in the different ecoregions of North Carolina, plan strategies for site preparation, planting and maintenance, create a timeline for habitat establishment, and identify funding sources for pollinator habitat projects. Additionally, this toolkit provides a list of resources that may be helpful in planning and implementing a pollinator conservation and habitat enhancement project.

II. SPECIES SELECTION & SEED MIX DEVELOPMENT

Seed Sourcing

A native plant species is one that, other than as a result of an intentional or accidental introduction, historically occurred or currently occurs in a particular region, ecosystem, or habitat. It is recommended that North Carolina native plant species be used exclusively in all pollinator habitat creation and enhancement projects in North Carolina. Native species are often preferred by pollinator species for food, shelter and nesting sites. In some cases, pollinator species rely solely on native species.

In selecting appropriate native plant species for pollinator projects, it is also important to consider the specific location of the future plantings, namely with respect to ecoregion. The state of North Carolina encompasses 3 main ecoregions: Mountains, Piedmont, and Coastal Plain (for the purpose of this toolkit, the Sandhills are included in the Coastal Plain ecoregion) (Figure 1). Within each ecoregion there may be local site adaptations of native plant species known as ecotypes. These ecotypes represent species' adaptations to the specific environmental conditions (such as climate, soil type, and elevation) that occur within that

region. Ecotypes typically have a higher rate of establishment and increased genetic compatibility with nearby populations of the same species. Additionally, ecotypes of native plant species may have specific phenotypic and phenological links with their pollinators. The use of ecotypes becomes especially important when working with species that are native to a large geographic area. For example, butterfly milkweed (*Asclepias tuberosa*) occurs throughout the entire eastern United States, however a person planting pollinator habitat in Florida should avoid butterfly milkweed seed that was collected from plants growing in Minnesota. Instead they would have a greater chance of success using seed collected from Florida plants (or at the very least, plants from the southeastern U.S.). Similarly, someone planting pollinator habitat in the mountains of Tennessee might not want to use seed from the coastal plain of Georgia. It is recommended that pollinator projects in the state of North Carolina utilize NC ecotypic seed whenever possible. If NC ecotypic seed is unavailable, it is recommended that effort be made to match up the seed source with the ecoregion of the planting (i.e. using seed collected from piedmont plants for a pollinator planting installed in the Piedmont, even if the only ecotypic seed that is available is from another southeastern state).

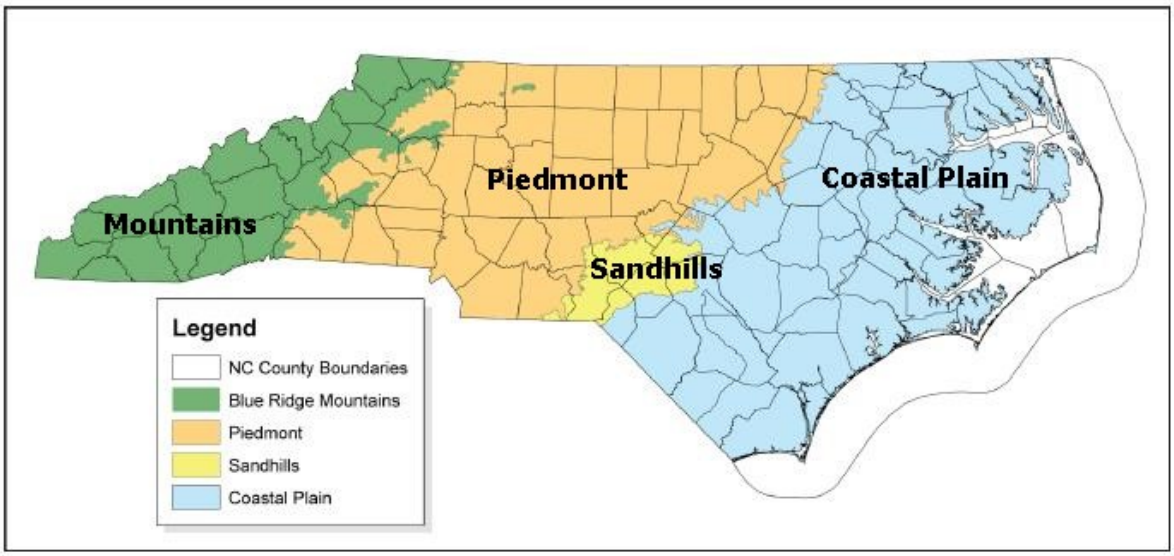

Figure 1. North Carolina Ecoregion Map, ©NC Wildlife Resources Commission

Despite the importance of using locally adapted native ecotypic seed in pollinator habitat plantings, the current commercial availability of North Carolina ecotypic seed is incredibly low. As of January 2019, there are only a few regional seed suppliers currently offering bulk amounts of NC ecotypic seed on a large-scale basis. And even among these suppliers, species selection is fairly limited (Table 1).

Seed Supplier	Location	# species of NC ecotypic seed offered
Ernst Conservation Seed	Crawford Co., PA	33
Garrett Wildflower Seed Farm	Johnston Co., NC	14
Mellow Marsh Farm	Chatham Co., NC	32
Roundstone Native Seed	Hart Co., KY	13

Table 1. Commercial seed growers currently offering North Carolina ecotypic seeds

The North Carolina Pollinator Conservation Alliance, a partnership of more than 20 local, state, and federal conservation organizations including the North Carolina Botanical Garden, is currently working with local and regional growers to increase the availability of NC ecotypic seeds in order to meet the current and anticipated future demand for pollinator and other native plantings.

Species Diversity

For any pollinator planting, multiple flowering species in each bloom period (spring, summer and fall) should be included. At least three species should be in bloom during each bloom period. This is to ensure the availability of a continuous nectar (carbohydrates and amino acids) and pollen (protein) supply for numerous species of pollinators throughout the year. It is especially important to have spring (early) blooming species for insects that emerge early from winter dormancy, as well as fall (late) blooming species for insects that are migrating or preparing for overwintering (such as queen bumblebees). A diversity of flowering species that includes different flower colors, shapes, sizes, and heights will attract a wide variety of pollinator species.

For projects using seed and seed mixes, native flowering herbaceous perennials should compose >50% of the seed mix. Native clump-forming bunch grasses should be included to provide pollinator nesting and overwintering sites and as fuel for prescribed burns (if applicable), but bunch grasses should generally compose <25% of the seed mix. It may be more feasible to establish native bunch grasses by plugs rather than seed. Other shorter, non-clump forming native grass species should also be selected, but similarly these species should only compose ≤25% of the seed mix. It may also be desirable to include fast-growing native annuals and early successional native species in the seed mix. These species will establish quickly and provide early floral resources, as well as limit the spread of non-native weeds and prevent erosion during the first year while native perennials are getting established. Additionally, native shrubs and trees should be included when feasible, as these species also provide an important food source for pollinators and their larvae. Many shrubs have pithy stems that cavity nesting insects use for nesting and overwintering.

It is also important to include a diversity of larval host plants for lepidopteran (butterfly and moth) species. Lepidopteran species lay their eggs on specific plants and their larva will then feed on those plants once they hatch. Some lepidopteran species will use a wide range of plant species as hosts, while other species require a single genus or species.

