Clean Energy Extension

BEST MANAGEMENT PRACTICES FOR POLLINATOR-FRIENDLY SOLAR ARRAYS

Guidelines for Establishing and Maintaining Native Vegetation at Massachusetts Solar Photovoltaic Facilities to Provide Habitat for Pollinators and Other Wildlife

Compiled by UMass Clean Energy Extension, a program of the University of Massachusetts Amherst Center for Agriculture, Food, and the Environment

UMass Amherst

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Purpose:

The purpose of this document is to provide guidance in development of Site Establishment and Maintenance Plans for solar PV facilities participating in the Pollinator-Friendly Certification Program in Massachusetts. As such, this document is primarily directed towards **ecological professionals working as plan preparers**. However, this document is also intended to be accessible to **municipal officials and board members** considering Pollinator-Friendly Certification requirements for solar PV facilities installed in their communities, to **solar facility developers and managers** participating in the Pollinator-Friendly Certification Program, and to **landowners** considering requiring Pollinator-Friendly practices for solar PV facilities installed on their properties.

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BACKGROUND

Introduction

Utility-scale solar photovoltaic (PV) facilities provide an important source of renewable electricity generation, but can also displace natural habitats that benefit to native wildlife. In Massachusetts, the continuing growth of solar PV capacity has led to concerns about conversion of land from open space to solar energy facilities; solar energy development continues to result in destruction of native grassland, shrubland, and forest habitats. One approach other states have taken to reduce the impacts of solar PV expansion is to encourage the management of vegetation under and around solar PV arrays to support native flowering plants and associated pollinator species. This has been accomplished through the development of pollinator-friendly solar PV certification programs.

In Massachusetts, UMass Clean Energy Extension has spearheaded development of a Pollinator-Friendly Certification Program for solar PV facilities within the state. We have convened a Review Board of stakeholders, including members with experience in apiary science, pollinator biology, agriculture, wildlife regulation, regional planning, renewable energy policy, and solar PV development. This group has reviewed the initial certification criteria for 2019, and provided input and comments regarding this Best Management Practices document.

Scope

The Pollinator-Friendly Certification Program, overseen by UMass Clean Energy Extension, establishes specific criteria solar facility developers and operators must meet in order to qualify as "pollinator-friendly." The certification is arranged in a LEED-style framework, with Certified, Silver, Gold, and Platinum ratings that have specified criteria for establishment, maintenance, monitoring, and reporting. The Certification Criteria are available on our website. The purpose of this document is to complement the Certification Criteria, providing additional details and guidance to aid in development of a Site Establishment and Maintenance Plan to qualify for pollinator-friendly status, and providing Best Management Practices to allow for maintenance of native, pollinator-friendly vegetation under and around solar arrays in the long term. While this document is focused on providing guidance to solar facility developers and managers participating in the Pollinator-Friendly Certification Program, it may also prove of use to solar facilities operating outside of this program, whether in Massachusetts or other New England states.

In general, the Pollinator-Friendly Certification Program is not intended to address solar siting within the overall landscape. Instead, this document seeks to inform design and maintenance of solar PV facilities, whether established or proposed, within a specified location and for a known project footprint. It is targeted towards new solar PV facilities in the planning stages for which a location has already been selected, as well as towards existing solar facilities seeking to convert from gravel or non-native vegetation to native plantings.

In maintaining the above-stated focus, the Pollinator-Friendly Certification program does not intend to downplay the role of siting in determining the impact of solar PV development on native plant and wildlife species. The siting of solar PV facilities at the landscape scale can play

an important role in the impact that solar energy development has on natural ecosystems within the state. A preference for siting of development on buildings, over parking lots, or on brownfields, landfills, or other previously developed sites, as well as considerations of placement relative to wildlife corridors and ecological integrity, can limit impacts of development on natural and agricultural landscapes. Habitat replication or protection of undeveloped land to offset loss of habitat to development are also methods that have been proposed to mitigate the impact of solar PV development. Decisions at the landscape scale are often driven by state regulations, incentives, interconnection opportunities, property ownership, and municipal bylaws. While future regulations and incentives could direct solar PV siting primarily towards previously developed land, significant acreage of undeveloped land has already been converted to solar PV generation, or is slated for conversion under existing incentive structures. Further, even previously developed sites, such as landfills or brownfields, could prove of enhanced value to native species when re-developed as solar PV facilities, if maintained with native plant species rather than gravel or non-native vegetation. We therefore consider a Pollinator-Friendly Certification Program to be of value whatever the state regulatory framework regarding solar siting on a landscape scale.

Current State of Knowledge

It is important to recognize that "pollinator-friendly" practices and programs are relatively new to the United States and to the Northeast in particular, and little research is available concerning best practices to establish native plants at solar PV facilities, or the extent to which these sites can offer meaningful habitat benefits to native species. Currently, no published scientific studies are available quantifying actual impacts of pollinator-friendly practices on pollinators or other native species at solar facilities. The best management practices included in this document are drawn from pollinator, vegetation, and wildlife management guidelines designed for use at other types of sites and facilities, as well as research publications and reports regarding invasive species control, pollinator biology, and related topics. As more solar arrays are specifically designed to be pollinator-friendly, and more research is conducted, we expect to gain a better understanding of how solar PV facilities can be established and managed to maximize habitat benefits to native plants and wildlife, and minimize negative impacts of development. These guidelines will be updated to reflect our growing understanding as additional information becomes available.

This document draws heavily on publications distributed by the Xerces Society, the North American Pollinator Protection Campaign (NAPPC), and the Natural Resources Conservation Service (NRCS), as well as information and input provided by the MassWildlife Natural Heritage and Endangered Species Program (NHESP) and the NHESP Advisory Committee. A complete list of references and recommended resources is included at the end of this document.

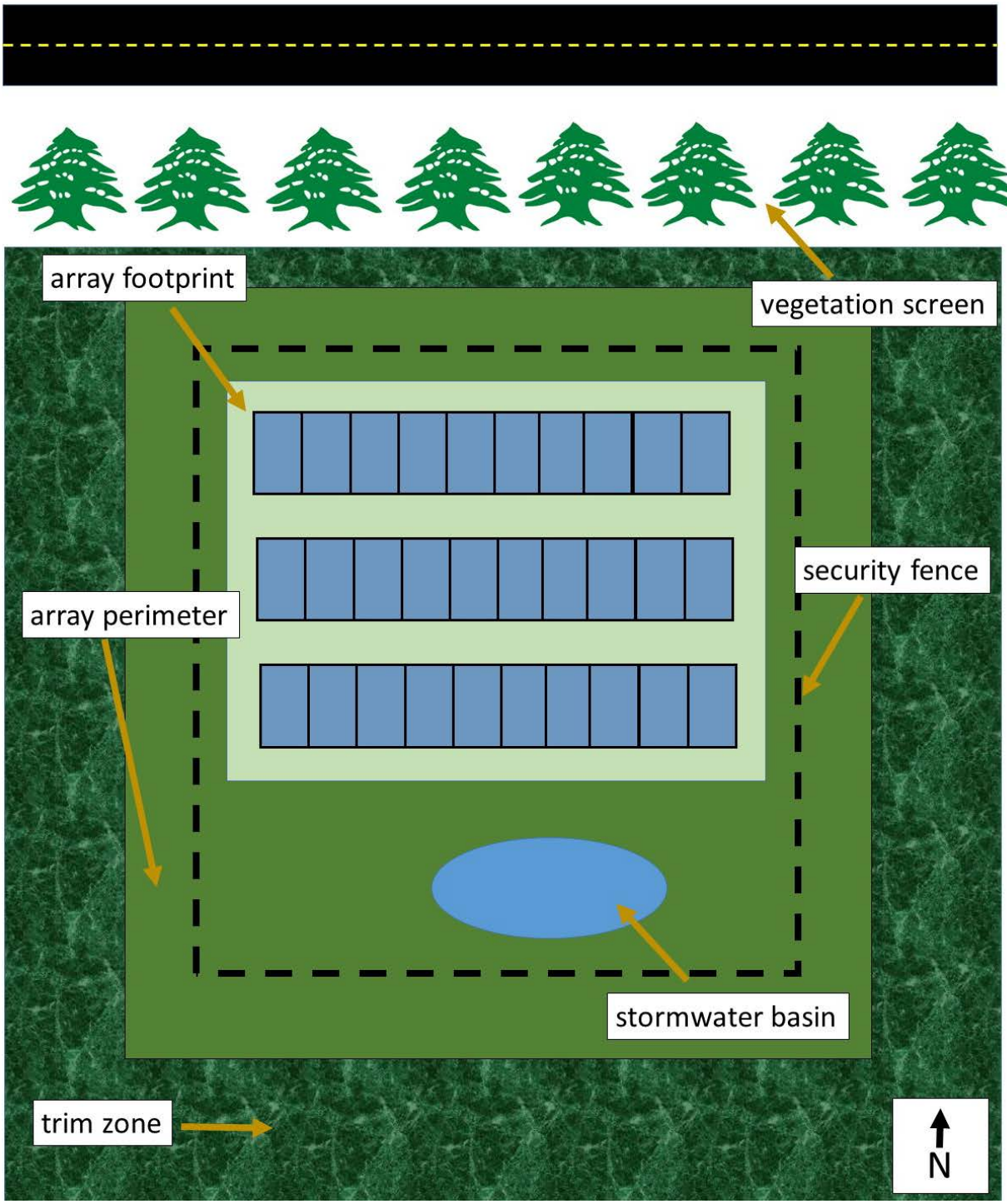
Solar Facility Site Terminology

Within this document, we use the following terms to refer to different sections of a solar facility site:

- **Array footprint** – The area beneath the solar PV panels, between adjacent rows of panels, and immediately surrounding the array. In a typical solar array, this area is reduced to bare ground during facility construction, and following site establishment, the resulting vegetation must be kept short to prevent shading of panels. The allowable height of vegetation is dependent on the height of the lower edge of the solar panels. A typical panel height is 36", necessitating that all vegetation within the array footprint be kept cropped below that height (typically no more than 30" high).
- **Array perimeter** – The area surrounding the array footprint, inside and immediately outside the surrounding security fence. In a typical solar array, this area is also reduced to bare ground during facility construction. Following site establishment, the resulting vegetation must be kept relatively short, but depending on the height of the solar panels and the width of this perimeter area, it may be possible for vegetation to be allowed to grow somewhat higher than in the array footprint (e.g. 42"-60").
- **Trim zone** – The area falling outside the array perimeter, which must be kept trimmed to prevent shading of the solar PV facility by adjacent trees. In a typical array, this area extends a distance equal to at least double the height of surrounding trees on the east, west, and south sides of the array, with a smaller setback required on the north side. In typical cases, this area will not be severely disturbed during facility construction, but for the life of the solar array, it must be kept trimmed to 10'-12' to prevent panel shading.
- **Vegetation screen** – A line of vegetation, including shrubs or small trees, installed for aesthetic purposes to block or limit the view of a solar PV facility from the road or adjacent properties. A vegetation screen is not required as part of Pollinator-Friendly Certification, but may be required by municipal bylaws or included in Orders of Conditions for permits approved by municipal-level boards or commissions. Vegetation screens may also be installed voluntarily to mitigate effects on abutters or other community residents.
- **Stormwater basin** – Stormwater Management Standards may require construction of a stormwater basin at some sites to slow water runoff from the site during storm events. Depending on the size of the basin, and whether it is anticipated to hold standing water, it may present an opportunity to provide plantings of native wetland species, as well as a perennial water source for pollinators and other wildlife.

A simple diagram displaying a generic pollinator-friendly solar PV facility, demonstrating the terminology used in this document, is shown on the following page.

Generic Pollinator-Friendly Solar PV Facility Diagram



SITE ESTABLISHMENT AND MAINTENANCE PLAN

Plan Components

In order to qualify for Pollinator-Friendly Certification, the solar facility developer or manager must submit an Application Form (available on our website), which should include a Site Establishment and Maintenance Plan. The application should demonstrate the credentials of the plan preparer, and provide a description of initial site conditions and existing vegetation. The application should also provide a description of proposed seed mix(es) and plantings to be made at the site, including important characteristics of chosen species (e.g. species name, status in Massachusetts, geographic origin, bloom time, habitat requirements, habitat value). The plan should outline a strategy for control of any invasive species present on or immediately adjacent to the site, weed control, seedbed preparation, seeding, and plant establishment. The plan should describe any special features to be incorporated into the site (e.g. bee nesting habitat, perennial water source, educational signage, wildlife habitat). The plan should describe anticipated vegetation management activities during the establishment phase (first 3-5 years), including mowing, trimming, and invasive plant control, as well as maintenance of any special features. The section of the plan that addresses long-term maintenance should describe anticipated vegetation and habitat management activities following successful site establishment. Key features of the site must be monitored periodically to ensure that pollinator-friendly vegetation and habitat features are growing and being maintained as designed, and successfully meeting Pollinator-Friendly criteria. The required schedule of monitoring, based on the level of certification proposed, should also be noted in the plan.

Plan Preparer

Plans for pollinator-friendly vegetation establishment and maintenance at the solar PV facility should be compiled and written by a professional biologist or ecologist with relevant experience and expertise in pollinator habitat creation, grassland habitat restoration, and/or knowledge of native New England plant communities. A copy of the plan preparer's resume and a statement of relevant work experience should be included with the application. Unless another situation has been arranged, it is expected that the solar facility developer or owner will contract with a biologist or ecologist to prepare the plan, and will work with the preparer to assure the plan is achievable and compatible with on-site needs for energy generation.

Site Description

Before preparing the Site Establishment and Maintenance Plan, the plan preparer should review the engineering plans for the existing or proposed solar PV facility.