Project Types

Before doing any new planting, it is a good idea to do a habitat assessment (https://xerces.org/pollinator-conservation/habitat-assessment-guides/), especially in natural areas or rights-of-way. Some periodically disturbed areas support diverse native species. All pollinator habitat plantings should be large enough to provide both foraging and nesting sites. Species selection will be largely dependent on the location and type of the project. Projects to create or enhance pollinator habitat typically fall into one of the following categories:

1. Residential / small garden (< 1 acre)
    - These small-scale pollinator gardens should be composed of a wide range of densely planted herbaceous perennials and annuals, with perhaps a few shrubs and trees scattered in as specimen plantings as space allows. Shrub and tree plantings that may take less maintenance are also tremendously valuable.
    - Urban pollinator gardens might also include a small water feature to provide fresh drinking water for pollinators or a low-lying area that stays consistently damp for "puddling," a behavior exhibited by butterflies and other insects thought to be necessary for obtaining minerals and amino acids.
    - Interpretive signage in the garden can help to educate neighbors and HOAs about the important role of native pollinators in the landscape. Additionally, "no spray" signs can let neighbors know to be more diligent in their application of pesticides or herbicides.
2. Public spaces (parks, greenways, community gardens)
    - Pollinator habitat that is planted in highly visible public spaces should be composed of densely planted herbaceous species as well as pollinator-friendly shrubs and trees.
    - Interpretive signage and/or outreach materials at the site may be helpful to explain the planting as well as the important relationship between native plants and pollinators.
3. Roadsides
    - Roadside plantings should consist of densely planted herbaceous species. Woody species should be minimized to maintain ease of maintenance.
    - Maintaining regularly mown safe roadside margins (i.e. a 10-15 foot "clear zone" adjacent to the pavement or shoulder) is recommended to increase sight distance and driver safety. In some areas, these "clear zone" distances are legislated.
    - Pollinator habitat should not be planted in roadside medians in order to minimize insect mortality by vehicle strikes (Keilsohn et. al. 2018).
    - After establishment of native species, maintenance costs are typically reduced due to fewer required mowings beyond the "clear zone."
    - The U.S. Department of Transportation, Federal Highway Administration has created best management practices for roadside pollinator habitat, which can be found here: http://www.xerces.org/wp-content/uploads/2016/08/BMPs_pollinators_landscapes.pdf
4. Agriculture
    - Farmers can add pollinator habitat by installing appropriate plantings in field borders, hedgerows, and buffer strips in and around fields, converting old fields no

longer in agricultural production into pollinator habitat, and planting conservation cover crops in fields currently in production. See the North Carolina Pollinator Protection Strategy (http://www.ncagr.gov/pollinators/NCPollinatorProtection.htm) for more discussion about additional techniques that farmers can employ to support and enhance native pollinator populations, including reducing mowing and avoiding deep tillage.

- The creation of hedgerows, which typically include a variety of tree and shrub species that vary in height, can be a good way to provide valuable pollinator forage and facilitate movement of pollinators across the landscape. Hedgerows generally support a higher diversity and density of pollinator species than in surrounding landscapes, and they are also useful as general wildlife habitat. A list of native trees and shrubs that are appropriate for use in hedgerows has been developed by the North Carolina Pollinator Conservation Alliance and is included in Appendix A.
- There are programs within the USDA's Farm Bill that can be used to promote pollinator conservation and habitat creation on agricultural lands. For more information (and for additional discussion on specific techniques to enhance pollinator habitat on agricultural lands) see the "Using Farm Bill Programs for Pollinator Conservation" document found here: https://plants.usda.gov/pollinators/Using_Farm_Bill_Programs_for_Pollinator_Conservation.pdf

5. Solar farms
    - The North Carolina Pollinator Conservation Alliance has created guidelines for creating pollinator habitat using native species on solar sites (http://ncpollinatoralliance.org/wp-content/uploads/2018/10/NC-Solar-Technical-Guidance-Oct-2018.pdf)
    - Landowners who want to consider installing pollinator habitat on solar farms on their land (instead of installing turf grass or other options) should first review the following link in order to fully understand how these solar farm contracts work. It is important to note that interested landowners should discuss the option of installing pollinator habitat very early in the contracting process, particularly prior to signing any solar farm contracts. https://content.ces.ncsu.edu/landowner-solar-leasing-contract-terms-explained
    - After establishment of native species, maintenance costs are typically reduced due to fewer required mowings.
6. Transmission rights-of-way
    - Rights-of-way often host diverse native plants, so it is important to conduct a habitat assessment (https://xerces.org/pollinator-conservation/habitat-assessment-guides/) prior to considering installing a new planting.
    - Pollinator habitat in powerline and utility corridor rights-of-way should include only herbaceous perennials, annuals and low-growing shrubs. These are great areas to include a lot of diversity in the seed mixes because there is no height constraint for the herbaceous species.

- Trees should NOT be planted in utility corridor rights-of-way as they may interfere with utility lines as well as the ability of the utility companies and their contractors to access and maintain these.
- If a property owner wishes to plant pollinator habitat on a utility easement or right-of-way and does not want the utility company or their contractors to spray with herbicides, the property owner can contact their local utility office to receive "do not spray" signs to place on the easement. However, the utility company typically retains the right to maintain the easement as needed.
- After establishment of native species, maintenance costs are typically reduced due to fewer required mowings.
- To view a map of North Carolina's electric power providers, please see the following map: https://www.carolinacountry.com/your-energy/energy-education/electric-utilities-in-north-carolina

7. Ecological restoration (large-scale, ≥ 1 acre)
   - Ecological restoration should target as many species as possible over what are usually large areas. Pollinator species should be included to maximize diversity and ecosystem function.
   - Mixes of herbs, grasses, vines, shrubs and trees should be targeted as appropriate for site conditions and project type.
   - Since these are uncultivated areas that will receive minimal post planting care, ecotypes that are site and range appropriate will have the highest value and chance of success.

Recommended Species / Seed Mixes

A list of recommended North Carolina native plant species for pollinators, as well as which ecoregion(s) and project(s) they are appropriate for, is included in Appendix B. This list is not intended to be comprehensive, but to represent the best of the best when it comes to providing either nectar and pollen, larval food, or habitat for pollinators. It is also important to note that the list provided in Appendix B is composed mostly of herbaceous species because many of the projects discussed in this document are focused on establishing herbaceous vegetation. There are many other native trees and shrubs not included in this list that are utilized by and valuable to pollinators.

A condensed list of the top 12 most versatile pollinator species for each ecoregion is provided in Table 2. The species in this table are appropriate for most of the project types discussed above, and seeds of these species are already commercially available (although NC ecotypic seed is not yet commercially available for all of these). Please refer to the full table in Appendix B for more information about each of these species.

Mountains	Piedmont	Coastal Plain
Asclepias tuberosa	*Asclepias tuberosa*	*Asclepias tuberosa*
Aquilegia canadensis	*Chrysopsis mariana*	*Baptisia albescens*
Chrysopsis mariana	*Coreopsis auriculata*	*Ceanothus americanus*
Coreopsis major	*Eryngium yuccifolium*	*Chrysopsis mariana*
Eutrochium purpureum	*Eutrochium fistulosum*	*Helianthus angustifolius*
Monarda fistulosum	*Parthenium integrifolium*	*Liatris spicata*
Pycnanthemum incanum	*Penstemon laevigatus*	*Monarda punctata*
Rudbeckia hirta var. hirta	*Pycnanthemum tenuifolium*	*Muhlenbergia capillaris*
Schizachyrium scoparium	*Schizachyrium scoparium*	*Panicum virgatum*
Solidago nemoralis	*Symphyotrichum grandiflorum*	*Solidago odora*
Symphyotrichum novae-angliae	*Vernonia glauca*	*Symphyotrichum grandiflorum*
Vernonia noveboracensis	*Zizia aurea*	*Vernonia acaulis*

Table 2. Top 12 pollinator species for each NC ecoregion

A comprehensive, searchable online database for selecting the most appropriate native plant species for a particular project in each ecoregion of North Carolina will be made available by the North Carolina Botanical Garden in the future. The goal of such a database is to facilitate the development of custom species lists for any specific project across the state, as well as connecting potential customers with local and regional seed producers that are growing the species of interest.

Additionally, the North Carolina Pollinator Conservation Alliance is currently developing a general all-purpose pollinator seed mix composed of 12-14 native herbaceous species that will be appropriate for small-scale (< 1 acre) pollinator habitat projects across all three ecoregions of North Carolina.

Once the appropriate plant species have been identified for the specific ecoregion, project type, and site conditions, an online seed calculator can be a useful tool to help create a custom seed mix within the project budget. The Xerces Society's Seed Mix Calculator (https://xerces.org/xerces-seed-mix-calculator/) includes a wide variety of commercially available species as well as estimated seed prices based on current market availability.

III. PLANTING SPECIFICATIONS

Site Selection

It is important to consider previous and adjacent land use before selecting an appropriate site for a native pollinator planting. Some important things to consider are:

- What is the existing vegetation? Would management, such as removal of invasive species, improve the site more than a new planting?
- Has there been a history of pre-emergent herbicide or persistent pesticide use on the site? If so, is there a chance that harmful residue remains in the soil? If there is a

history of pesticide use, it is important to know which types because certain ones may remain in the soil longer than others (in extreme cases, up to 18 months). Pre-emergent herbicide residue can potentially inhibit native seed germination, and any pesticide residue in the soil can be absorbed by plants and subsequently affect pollinators.