For all sites, the plan preparer should visit the solar PV facility site during the growing season, and perform an assessment of existing site conditions. The preparer should describe existing vegetation present at the site, including the most abundant plant species present at the site, any uncommon or rare native plant species present on or adjacent to the site, and the location and extent of any invasive species present on or adjacent to the site. For undeveloped sites, the plan preparer should describe any soil seed bank expected to persist in the array footprint and perimeter following site development, as well as any native plants which should be left

undisturbed in the trim zone surrounding the array. Soil and hydrological conditions relevant to plant establishment should also be noted in this assessment. The ecologist should include a copy of the soil description for the property, as determined from the USDA NRCS Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx). Alternatively, a soil test by a third-party soil testing laboratory may be conducted (e.g. https://ag.umass.edu/services/soil-plant-nutrient-testing-laboratory). A map and description of any adjacent wetlands, vernal pools, or Estimated or Priority Habitat may also be included in this assessment. Alternatively, copies of documents filed with the municipal Conservation Commission, Army Corps of Engineers, and Massachusetts Natural Heritage Endangered Species Program may be provided as documentation of these habitat features.

CHOICE OF PLANT SPECIES

Recommended Plantings for Pollinators

In general, the Pollinator-Friendly Certification criteria call for use of plant species native to Massachusetts; invasive plant species must be avoided under all circumstances. The plan preparer should consider which species are most appropriate to the site conditions and natural communities present at and adjacent to the site. Practicality dictates that within the array footprint, it will be important to select relatively low-growing species which are at least somewhat shade-tolerant, but more flexibility is possible regarding selection of wildflower, grass, sedge, and shrub species to be planted in the array perimeter and trim zone. The plan preparer should select a high diversity of species with variation in bloom times and pollinating species (e.g. bees, beetles, butterflies, flies, hummingbirds). Butterfly host plants and plant species which provide nectar and pollen resources to specialist bees should also be included. There may be an opportunity to include plantings of rare or uncommon species, but such introductions should only be conducted in close consultation with MassWildlife and non-governmental organizations concerned with preserving native plant diversity (e.g. New England Wildflower Society). *Seeds and seedlings to be planted at the solar facility MUST NOT be pre-treated or coated with insecticides or fungicides.*

A spreadsheet of native plants that have been recommended by conservation organizations for plantings to benefit pollinators and native wildlife is available online at the UMass Clean Energy Extension Website (https://ag.umass.edu/clean-energy/current-initiatives/wildlife-friendly-solar-pv-for-massachusetts**).** The spreadsheet includes basic information about native wildflowers, grasses, flowering shrubs, and flowering tree species. This list is by no means exhaustive, and it is important to note that many plant characteristics, including height and bloom period, are reported differently by different sources, and may vary depending on site conditions, including soil fertility, moisture, and shading. This spreadsheet can serve as a starting point for selecting appropriate species for pollinator-friendly plantings, but other species may be better suited to a particular site and site conditions, and plant characteristics can vary by plant source or growing conditions. Always check with the seed or plant vendor regarding the characteristics of the ecotype provided by the supplier in terms of maximum height, bloom period, and propagation requirements (e.g. sun/shade, moisture, soil type).

The choice of plantings at a particular site will to an extent be dictated by the availability of native seed or seedlings from the local region at affordable prices. It should be noted that native plant seed and seedlings may be more expensive than non-native turfgrass in terms of initial plant purchase and establishment costs. However, these higher initial costs are typically offset by lower maintenance costs over the long-term, since native plantings require less management, following site establishment.

The following sections provide more detail about specific categories of plant species. Additional resources can be found in the REFERENCES AND RESOURCES section, under *Planting for Pollinators, Native Plant Information,* and *Invasive Plant Identification and Control*.

Native Species

In all cases, the plan should demonstrate a preference for species native to Massachusetts. Species native to New England or the Northeast (New York, Pennsylvania) may be acceptable under certain circumstances, if included to meet other clearly articulated pollinator-friendly objectives. It is important to recognize that different "ecotypes" may exist across a plant's range. These locally-adapted forms of a plant species have evolved to survive in the unique habitat conditions found in a localized region. For widespread, common species, it may not be problematic to introduce seed from another part of the Northeast, so long as the ecotype is adequately adapted to local site conditions. However, for less common species, it can be problematic to introduce genetic variants from another part of the region, which could potentially contaminate the local gene pool. If the proposed site establishment plan calls for including a plant species that is rare or relatively uncommon in Massachusetts, it is important for the plan preparer to consult with MassWildlife or relevant native plant conservation organizations to ensure the introduction is not likely to pose a danger to local plant ecotypes.

The following sources can be used to verify that a particular species is native to Massachusetts.

- **GoBotany**, a searchable database provided by the Native Plant Trust, which provides information concerning the distribution and conservation status of thousands of plant species occurring in the state. https://gobotany.nativeplanttrust.org/
- **The Vascular Plants of Massachusetts** provides a county-level listing of native and non-native plant species, available from MassWildife. http://archives.lib.state.ma.us/bitstream/handle/2452/120973/ocn747431427.pdf?sequence=1

Rare and Uncommon Species

Unless working directly with MassWildlife or a native plant conservation organization, it may be difficult to gain access to seeds or seedlings of rare plant ecotypes within the state. As noted above, it is important not to introduce outside ecotypes, except in close consultation with the aforesaid organizations. The following resources can provide information about what plant species may be rare or uncommon in the state.

- **MassWildlife NHESP** provides a list of plant species that are endangered, threatened, or of special concern in Massachusetts. https://www.mass.gov/service-details/list-of-plants

- **The State Wildlife Action Plan** lists Species of Greatest Conservation Need in Massachusetts. https://www.mass.gov/files/documents/2016/11/wi/massachusetts-species-of-greatest-conservation-need.pdf
- **GoBotany**, a searchable database provided by the Native Plant Trust, provides information concerning the distribution and conservation status of thousands of plant species occurring in the state. https://gobotany.nativeplanttrust.org/
- **Flora Conservanda**, compiled by the Native Plant Trust, provides the status of most plant species occurring in the state. http://www.nativeplanttrust.org/documents/22/flora-conservanda-brumback-etal-13-20.pdf

Invasive Species

Invasive plant species present at the site should be controlled, even if they serve as a potential pollen or nectar source. Under no circumstances should an invasive plant species be purposefully introduced to the site. The following resources can be of use in determining if a species is likely to be invasive.

- **Massachusetts Invasive Plant Advisory Group** (MIPAG) provides a list of species considered invasive in Massachusetts. Species listed on the Invasive, Potentially Invasive, and Likely Invasive should all be avoided. https://www.massnrc.org/mipag/index.htm
- **The Invasive Plant Atlas of New England** (IPANE) provides a list of invasive plant species which should be avoided. https://www.eddmaps.org/ipane/ipanespecies/current_inv.htm

Wildflowers, Flowering Shrubs, and Woody Plants

The focus of Pollinator-Friendly Certification planting guidance is on flowering plants with high quality nectar and pollen resources, which can providing foraging habitat to pollinating insects and hummingbirds. At most sites, it will be practical to plant only low-growing wildflowers within the array footprint, but taller wildflowers and low-growing shrubs can be planted in the array perimeter, and taller shrubs and small trees can be considered for the trim zone. When selecting a variety of plantings for these three zones, consider the following characteristics:

Bloom Period – A range of flowering species should be selected to provide pollen and nectar resources for the entire growing season. Depending on the level of designation, *Pollinator-Friendly Certification criteria call for at least three species to be in planted that flower within 2-4 different bloom periods.*

Planting for Specialist Bees - Almost 30% of New England native bee species have special diets restricted to one plant family or a few plant genera. Including plants that provide nectar or pollen to specialist bees helps to promote bee diversity. See the "Xerces Specialist Bees" column in the Recommended Plant List (https://ag.umass.edu/clean-energy/current-initiatives/wildlife-friendly-solar-pv-for-massachusetts), to see which recommended wildflower and shrub species provide foraging resources to specialist bees. Depending on the level of designation, *Pollinator-Friendly Certification criteria call for at least 25% of planted species to support specialist bees or serve as host plants for rare or uncommon native butterflies and moths.*

Butterfly Host Plants – Butterflies and moths require certain plant species on which they lay their eggs and larvae develop. While some species are able to use a wide range of plants for oviposition and development, others are limited to a few specific host plants. The plan preparer should consider opportunities to include host plants for butterflies and moths, particularly those limited to a few species or genera. At least 2% of the seed mix should be a milkweed species, in order to support monarch butterfly reproduction. Review the "Host for Butterflies of Conservation Concern" column in the Recommended Plant List (https://ag.umass.edu/clean-energy/current-initiatives/wildlife-friendly-solar-pv-for-massachusetts), to see which recommended wildflower, shrub, and sedge species serve as host plants for rare or uncommon butterflies and moths. Depending on the level of designation, *Pollinator-Friendly Certification criteria call for at least 25% of planted species to support specialist bees or serve as host plants for rare or uncommon native butterflies and moths.*

Additional details on butterfly species and their host plants can be found on the **Butterflies of Massachusetts** website: www.butterfliesofmassachusetts.net