- Is there continued pesticide use on adjacent lands? Pesticide drift from neighboring properties could potentially be catastrophic for a pollinator habitat project.
- Are abundant and aggressive invasive/non-native weeds present on adjacent lands? Neighboring populations of aggressive weeds can easily colonize newly installed pollinator plantings.
- Are there vegetated buffers or wildlife habitat corridors nearby to facilitate pollinator movement and provide "safe zones"? These areas provide food, shelter, and nesting sites and also allow for pollinators to travel between sites. Ultimately, these habitat corridors will enhance pollinator dispersal and reproduction.
- Is there a clean and reliable water source nearby to provide drinking and "puddling" opportunities for pollinators?
- Is there heavy pressure from mammalian herbivores, specifically deer and/or rabbits? If so, any plantings should include species that are fairly deer resistant or include exclusion fences.

Site Analysis

Once an appropriate site has been selected, a thorough vegetation survey and site analysis should be conducted prior to any site prep or planting. A vegetation survey can provide useful information as to what species may be persistent in the soil seed bank, which can help guide species selection and also inform future management strategies. Similarly, a site analysis can be used to evaluate local conditions such as topography and microclimate. Topography should be analyzed broadly across the entire site as well as by noting small-scale variations within the site such as slopes, dips, gullies, or other low points. These small-scale variations in topography can drastically affect site drainage and can inform future stormwater management issues and decisions. Small-scale changes in topography can also interact with varying degrees of sun exposure and soil composition to create multiple unique microclimates within the site. Identifying and understanding these microclimates can aid in plant species selection, siting, and arrangement within the site.

Site Prep

To maximize the chances of a successful pollinator planting, existing invasive and/or non-native vegetation, weeds, and turf grasses should be removed prior to planting. For information about the invasive plant species in North Carolina, please visit the website of the NC Invasive Plant Council (http://nc-ipc.weebly.com/nc-invasive-plants.html). It is important to be aware that in some cases, in may take up to a year or two to ensure that weeds are controlled.

Invasive species and weed removal can be done by a variety of methods depending on the size and scope of the project. For smaller projects, like residential gardens and smaller

public spaces (typically ≤ ½ acre), it may be possible to remove existing undesirable vegetation by organic methods such as digging, sod removal, sheet mulching, solarization (raising the soil temperature high enough to kill weeds and weed seeds), or a combination of these methods.

- Sod removal = in early fall, thoroughly water the area 24 hours prior to removal; cut strips of sod using sod cutter (available for rent at equipment rental companies); remove sod strips from the site; do not till following sod removal as this may expose additional weed seeds; rake the soil surface smooth and/or use a turf roller to lightly pack the surface; immediately plant/sow pollinator plants
- Sheet mulching = in the winter or spring, mow and water the area; apply a 1" layer of grass-clippings or other nitrogen-based plant material and thoroughly water; apply a ½" layer of cardboard or newspaper on top of the first layer and thoroughly water; repeat these layers once or twice depending on the amount of weeds present; keep the entire sheet mulch moist throughout the growing season; in late fall, remove the top layer and plant/sow pollinator plants
- Solarization = in the spring, mow or till and subsequently remove clipped vegetation, thoroughly water the area and cover with black plastic sheeting; bury the edges of the sheeting to prevent airflow and put a weight in the middle if necessary; repair any holes or rips immediately and keep the plastic sheeting in place throughout the summer; remove the plastic in early fall; do not till following solarization as this may expose additional weed seeds, however it may be beneficial to add a thin layer of weed-free compost on top of the soil once the sheeting is removed; immediately plant/sow pollinator plants.

For an in-depth description of additional organic site prep options, including organic site prep for large-scale pollinator projects, please see the Xerces Society's Organic Site Preparation for Wildflower Establishment document, found here: http://xerces.org/wp-content/uploads/2016/10/2016-027_Organic-Site-Prep-Guidelines_May2017_web.pdf

Application of a post-emergent (non-persistent) broad-spectrum herbicide may be necessary for control and eradication of certain weedy and/or invasive species, particularly for large-scale pollinator habitat projects. Herbicide application should be timed when weeds are actively growing, so it is possible that application may need to be repeated across multiple seasons to control both warm-season and cool-season weedy species. Prior to initial application, mow and remove clipped vegetation from the site. As soon as weeds begin re-sprouting, apply the herbicide following the instructions and recommended application rates located on the label.

Herbicide should be applied during sunny and dry conditions on days with very light winds (maximum of 10 mph). Apply herbicides in the early morning (after the foliage has dried) or late in the evening when pollinators are not active. Repeat the herbicide treatment as needed throughout the growing season. Do not till following herbicide treatment as this may expose additional weed seeds. Allow a minimum of 72 hours between the last herbicide application and seeding/planting. If a pre-emergent herbicide is used (not recommended), it will be necessary to allow for more time between application and planting (potentially up to 3 months).

Soil Amendment

Following site prep but prior to planting, collect soil samples and have them analyzed by the North Carolina Department of Agriculture soil testing laboratory. Unless the soil is extremely deficient in nutrients such as phosphorous or potassium, do not amend the soil. Soil amendments or fertilizers are typically not necessary for native plant species and will only serve to encourage the growth of unwanted weeds.

Cover Crops

Following site prep, a cover crop can be used to help stabilize the soil prior to seeding or planting native species. This may not be necessary for every project, but a cover crop can be beneficial if the time between site prep and seeding is greater than a few months or if there is any chance of residual pesticides being present on the site. A cover crop can provide more time to allow pesticides to break down in the soil while also helping to prevent weed infestation following site prep.

If a cover crop is desired and site prep is completed by the fall but the site will not be seeded or planted with native species until the spring, an annual such as *Triticum aestivum* (winter wheat) or *Pisum sativum* (garden pea) can be sown anytime from September through December at a rate of 30 lbs./acre for the wheat and 50 lbs./acre for the pea. If site prep is completed by the spring or early summer and the site will not be seeded or planted with native species until the fall, a cover crop such as *Urochloa racemosa* (browntop millet) or *Pisum sativum* (garden pea) can be sown anytime from May – August at a rate of 20 lbs./acre for the millet and 50 lbs./acre for the pea.

Following the sowing of the cover crop, a 1” layer of straw mulch can be added for erosion control, to prevent the seed from washing away, and to help retain soil moisture. When the site is ready to be planted with native species, the cover crop should be harvested or mowed down and removed from the site.

Timing

The ideal time to direct sow seed of most native herbaceous species is in the fall or early winter (October thru December) to allow the seeds to naturally break dormancy over the winter. Some native herbs and grasses do not require a period of cold stratification to break dormancy and can be sown in the spring. Many commercial seed mixes include a variety of species, including ones that do not need cold stratification, to ensure some seed germination and growth from spring planting projects. Nursery-grown containerized plants or plugs can be planted in either fall or spring.

Planting Layout

Herbaceous species should be planted in masses to facilitate foraging, cross-pollination and seed set, and plant density should be high enough to provide pollinators with shelter and protection from predators. For larger project areas, the absolute number of individuals planted may be slightly smaller if bigger, nursery-grown containerized plants are used.

Multiple vegetation layers plus leaf litter, brush piles, and dead plant material should be included where possible as nesting sites and additional shelter from predators. It is also

important to allow for areas of uncovered soil for ground-nesting bees. It may be appropriate to leave standing wood or install manufactured "bee hotels" as nesting sites for native solitary bees. However, if manufactured "bee hotels" are used, it is important to properly clean and monitor them for signs of disease and parasites in order to maintain overall pollinator health (MacIvor & Packer 2015).

Seeding Rate

The seeding rate recommended by the Xerces Society for pollinator-friendly native herbaceous perennials is 40-60 seeds per square foot (https://www.xerces.org/wp-content/uploads/2013/12/EstablishingPollinatorMeadows.pdf). In general, this corresponds to 10-18 lbs. of seed for 1 acre depending on the region and species included in the mix. Ernst Conservation Seed recommends a higher seeding rate, between 20-40 lbs. per acre, which corresponds to roughly 80-160 seeds per square foot. While this higher seeding rate may be preferable to ensure a successful planting, the higher upfront cost of the seed may be prohibitive for some projects. Individual projects should seek to balance budget concerns with maximizing chances of success in determining appropriate seeding rates.