Grasses and Sedges

Graminoids do not offer high quality nectar or pollen resources the way that wildflowers and flowering shrubs do, but it is often useful to include at least one native warm-season grass or sedge in array footprint and array perimeter seed mixes. The deep root systems of these plants provide drought resistance and soil-holding capabilities. Native grass root systems also regenerate every three to four years, resulting in increased soil fertility, organic matter, and carbon sequestration. For pollinator-friendly plantings, short, clump-forming grasses are preferable to large, spreading, or sod-forming grasses. Clump-forming grasses allow for the presence of more bare ground under and between individual plants, ensuring that wildflowers are able to colonize the site. Open patches can also provide dusting areas and travel corridors for birds. Warm-season grasses do not mat down easily under winter snows, and can therefore also provide birds with winter escape cover and spring nesting cover. In addition, grasses and sedges are larval host plants for some butterflies and moths, and provide nesting and overwintering sites for a variety of insect species.

Local Plant Communities

When determining which species to plant at a particular site, it is important to consider what plant resources may already be present at the site. Consider the existing soil seed bank and whether any native wildflowers can be expected to regenerate following site disturbance. Also consider opportunities to retain native shrubs and other species already present in the trim zone. If developing a plan for a site that is already developed, disturbed, or was previously forested with little shrub or understory cover, visit nearby open natural areas to see what native plants are thriving in neighboring grasslands and shrublands.

Vegetation Screen Plantings

For vegetation screens, consider including a mix of native evergreen and deciduous species to provide attractive, year-round vegetation at a range of heights. Evergreen species can shield the solar array from a nearby roadway or neighboring houses during the winter months. Native

spruces and firs can all provide thick, year-round foliage, but depending on the proximity to the array, may require frequent trimming. Native cedars may also require eventual trimming, but are a good choice for solar array vegetation screens. In certain habitats, native juniper bushes may also be appropriate. Native laurels and yew can provide low evergreen growth to block solar array views as trees in vegetation screens grow, but native laurels can be slow to grow and spread. Good choices for deciduous species include native dogwoods, viburnums, willows, and high bush blueberry.

PURCHASING PLANTS

In most cases, planting from seed will be more financially viable than planting from seedlings, for non-woody plants, such as wildflowers, grasses, and sedges. Shrubs and woody plants can be grown from seedlings or saplings. The amount of seed or number of seedlings to be planted should be determined according to the plant vendor's recommendation regarding the appropriate planting density.

Remember, *seeds and seedlings to be planted at the solar facility MUST NOT be pre-treated or coated with insecticides or fungicides.* Purchase plants from a reliable source, allowing several months lead time to ensure availability. Check with your supplier to ensure seeds and seedlings have not been pre-treated. Whenever possible, purchase seed and seedlings collected or propagated from local or regional ecotypes. For native grasses, do not to use seed originating more than 100 miles north or 200 miles south of the project site, to minimize problems with hardiness and disease. Within the Northeast, east-west variation is not critical because precipitation is not a limiting factor, but elevation can be important. An elevation increase of 1,000 feet is equivalent to a move of 175 miles to the north.

As pollinator-friendly solar array plantings become more common, appropriate seed mixes may become available. At this point in time, however, it is best to purchase seed of individual species and prepare your own mix, appropriate to site conditions and location. Read the *Planting* section below before preparing seed mixes – to ensure even planting, certain preparation practices should be followed, such as not mixing small, hard seeds with light, fluffy seeds.

Native bunch grasses and sedges should not comprise more than 10% of seed mixes per square foot. On high quality soils, a lower grass seeding rate may be necessary to avoid developing stands that are too dense. Vendors' labels on bags of grass seed should list the percentage of pure live seed, germination rates, percentage of inert materials, and percentage of dormant seed and weed seeds in each bag. Purchase native grass seed in terms of pounds of pure live seed (PLS) – this measure is based on a combination of purity and germination rate. Using PLS ensures that you are paying only for viable seed of the species or cultivar desired, not for dead seed, sticks, stems, or weeds. The tags should also indicate a lack of noxious weeds.

PLS % = (% purity x % viable seed) divided by 100.

The Xerces Society provides a tool for calculating custom seed mixes:
https://xerces.org/xerces-seed-mix-calculator/

Sources of Native Seed and Seedlings

The Western Mass Pollinator Network maintains a list of recommended seed and seedling sources: https://www.wmassbees.org/best-nurseries

The following is a list of seed and seedling sources known to sell some native plants, but other sources are available in the state and region. More sources will be added, as we become aware of them.