Planting Methods

For small-scale projects, broadcast seeding by hand (i.e. scattering seed onto the soil surface) is the easiest method for planting seed and seed mixes. However, this method may require higher seeding rates to ensure good seed to soil contact. Nursery-grown containerized plants or plugs can be used for individual species that are either difficult to establish from seed or are extremely slow-growing. For large-scale projects, seed can be spread with mechanical seed spreaders, drop seeders, or native seed drills, such as a Truax native seed drill which is designed to accommodate different types and sizes of seeds. However, it should be noted that seeds of some species may be more prone to cause clogs in mechanical seed spreaders or seed drills.

To promote an even seed distribution and enhance the success of the seeding and subsequent germination, mix the seed with an inert material such as coarse sand prior to broadcast seeding. If the different species of seeds being used are not already pre-mixed, it may be better to sow them separately as individual species. This will also help to ensure a more even distribution of species across the site.

Following sowing, seeds should be firmly pressed into the soil to maximize seed to soil contact and to also prevent the loss of seeds from wind, rain, and seed predators. This can be done using a rake, sod roller, or culti-packer depending on the size of the project. Many native herbaceous species have very small seed, so seeds should not be pressed more than approximately ⅛" into the soil. It is possible that over time, re-seeding of some species may be necessary to enhance and support diversity, particularly if more aggressive natives are expanding.

It is typically not necessary to water native pollinator plantings unless drought conditions are experienced following sowing or planting. Once established, native plants usually do not need supplemental irrigation. In fact, supplemental irrigation may actually encourage the growth of unwanted weedy species.

IV. MAINTENANCE SPECIFICATIONS

Mowing and Prescribed Burning

Mowing a portion of the site will be necessary annually for weedy and invasive species control (Figure 2a). However, after the third year post planting, these activities should be carefully managed and timed to minimize any adverse impacts to pollinators and other wildlife that have colonized the site. In order to provide some areas for insect and wildlife refugia throughout the year, do not mow the entire site in any given year. Instead, only mow ⅓ – ¼ of the total site each year. Similarly, do not mow any individual portion of the site more frequently than once every two years. This allows for dormant insects and larvae to complete their life cycle and recolonize other areas of the site.

The timing of mowing within the year is also very important. From a pollinator and wildlife standpoint, the ideal time to mow is in either late winter or early spring, from December – March, with March being the ideal time. This avoids the primary nesting season for native wildlife, which occurs from spring through the summer. However, if woody species are beginning to encroach on the site and their elimination is a management priority, the best time to mow is late summer through early fall, before the woody species begin to go dormant. If mowing is conducted during this time period, it should be limited in scope and conducted only in areas with the highest degree of woody encroachment.

Prescribed burning (Figure 2b), where feasible and allowed by the landowner or local regulations, is an ideal management tool for long-term management of large-scale native pollinator plantings. Burning not only controls woody vegetation and removes any accumulated plant material, but it also enhances native perennial re-growth and often stimulates flowering and seed set. If burning is used as a management tool, the same guidelines regarding frequency and timing should be followed as those listed above for mowing. Do not burn the entire site in any given year. In order to only burn a portion of the site in any given year, a permanent fire break may need to be installed within the planting area. For more information about the use and benefits of prescribed fire, as well as laws and regulations regarding prescribed burning in North Carolina, please visit the NC Prescribed Fire Council website http://www.ncprescribedfirecouncil.org/resources.html. Additionally, the NC Forest Service maintains a list of private contractors across the state with experience in prescribed burning (https://www.ncforestservice.gov/Managing_your_forest/contract_services.htm).

Figure 2a: Late season mowing ©Johnny Randall

Figure 2b: Prescribed burn ©Johnny Randall

Herbicide, Fertilizer, and Pesticide Application

The application of herbicides within an established pollinator planting should only be done so in a targeted way that minimizes the exposure of the native species to herbicide. Direct foliar application or the cutting of woody stems followed by herbicide application to the cut surface are two methods that minimize exposure. Herbicide application for control of woody vegetation is most effective when done in late summer or early fall, as the herbicide will be absorbed and transported to the plant's roots. Herbicides should only be applied during sunny, dry conditions and on days with very light winds (maximum of 10 mph), and always follow the recommended application rates located on the herbicide's label. Apply herbicides in the early morning (after foliage has dried) or late in the evening when pollinators are not active.

Fertilizer application is not necessary in native pollinator plantings. Native plants do not require fertilizer and in fact, application of additional nutrients will often encourage the growth of weedy species.

Pesticides should not be used at all in any native pollinator planting, and care should be taken to protect the site from pesticide exposure and drift from adjacent properties. For information regarding guidelines on agricultural pesticide application, pesticide toxicity to bees, and factors affecting honey bee health, please visit the NC Department of Agriculture & Consumer Services' N.C. Pollinator Protection Strategy (http://www.ncagr.gov/pollinators/NCPollinatorProtection.htm)

Invasive Species Control

Non-native, invasive species can be controlled by targeted mowing, spot herbicide application, or a combination of these two methods. If a combination of the two methods is used, it will be most effective to mow invasives early in the growing season followed by a fall herbicide application. Manual removal of invasive species is preferred, but this is only practical for small-scale projects.

V. NATIVE POLLINATOR HABITAT ESTABLISHMENT TIMELINE

Year 1

Native perennial species are often slower to germinate and become established than non-native herbaceous species or even native annual and biennial species. Some native perennials may even take several seasons to germinate. Therefore, it is important to keep realistic expectations for the first year of a native pollinator planting and to focus on weed control to ensure the future success of the planting.

During the first year after seeding or planting, it is important to ensure that emerging native perennial seedlings get enough sunlight. It will be necessary to keep weeds short and also to prevent them from flowering and setting seed. For smaller projects, this can be accomplished by hand-clipping or string-trimming, however pulling weeds by hand in the first year is discouraged as it can damage the delicate root systems of any adjacent germinating native seedlings. For larger projects, weed control can be done by appropriately timed and repeated mowing. The timing and frequency of mowing will vary depending on the location of

the site and environmental conditions, but in general mowing should be done when weeds start to flower or when they reach approximately 12-18 inches in height (whichever comes first). Mowing should be repeated when weeds reach approximately 12-18 inches in height again, or if they begin to flower again. Mowing should be done to a height of roughly 10-12 inches, which should be high enough to avoid damaging native seedlings but short enough to target the flowering stalks of weeds. It is okay to mow even if some of the faster-growing native annuals and biennials are already flowering.

It may also be beneficial to do a targeted, very careful spot spraying of herbicide using a backpack sprayer. This can be useful to control shorter weeds (like dandelions) that may be missed by a mower.

Year 2

In the second year following planting, the native perennials should be on their way to establishment. Most species will have germinated and put on considerable growth. However, the site still might not look like a mature pollinator planting, as plant density may still be a little low. For publicly accessible sites, interpretive signage or outreach materials at the site may be helpful to explain the process and anticipated outcome.

Weed control should still be a high priority, and mowing to a height of 10-12 inches can be continued and targeted for when biennial weeds begin to flower. The frequency of mowing in the second year should be lower as the native perennials become established and annual weeds become less of a problem. For smaller projects, hand-weeding following a rainfall (easier to pull weeds, minimizes soil disturbance) can be done to remove weeds before they set seed. As in the first year, a carefully controlled spot spraying of herbicide can be used to target shorter or woody weed species.

Year 3

By the third growing season, the majority of the native perennials will start flowering. The site will finally start to look like an established planting and pollinators may begin visiting the area. An annual or bi-annual mowing or targeted herbicide application will still be necessary to prevent the establishment of woody or invasive vegetation. For large-scale projects, it may also be feasible and beneficial to incorporate prescribed burning into the site management.

VI. FUNDING OPPORTUNITIES

Small-scale opportunities (≤ $5,000)

Small grants geared towards residential or municipal gardens can be a great way to integrate pollinator habitat and teach about the connection between food and pollinators. Science, Technology, Engineering, and Math (STEM) project grants can combine citizen science and other projects to learn about pollinators and pollinator habitat. The following is a list of small-scale funding opportunities that may be applicable to pollinator conservation and habitat development and enhancement.

- **Annie's Grants for Gardens:** This program provides funds up to $5,000 to support edible gardens in a K-12 school setting. https://www.annies.com/giving-back/grants-for-gardens
- **Bayer Feed a Bee:** This program provides up to $5,000 in funding for projects focused on establishing or enhancing pollinator forage. https://beehealth.bayer.us/what-is-bayer-doing/feed-a-bee
- **Captain Planet Foundation:** STEM focused grants up to $2,500 to support STEM education in K-12 schools. http://captainplanetf.wpengine.com/grants/
- **Fiskar's Project Orange Thumb:** This program provides $3,500 in gift cards to buy materials and supplies for beautification and gardening projects. http://www2.fiskars.com/Community/Project-Orange-Thumb
- **Home Depot Community Impact Grants:** These grants are awarded to 501c3 designated organizations and are focused on projects that benefit veterans and/or diverse and underserved communities. Grant awards are up to $5,000 in Home Depot gift cards and must be used within six months of receipt. https://corporate.homedepot.com/grants/community-impact-grants
- **Lowe's Toolbox for Education:** Grants of typically up to $5,000 (larger awards are possible) for K-12 schools to build and upgrade/improve outdoor classrooms and gardens. https://toolboxforeducation.com
- **Monarch Watch Free Milkweed Program:** This program provides free milkweed plugs on a first-come, first-served basis for schools, community groups, and large scale restoration projects. https://monarchwatch.org/bring-back-the-monarchs/milkweed/free-milkweeds/
- **The Nature Conservancy Nature Works Everywhere:** Grants of $2,000 to support green infrastructure projects in public and charter schools. https://www.natureworkseverywhere.org/grants/
- **Scott's Grow1000 Grassroots Grants:** Small grants up to $1,500 awarded to 501c3 community groups to establish pollinator habitat. https://scottsmiraclegro.com/responsibility/gro1000/#help
- **Toshiba America Foundation:** Grants up to $5,000 are available to K-12 classrooms for STEM related projects. https://www.toshiba.com/taf/
- **Walmart Community Grant Program:** This broad-scale program provides grants up to $5,000 to 501c3 non-profit organizations, schools, and churches to support projects that focus on benefiting low-income and under-served populations. http://giving.walmart.com/apply-for-grants/local-giving
- **Whole Foods Whole Kids Foundation:** Grants of up to $2,000 are available to help K-12 schools and non-profits start a garden program or observation bee hives. https://www.wholekidsfoundation.org/programs/honey-bee-hive-grant

Large-scale opportunities (> $5,000)

In addition to the large-scale grant programs listed below, landowners and farmers who are interested in creating pollinator habitat are urged to check with their local county extension office for any locally-available financial resources.

- **Lowe's Community Partners Grants:** Grants of typically up to $25,000 (larger awards are possible) are provided to non-profits and municipalities for a variety of projects but can include grounds improvements and renovations/upgrades. https://newsroom.lowes.com/apply-for-a-grant/
- **National Fish & Wildlife Foundation Monarch Butterfly and Pollinators Conservation Fund:** These large grants are awarded to 501c3 non-profit organizations and universities that are typically involved in large-scale partnership projects that increase the quality, quantity, and connectivity of monarch and pollinator habitat. Priority for these grants is typically given to projects within the monarch butterfly eastern population migratory flyway, which includes mostly Midwestern states. https://www.nfwf.org/monarch/Pages/home.aspx
- **North Carolina Agriculture Cost Share Program:** This program provides financial assistance for implementing best management practices (BMPs) to improve water quality, which could also include pollinator habitat establishment. This program is administered by local soil and water conservation districts, and each district sets their own priorities. The main BMPs listed within this program that are most applicable to pollinator habitat establishment would be "cropland conversion" and "riparian buffer". Cropland conversion practices often take highly erodible crop fields out of row crop production and plant in either grasses, trees, or wildlife plantings. Similarly, riparian buffers could be planted in native species beneficial to pollinators and other wildlife. The minimum commitment for these BMPs is 10 years. For more information about this program, please see: http://www.ncagr.gov/SWC/costshareprograms/ACSP/
- **U.S. Department of Agriculture / Natural Resource Conservation Service Program:** This is the only state-wide cost-share grant for pollinator habitat development. Landowners and farmers in North Carolina may be eligible for some of these programs. It is important to note that most of these 'Farm Bill' programs require a 10-year commitment and also that land use requirements be met during this period. For more information about this program, please see: https://plants.usda.gov/pollinators/Using_Farm_Bill_Programs_for_Pollinator_Conservation.pdf
  To determine landowner eligibility, please see: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/nc/home/?cid=nrcs142p2_046676

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APPENDIX A

NORTH CAROLINA NATIVE TREES AND SHRUBS FOR USE IN HEDGEROWS

Species	Common Name	Growth Habit	Bloom Time
Acer ruburm	Red Maple	Tree	Spring
Aesculus pavia	Red Buckeye	Small Tree	Spring
Amelanchier arborea	Serviceberry	Small Tree	Spring
Callicarpa americana	Beauty Berry	Shrub	Summer
Carya glabra	Pignut Hickory	Tree	Spring
Carya ovata	Shagbark Hickory	Tree	Spring
Ceanothus americanus	New Jersey Tea	Shrub	Summer
Cephelanthus occidentalis	Buttonbush	Shrub	Summer
Cercis canadensis	Eastern Redbud	Small Tree	Spring
Clethra alnifolia	Sweet Pepperbush	Shrub	Summer
Cornus florida	Flowering Dogwood	Small Tree	Spring-Summer
Crataegus phaenopyrum	Washington Hawthorn	Small Tree	Spring
Diospyros virginiana	Persimmon	Tree	Spring-Summer
Halesia carolina	Carolina Silverbell	Small Tree	Spring
Ilex opaca	American Holly	Small Tree	Spring
Lindera benzoin	Spicebush	Shrub	Spring-Summer
Malus angustifolia	Southern Crabapple	Small Tree	Spring
Malus coronaria	American Crabapple	Small Tree	Spring
Prunus americana	American Plum	Small Tree	Spring
Prunus angustifolia	Chickasaw Plum	Small Tree	Spring
Prunus serotina	Black Cherry	Tree	Spring
Prunus virginiana	Choke Cherry	Shrub	Spring-Summer
Rhus glabra	Smooth Sumac	Small Tree	Spring-Summer
Rhus copallinum	Winged Sumac	Small Tree	Summer-Fall
Rubus spp.	Raspberry, Blackberry	Shrub	Spring-Summer
Salix nigra	Black Willow	Small Tree	Spring
Sambucus canadensis	Elderberry	Shrub	Summer
Sassafras albidum	Sassafras	Small Tree	Spring
Vaccinium spp.	Blueberries	Shrub	Spring-Summer
Viburnum prunifolium	Black Haw	Shrub	Summer-Fall
Viburnum rafinesquianum	Downy Arrowwood	Shrub	Summer-Fall

APPENDIX B

THE BEST NORTH CAROLINA NATIVE PLANT SPECIES FOR POLLINATORS

Key to Project Type:
1 = residential, small garden
2 = parks, greenways, public spaces
3 = roadsides
4 = agricultural
5 = solar farms
6 = utility right-of-way
7 = ecological restoration