- **Native Plant Trust** sells native plants for pollinator plantings and other purposes. http://www.newenglandwild.org/store/buy-native-plants
- **Ernst Seed Company** has pre-mixed pollinator seed mixes and other native seed options for custom mixes. https://www.ernstseed.com/xerces-society-seed-mixes/
- **Prairie Moon** specializes in native seeds and plants. https://www.prairiemoon.com/
- **Fiddlehead Creek Native Plant Nursery** https://www.fiddleheadcreek.com
- **Native Haunts** sells native trees, shrubs, and perennial seeds. https://www.nativehaunts.com/
- **New England Wetland Plants** is a wholesale nursery selling native trees, shrubs, ferns, wetland plants, and wildflower mixes. http://newp.com/

SITE PREPARATION

Site preparation is one of the most important and often inadequately addressed components of pollinator-friendly planting projects. Time and effort spent in eliminating undesired plants and preparing the seedbed prior to planting will pay off in the long-term.

Weed and Invasive Species Control

Site preparation is particularly important at sites with high weed pressure, where prior to site development there was a persistent, multi-year cover of undesirable plants, or the site was dominated by sod-forming grasses and rhizomatous forbs. Abatement of perennial weeds is of paramount importance – there are more options available to reduce biennial and annual plants after planting.

Smother cropping, repeated shallow cultivation, and soil inversion are all ways to reduce weed pressure without the use of broadcast herbicides. Any tillage operations should be done when the soil is moist, but not wet. For more details on recommended weed removal techniques, see **Organic Site Preparation for Wildflower Establishment:** http://xerces.org/wp-content/uploads/2016/10/2016-027_Organic-Site-Prep-Guidelines_May2017_web.pdf

The presence of invasive species on or adjacent to the site prior to construction and native plant establishment can be problematic. Invasive species thrive on disturbed sites, and can quickly spread following site development if a plan is not in place to control them. During site

establishment, make sure infested areas are clearly demarcated, a work plan is in place to avoid spread of invasive plants from these areas, and that personnel working on site clearly understand how work should progress to avoid invasive plant spread. For example, if soil is being moved around the site, ensure soil will not be moved from areas that are infested to areas free of invasive species. Where possible, have work progress from uninfested areas to infested areas, to ensure soil and seeds are not transported on dirty equipment. Where this progression of work is not possible, equipment must be thoroughly cleaned when moving from infested to uninfested areas. These practices can help to contain existing infestations. For recommendations on controlling invasive plants where they already occur, see the *Invasive Species Control* section of this document under SITE MANAGEMENT. All equipment must be thoroughly cleaned prior to use on the site to ensure invasive plants are not introduced to the site from outside locations.

Soil Stabilization and Cover Crops

Cover crops can be used to stabilize soils and provide competition to weeds prior to the planned seeding date for native plants. Perennial species should not be used as cover crops, as they require herbicide application to kill them before seedbed preparation and seeding. Winter-killed cover crops like oats, field pea, oilseed radish, and rapeseed are preferable. Annual rye grass was once commonly used as a cover crop, but is generally avoided now due to its ability to inhibit germination of native species. A variety of other cover crops that are used to stabilize soils in agricultural fields, such as buckwheat, pennycress, and radishes, may also have potential uses as cover crops at pollinator-friendly sites. In some cases, straw mulch or erosion fabric may be needed to help stabilize steep slopes. Containerized plants can later be installed directly into erosion fabric by cutting holes for planting.

PLANTING

Seeding Dates

Spring seeding is generally favored for native grass establishment, while fall seeding is often preferred for planting wildflower, sedge, and rush seed, to allow winter conditions to naturally break seed coats. Fall dormant seeding should be conducted in the late fall (October-December), preferably before the soil freezes, and before the planting site is covered with snow. Optimum seeding dates for native grasses throughout the Northeast are between mid-spring and early summer (typically May-June). Warm-season grasses require minimum air temperatures of 60-65ºF and soil temperatures of 50ºF to germinate. If a wetland project will be constructed in the spring/early summer, or will have flowing or fluctuating water levels, it may be better to seed these sites in late spring after water levels stabilize. Spring seeding of wetland and upland areas should be conducted before the end of June, as high summer temperatures can lead to the loss of young seedlings.

Seedbed Preparation and Planting

The soil surface should be prepared prior to planting. Ideally, the seedbed should be a smooth, lightly packed surface, free of clumped sod and tall stubble. A light-weight harrow or roller can be used to prepare the soil surface. Prior to planting, a shallow raking can be performed on a

warm day to kill any uprooted weed seedlings. Laying down a thin layer of weed-free compost can also aid in wildflower seed establishment.

Seeding can be done using hand broadcast at small sites, or broadcast seeders, drop seeders, or fertilizer spreaders at large sites.