Species	Common Name	Duration	Habit	Nectar or host/habitat	Mountains	Piedmont	Coastal Plain	Soil moisture	Light exposure	Flowering season	Max height (feet)	Project type (see 'key to project type')
Actaea racemosa (syn. *Cimicifuga racemosa)*	black cohosh	perennial	herb	nectar	x	x		dry, avg, moist	part shade, shade	summer	8	1, 2
Agrostis hyemalis	small bentgrass	perennial	grass	host/habitat	x	x	x	dry, avg	sun	summer	3	3, 4, 5, 6
Aletris farinosa	white colicroot	perennial	herb	nectar	x	x	x	dry, avg, moist	sun	summer	3	1, 2, 3, 4, 5, 6, 7
Allium cernuum	nodding onion	perennial	herb	nectar	x	x		avg, dry	sun	summer	1.5	1, 2, 3, 4, 5, 6
Amelanchier arborea	common serviceberry	perennial	shrub, tree	nectar	x	x	x	moist, avg	sun, part shade	spring	25	1, 2
Ampelaster carolinianus (syn. *Aster carolinianus)*	climbing aster	perennial	vine	nectar			x	avg, moist, wet	sun	fall	6	1, 2
Amsonia ciliata	fringed bluestar	perennial	herb	nectar			x	avg	sun, part shade	spring	2	1, 2, 3, 4, 5, 6
Amsonia tabernaemontana	eastern bluestar	perennial	herb	nectar	x	x	x	avg	sun, part shade	spring	3	1, 2, 3, 4, 5, 6, 7
Andropogon gerardii	big bluestem	perennial	grass	host/habitat	x	x	x	dry, avg, moist	sun, part shade	summer, fall	8	1, 2, 3, 4, 6, 7
Andropogon ternarius	split-beard bluestem	perennial	grass	host/habitat	x	x	x	well-drained	sun, part shade	fall	4	1, 2, 3, 4, 6, 7
Aquilegia canadensis	columbine	perennial	herb	nectar	x	x	x	avg, dry	sun, shade	spring	3	1, 2, 3, 4, 6, 7
Asclepias incarnata	swamp milkweed	perennial	herb	nectar, host/habitat	x	x	x	avg, moist, wet	sun, part shade	summer	6	1, 2, 3, 6, 7
Asclepias syriaca	common milkweed	perennial	herb	nectar, host/habitat	x	x		avg, dry	sun	summer	6	2, 3, 6
Asclepias tuberosa	butterfly milkweed	perennial	herb	nectar, host/habitat	x	x	x	dry, average, well-drained	sun, part shade	summer	3	1, 2, 3, 4, 5, 6, 7
Asclepias variegata	white milkweed	perennial	herb	nectar, host/habitat	x	x	x	dry, average	sun, part shade	summer	3	1, 2, 3, 4, 5, 6, 7
Asimina triloba	paw-paw	perennial	tree	host/habitat	x	x	x	avg, moist, wet	sun, part shade, shade	spring	30	1, 2

Baptisia albescens	spiked wild indigo	perennial	herb	nectar		x	x	avg, dry	sun	spring, summer	4	1, 2, 3, 4, 5, 6, 7
Bidens aristosa	bearded beggarticks	annual, biennial	herb	nectar	x	x	x	avg, moist	sun, part shade	summer, fall	6	1, 2, 3, 4, 6, 7
Blephilia ciliata	downy woodmint	perennial	herb	nectar		x		dry, avg	sun, part shade	summer	2.5	1, 2, 3, 5
Callicarpa americana	beauty berry	perennial	shrub	nectar, host/habitat	x	x	x	avg	sun, part shade	summer	8	1, 2, 7
Ceanothus americanus	New Jersey tea	perennial	shrub	nectar	x	x	x	avg, well-drained	sun, part shade	spring	4	1, 2, 3, 4, 6, 7
Centrosema virginianum	spurred butterfly pea	perennial	vine	nectar	x	x	x	well-drained	sun	summer	5	1, 2, 3, 4, 6, 7
Cephalanthus occidentalis	button bush	perennial	shrub, tree	nectar, host/habitat	x	x	x	average, moist, wet	sun	summer	8	1, 2, 7
Cercis canadensis	eastern redbud	perennial	tree	nectar, host/habitat	x	x	x	avg	sun, part shade	spring	30	2, 3
Chamaecrista fasciculata var. *fasciculata* (syn. *Cassia fasciculata)*	partridge pea	annual	herb	nectar, host/habitat	x	x	x	dry, avg	sun	summer, fall	3	4, 5, 6, 7
Chamaecrista nictitans var. *nictitans* (syn. *Cassia nictitans)*	sensitive pea	annual	herb	nectar, host/habitat	x	x	x	dry, avg	sun	summer, fall	2	4, 5, 6, 7
Chasmanthium latifolium	river oats	perennial	grass	host/habitat	x	x	x	avg, moist, wet	part shade, shade	summer, fall	4	1, 2, 3, 7
Chelone glabra	white turtlehead	perennial	herb	nectar	x	x	x	avg, moist, wet	sun, part shade	summer, fall	5	1, 2, 3, 6, 7
Chelone lyonii	pink turtlehead	perennial	herb	nectar	x			avg, moist, wet	sun, part shade	summer	3	1, 2, 3, 6, 7
Chrysogonum virginianum	green and gold	perennial	herb	nectar	x	x	x	dry, avg, moist	sun, part shade	spring, summer	1	1, 2, 3, 5
Chrysopsis mariana	Maryland golden aster	perennial	herb	nectar	x	x	x	avg, dry, well-drained	sun, part shade	summer, fall	2	1, 2, 3, 4, 5, 6, 7
Cirsium discolor	field thistle	perennial	herb	nectar, host/habitat	x	x		avg, dry	sun, part shade	summer, fall	8	3
Clethra alnifolia	coastal sweetpepperbush	perennial	shrub	nectar			x	avg, moist, wet	sun, part shade	summer	5	1, 2, 3, 7
Conoclinium coelestinum (syn. *Eupatorium coelestinum)*	blue mistflower	perennial	herb	nectar		x	x	avg, moist, wet	part shade, shade	summer, fall	3	1, 2, 3, 4, 5, 6
Coreopsis auriculata	lobed tickseed	perennial	herb	nectar	x	x	x	well-drained	sun, part shade	spring, summer	1	1, 2, 3, 4, 5, 6, 7
Coreopsis gladiata	coastal plain tickseed	perennial	herb	nectar			x	avg, moist	sun, part shade	fall	3	1, 2, 3
Coreopsis major	greater tickseed	perennial	herb	nectar	x	x	x	avg, dry	sun	summer	3	1, 2, 3, 4, 5, 6, 7
Coreopsis tripteris	tall tickseed	perennial	herb	nectar	x	x	x	avg	sun, part shade	summer	6	1, 2, 3, 4, 6

Coreopsis verticillata	whorled tickseed	perennial	herb	nectar		x	x	avg, dry	sun	summer	3	1, 2, 3, 4, 5, 6
Crataegus crus-galli	cockspur hawthorn	perennial	shrub, tree	nectar, host/habitat	x	x	x	avg	sun	spring	35	2
Danthonia sericea	downy danthonia	perennial	grass	host/habitat	x	x	x	dry, avg, moist	sun, part shade	spring	3	3, 4, 5, 6, 7
Dicentra eximia	bleeding heart	perennial	herb	nectar	x			moist, avg	part shade, shade	summer	2	1, 2
Dichanthelium clandestinum (syn. *Panicum clandestinum)*	deertongue witchgrass	perennial	grass	host/habitat	x	x		avg, moist	sun, part shade	summer	4	3, 5, 6
Elymus virginicus	Virginia wildrye	perennial	grass	host/habitat	x	x	x	avg, moist	sun, part shade	summer	4	3, 4, 5, 6
Eragrostis hirsuta	bigtop lovegrass	perennial	grass	host/habitat		x	x	dry, avg	sun, part shade	summer, fall	4	3, 4, 5, 6
Eryngium yuccifolium var. *yuccifolium*	rattlesnake master	perennial	herb	nectar	x	x	x	avg, dry	sun	summer	4	1, 2, 3, 4, 5, 6
Eupatorium perfoliatum	common boneset	perennial	herb	nectar	x	x	x	avg	sun, part shade	summer	4	1, 2, 3, 4, 6
Eurybia divaricata (syn. *Aster divaricatus)*	white wood aster	perennial	herb	nectar	x	x		avg	part shade, shade	fall	2	1, 2, 3, 4
Euthamia carolinana	flat-topped goldenrod	perennial	herb	nectar		x	x	avg	sun	fall	3	1, 2, 3, 4, 5, 6, 7
Eutrochium fistulosum (syn. *Eupatorium fistulosum)*	hollow-stem joe-pye weed	perennial	herb	nectar	x	x	x	avg, moist, wet	sun	summer	8	1, 2, 3, 4, 6, 7
Eutrochium purpureum (syn. *Eupatorium purpureum)*	sweetscented joe pye weed	perennial	herb	nectar	x	x		avg, moist	sun, part shade	summer	6	1, 2, 3, 4, 6, 7
Gaillardia pulchella var. *drummondii*	indian blanket	annual, biennial	herb	nectar			x	dry, avg	sun	summer, fall	2	1, 2, 3, 5
Geranium maculatum	spotted geranium	perennial	herb	nectar	x	x	x	avg, moist, wet	part shade, shade	spring	2	1, 2, 3
Helenium autumnale	common sneezeweed	perennial	herb	nectar	x	x	x	avg, moist, wet	sun	summer, fall	5	1, 2, 3, 4, 6, 7
Helenium flexuosum	purplehead sneezeweed	perennial	herb	nectar	x	x	x	avg, moist, wet	sun	summer	3	1, 2, 3, 4, 6, 7
Helianthus angustifolius	swamp sunflower	perennial	herb	nectar		x	x	avg, moist, wet	sun	fall	6	1, 2, 3, 6, 7
Helianthus atrorubens	purpledisk sunflower	perennial	herb	nectar	x	x	x	avg, dry	sun	fall	6	1, 2, 3, 4, 6
Helianthus divaricatus	woodland sunflower	perennial	herb	nectar	x	x	x	avg, dry	sun, part shade	summer	7	1, 2, 3, 4, 6
Heliopsis helianthoides var. *helianthoides*	smooth oxeye	perennial	herb	nectar	x	x		avg, moist	sun, part shade	summer, fall	5	1, 2, 3, 5, 6
Heuchera americana	American alumroot	perennial	herb	nectar	x	x	x	avg, moist	part shade, shade	spring, summer	1	1, 2
Hibiscus moschuetos	crimson-eyed rose-mallow	perennial	herb	nectar, host/habitat	x	x	x	avg, moist, wet	sun	summer	6	1, 2, 3, 6, 7
Hypericum prolificum	shrubby St. Johnswort	perennial	shrub	nectar	x	x	x	dry, avg, moist, wet	sun, part shade, shade	summer	4	1, 2, 4

Iris cristata	dwarf crested iris	perennial	herb	nectar	x	x	x	moist, avg	part shade, shade	spring	0.5	1, 2
Iris verna	dwarf violet iris	perennial	herb	nectar		x	x	moist, avg	part shade, shade	spring	0.5	1, 2
Isotrema macrophyllum (syn. *Aristolochia macrophylla)*	pipevine	perennial	vine	host/habitat	x			avg, moist, wet	part shade, shade	summer	30	1, 2
Itea virginica	Virginia sweetspire	perennial	shrub	nectar	x	x	x	avg, moist, wet	sun, part shade	spring, summer	4	1, 2, 3, 7
Kosteletzkya pentacarpos (syn. *Kosteletzkya virginica)*	Virginia saltmarsh mallow	perennial	herb	nectar			x	avg, moist, wet	sun	summer, fall	6	1, 2, 3, 7
Lespedeza virginica	slender lespedeza	perennial	herb	nectar	x	x	x	avg, dry	sun	summer	2	3, 4, 5, 6, 7
Liatris pilosa (syn. *Liatris graminifolia)*	shaggy blazing star	perennial	herb	nectar		x	x	dry, avg, well-drained	sun	fall	3	1, 2, 3, 5, 6
Liatris spicata var. *spicata*	dense blazing star	perennial	herb	nectar	x	x		avg, dry	sun	summer	4	1, 2, 3, 4, 5, 6
Liatris squarrosa var. *squarrosa*	scaly blazing star	perennial	herb	nectar		x	x	avg	sun, part shade	summer, fall	2.5	1, 2, 3, 4, 5, 6
Lilium superbum	turk's-cap lily	perennial	herb	nectar	x			avg	sun, part shade	summer	7	1, 2, 3
Lindera benzoin	northern spicebush	perennial	shrub, tree	host/habitat	x	x	x	avg, moist, wet	sun, part shade	spring	9	1, 2
Liriodendron tulipifera	tuliptree	perennial	tree	host/habitat	x	x	x	avg	sun	spring	90	2
Lobelia cardinalis	cardinalflower	perennial	herb	nectar	x	x	x	avg, moist, wet	sun, part shade	summer	4	1, 2, 3, 7
Lobelia siphilitica	great blue lobelia	perennial	herb	nectar	x	x		avg, moist, wet	sun, part shade	summer	4	1, 2, 3, 7
Lonicera sempervirens	trumpet honeysuckle	perennial	vine	nectar, host/habitat	x	x	x	avg	sun, part shade	spring, summer	10	1, 2
Maianthemum racemosum	feathery false lily of the valley	perennial	herb	nectar	x	x	x	avg, moist	part shade, shade	spring	2	1, 2
Marshallia obovata var. *obovata*	piedmont Barbara's buttons	perennial	herb	nectar		x		dry, avg	sun	spring	2	1, 2, 3, 4, 5, 6
Mimulus ringens var. *ringens*	Allegheny monkeyflower	perennial	herb	nectar	x	x	x	avg, moist, wet	sun, part shade	summer	3	1, 2, 3, 7
Monarda didyma	scarlet beebalm	perennial	herb	nectar	x	x		avg, moist, wet	sun	summer, fall	4	1, 2, 3, 7
Monarda fistulosa var. *molis*	wild bergamot	perennial	herb	nectar	x	x		dry, avg, moist	sun, part shade	summer	5	1, 2, 3, 4, 5, 6
Monarda punctata var. *punctata*	spotted beebalm	perennial	herb	nectar	x	x	x	avg, dry	sun	summer	3	1, 2, 3, 4, 5, 6
Morella cerifera	wax mrytle	perennial	shrub, tree	host/habitat			x	avg, moist	sun, part shade	spring	15	1, 2, 3, 7
Muhlenbergia capillaris	muhly grass	perennial	grass	host/habitat	x	x	x	dry, avg, well-drained	sun	fall	3	1, 2, 3, 4, 5, 6
Oenothera fruticosa	narrowleaf evening primrose	perennial	herb	nectar	x	x	x	dry, avg	sun, part shade	spring, summer	2	1, 2, 3, 4, 5, 6

Packera anonyma (syn. *Senecio anonymus)*	Small's ragwort	perennial	herb	nectar	x	x	x	dry, avg	sun	spring	2.5	1, 2, 3, 4, 5, 6
Packera aurea (syn. *Senecio aureus)*	golden ragwort	perennial	herb	nectar	x	x		avg, moist, wet	sun, part shade	spring	2	1, 2, 3, 6
Panicum anceps (syn. *Coleataenia anceps* ssp. *anceps)*	beaked panicgrass	perennial	grass	host/habitat	x	x	x	avg, moist	part shade	summer, fall	4	3, 5, 6
Panicum virgatum	switchgrass	perennial	grass	host/habitat	x	x	x	dry, avg	sun	fall	5	1, 2, 3, 4, 6, 7
Parthenium integrifolium var. *integrifolium*	wild quinine	perennial	herb	nectar	x	x	x	avg, dry	sun	summer, fall	3	1, 2, 3, 4, 5, 6
Passiflora incarnata	purple passionflower	perennial	vine	nectar, host/habitat	x	x	x	avg	sun	spring, summer	12	1, 2, 3, 6
Penstemon canescens	eastern gray beardtongue	perennial	herb	nectar, host/habitat	x	x		avg	sun, part shade	summer	2.5	1, 2, 3, 4, 5, 6
Penstemon laevigatus	eastern smooth beardtongue	perennial	herb	nectar, host/habitat		x	x	avg	sun, part shade	summer	4	1, 2, 3, 4, 5, 6
Penstemon smallii	Small's beardtongue	perennial	herb	nectar, host/habitat	x	x		avg	sun, part shade	spring	3	1, 2, 3, 4, 5, 6
Phlox divaricata	wild blue phlox	perennial	herb	nectar	x		x	avg, moist	part shade, shade	spring	2	1, 2, 3
Phlox nivalis	trailing phlox	perennial	herb	nectar	x	x	x	avg, well-drained	sun, part shade	spring	1	1, 2, 3, 4, 5, 6
Phlox paniculata	fall phlox	perennial	herb	nectar	x	x	x	avg, moist, wet	sun, part shade	summer	5	1, 2, 3, 6, 7
Phlox stolonifera	creeping phlox	perennial	herb	nectar	x	x		avg, moist	part shade, shade	spring	1.5	1, 2, 3
Physocarpus opulifolius	common ninebark	perennial	shrub	nectar	x	x		dry, avg, moist	sun, part shade	spring	8	1, 2, 3
Physostegia virginiana	obedient plant	perennial	herb	nectar	x	x	x	avg, moist, wet	sun, part shade	summer, fall	4	1, 2, 3, 6, 7
Polygonatum biflorum var. *commutatum*	smooth Solomon's seal	perennial	herb	nectar	x	x		avg, moist	part shade, shade	summer	5	1, 2
Pontederia cordata	pickerelweed	perennial	herb	nectar	x	x	x	moist, wet	sun, part shade	summer	3	1, 2, 7
Pycnanthemum incanum	hoary mountainmint	perennial	herb	nectar	x	x		dry, avg	sun, part shade	summer	3	1, 2, 3, 4, 5, 6
Pycnanthemum muticum	clustered mountainmint	perennial	herb	nectar	x	x	x	dry, avg	sun, part shade	summer	3	1, 2, 3, 4, 5, 6
Pycnanthemum pycnanthemoides var. *pycnanthemoides*	southern mountainmint	perennial	herb	nectar	x	x		dry, avg	sun, part shade	summer	6	1, 2, 3, 4, 6
Pycnanthemum tenuifolium	narrowleaf mountainmint	perennial	herb	nectar	x	x	x	dry, avg	sun	summer	3	1, 2, 3, 4, 5, 6
Rhus copallinum	winged sumac	perennial	shrub, tree	host/habitat	x	x	x	dry, avg, moist	sun, part shade	summer	30	1, 2, 3

Rosa carolina	Carolina rose	perennial	shrub	nectar, host/habitat	x	x		dry, avg, moist	sun, part shade	summer	6	1, 2
Rudbeckia hirta var. *angustifolia*	coastal plain black-eyed susan	annual, biennial, perennial	herb	nectar			x	avg	sun	summer	3	1, 2, 3, 4, 5, 6, 7
Rudbeckia hirta var. *hirta*	woodland black-eyed susan	annual, biennial, perennial	herb	nectar	x			avg	sun	summer	3	1, 2, 3, 4, 5, 6, 7
Rudbeckia hirta var. *pulcherimma*	weedy black-eyed susan	annual, biennial, perennial	herb	nectar		x		avg	sun	summer	3	1, 2, 3, 4, 5, 6, 7
Rudbeckia laciniata	cutleaf coneflower	perennial	herb	nectar	x	x		avg, moist	sun, part shade	fall	7	1, 2, 3
Rudbeckia triloba var. *triloba*	browneyed Susan	perennial	herb	nectar	x			avg, dry	sun, part shade	fall	3	1, 2, 3, 4, 5, 6
Sassafras albidum	sassafras	perennial	tree	host/habitat	x	x	x	well-drained	sun, part shade	spring	30	1, 2
Saururus cernuus	lizard's tail	perennial	tree	nectar	x	x	x	moist, wet	part shade, shade	spring, summer	3	1, 2, 7
Schizachyrium scoparium	little bluestem	perennial	grass	host/habitat	x	x	x	dry	sun	fall	3	1, 2, 3, 4, 5, 6
Scutellaria incana	hoary skullcap	perennial	herb	nectar	x	x	x	dry, avg, moist	sun, part shade	summer	3	1, 2, 3, 5, 6
Scutellaria integrifolia	helmet flower	perennial	herb	nectar	x	x	x	avg, moist	sun, part shade	summer	2	1, 2, 3, 4, 5, 6, 7
Scutellaria ovata	heartleaf skullcap	perennial	herb	nectar	x	x	x	avg, dry	sun	spring	2	1, 2, 3, 4, 5, 6
Sedum ternatum	woodland stonecrop	perennial	herb	nectar	x	x		avg, moist	part shade, shade	spring	0.5	1, 2
Silene virginica	fire pink	perennial	herb	nectar	x	x	x	avg, dry	sun, part shade	spring, summer	1.5	1, 2, 3
Silphium asteriscus	starry rosinweed	perennial	herb	nectar	x	x		avg, dry	sun, part shade	summer, fall	6	1, 2, 3, 4, 6
Solidago caesia	wreath goldenrod	perennial	herb	nectar	x	x	x	moist, avg	part shade, shade	fall	3	1, 2, 3
Solidago erecta	slender goldenrod	perennial	herb	nectar	x	x		avg, dry	sun	fall	4	1, 2, 3, 4, 5, 6
Solidago nemoralis var. *nemoralis*	gray goldenrod	perennial	herb	nectar	x	x	x	avg, dry	sun	fall	3	1, 2, 3, 4, 5, 6
Solidago odora	anisescented goldenrod	perennial	herb	nectar		x	x	avg, dry	sun	fall	3	1, 2, 3, 4, 5, 6
Solidago pinetorum		perennial	herb	nectar		x	x	avg	sun	summer	3	1, 2, 3, 4, 5, 6
Solidago rugosa	wrinkleleaf goldenrod	perennial	herb	nectar	x	x		avg, dry	sun	fall	5	1, 2, 3, 4, 6
Solidago speciosa	showy goldenrod	perennial	herb	nectar	x	x		avg, dry	sun	fall	4	1, 2, 3, 4, 5, 6
Sorghastrum nutans	indiangrass	perennial	grass	host/habitat		x	x	avg, dry	sun	fall	6	3, 4, 5, 6, 7
Symphyotrichum concolor (syn. *Aster concolor)*	eastern silver aster	perennial	herb	nectar	x	x	x	avg	sun, part shade	fall	4	1, 2, 3, 4, 5, 6
Symphyotrichum grandiflorum (syn. *Aster grandiflorus)*	largeflower aster	perennial	herb	nectar		x	x	avg, dry	sun	fall	3	1, 2, 3, 4, 5, 6

Symphyotrichum novae-angliae (syn. *Aster novae-angliae)*	New England aster	perennial	herb	nectar	x	x		avg, moist	sun	fall	4	1, 2, 3, 4, 5, 6
Symphyotrichum patens var. patens (syn. *Aster patens)*	common clasping aster	perennial	herb	nectar	x	x	x	avg, dry	sun	fall	3	1, 2, 3, 4, 5, 6
Symphyotrichum undulatum (syn. *Aster undulatus)*	wavy-leaf aster	perennial	herb	nectar	x	x	x	avg, moist	sun	fall	4	1, 2, 3, 4, 5, 6
Thermopsis villosus	Aaron's rod	perennial	herb	nectar	x			avg, well-drained	sun	summer	5	1, 2, 3, 4, 6
Tiarella cordifolia var. *collina*	heartleaf foamflower	perennial	herb	nectar	x	x	x	moist, avg	part shade, shade	spring	1	1, 2, 3
Tridens flavus	purpletop tridens	perennial	grass	host/habitat	x	x	x	dry, avg	sun, part shade	summer, fall	4	4, 5, 6
Vaccinium corymbosum	highbush blueberry	perennial	shrub	nectar, host/habitat	x			avg, moist, wet	part shade	summer	15	1, 2
Verbesina alternifolia	common wingstem	perennial	herb	nectar, host/habitat	x	x	x	avg, moist, wet	sun, part shade	summer, fall	9	1, 2, 3, 7
Vernonia acaulis	stemless ironweed	perennial	herb	nectar		x	x	dry, avg	sun, part shade	summer	3	1, 2, 3, 4, 5, 6
Vernonia glauca	broadleaf ironweed	perennial	herb	nectar	x	x	x	dry, avg	sun, part shade	summer	5	1, 2, 3, 4, 5, 6
Vernonia noveboracensis	New York ironweed	perennial	herb	nectar	x	x	x	avg, moist, wet	sun	fall	7	1, 2, 3, 5, 6, 7
Veronicastrum virginicum	Culver's root	perennial	herb	nectar	x	x		moist, wet	sun, part shade	summer	4	1, 2, 3, 7
Viola sororia	common blue violet	perennial	herb	nectar	x	x	x	moist, avg	part shade, shade	spring	0.5	1, 2, 3
Yucca filamentosa	Adam's needle	perennial	herb	nectar	x	x	x	avg, dry	sun	spring	8	1, 2, 3, 6
Zizia aurea	golden alexanders	perennial	herb	nectar, host/habitat	x	x		avg, dry	sun	spring, summer	3	1, 2, 3, 4, 5, 6