For hand broadcast and broadcast seeders, seeds of similar sizes can be mixed together and bulked up with an inert bulking agent, such as sand, fine-grained vermiculite, clay-based kitty litter, gypsum, or polenta. Use 2-3 parts bulking agent for each part seed by volume. These inert carriers ensure even seed distribution in the mix, make calibration easier, and provide visual feedback on where seed has been applied. If using a broadcast seeder, a model with an internal agitator will be most effective. The equipment used should have a flow gate that closes down small enough to provide a slow, steady flow of the smallest wildflower seed. Planting should begin with the flow gate set to the narrowest opening; large seed can then be planted separately with the flow gate set to a wider opening. Conduct at least two perpendicular passes over the seed bed for even distribution. Do not cover the seed with soil after planting, however, a water-filled turfgrass roller or a cultipacker can be used to press the seed into the soil, providing better seed-soil contact. Planting prior to a light rainstorm can also help ensure good seed-soil contact, but avoid planting prior to a storm with heavy precipitation.

If using a drop seeder or fertilizer spreader, plant when conditions are dry enough to prevent soil sticking to the coulters. Under wet conditions, small seed is likely to stick to mud-caked parts of the drill, rather than the ground. Keep seed separated by species until ready to plant. Prior to planting, group seeds into categories of large smooth seed, small smooth seed, and tufted seed that does not flow easily. Loosely fill seed boxes with the appropriate seed batch for each box. Seed quantities that do not cover the agitator should be planted using some other method – the drill is difficult to calibrate for small seed volumes. As a general rule, planting depth should be no more than 1.5x the seed diameter (i.e. no more than ¼ inch), and small seeds should be planted on the soil surface. If planting on highly sandy soils, check with the seed vendor about planting depth. Move slowly during seeding (no more than 5 mph), and stop periodically to check for the appropriate planting depth and ensure no clogging is occurring.

Stormwater Basins

In and around stormwater basins, conditions may be appropriate for the use of wetland rather than upland species. In choosing plantings for this area, it is critical to consider basin hydrology. Some stormwater basins will have year-round standing water, and will support obligate wetland plant species, but many will only be flooded following storm events. This second group should be planted with facultative wetland species that are tolerant of both saturated and dry conditions.

At sites where standing water is expected, wetland species that thrive in saturated conditions can be planted directly as rootstock (rhizomes) and seedlings within the stormwater retention basin and along the anticipated edge of open water. Within the basin itself, submerged and floating-leaf plants can be planted at a density of 1 plant for every 3-4 square feet. Emergent plants can be planted along the anticipated shoreline at a rate of 1 plant per linear foot.

Typically, wetland seed mixes should not be applied directly within flooded basins, as wetland seeds will float. Wetland seed mixes can be used from the planned edge of open water to about 1-1.5 feet in elevation above the high water line, depending on the soil texture and capillary action of the soil. Consider the hydrology of other sections of the site where wetland seed mixes may be appropriate, including swales flowing into the wetland. If in doubt, check with the seed vendor for recommendations on where to transition from wetland to upland plantings.

The soil in the wetland area should be high in organic matter, and loose and uncompacted prior to planting. If possible, avoid moving heavy equipment over the stormwater basin site during construction. If site construction has resulted in compaction of the soil in and around the retention basin, an excavator can be used to dig and drop soil, breaking up the clods; organic matter can then be added and mixed in to create a loose, uneven surface.

Most wetland plant seeds need light to germinate, and will develop best if planted on the soil surface. Generally, the most effective method of planting is to use hand broadcast or a broadcast seeder, followed by use of a turfgrass roller or cultipacker to ensure seed-soil contact. Wetland grasses can be drill-seeded, but if a seed drill is used for planting wetland wildflowers and sedges, the drill must be calibrated carefully to ensure the small seed is placed appropriately on the soil surface.

SITE MANAGEMENT

Mowing

In all cases, mowing equipment must be washed before and after use at the site, to prevent the spread of invasive plants between sites. Mowing must be done in a low gear, at slow speeds, so that wildlife species have time to avoid the tractor and mower. Set the mower height at 7-12 inches above ground level. Mow in a pattern that allows wildlife to escape the tractor and mower. Start mowing from the center of the array and use a back-and-forth approach to mow the array footprint until reaching the edge of the array. Then return to the center to mow the other half of the array footprint, before mowing the array perimeter, beginning with the areas closest to the array. This will encourage wildlife to move outwards from the array, towards still-vegetated areas and eventually beyond the mowed area. This helps avoid concentrating fleeing animals into areas still to be mowed, where they could be struck and killed.

Array footprint – Within the array footprint, the ultimate goal of management should be to create conditions such that mowing is conducted no more than once per year. The choice of when to mow should be dependent on management objectives. In general, pollinator management guides recommend mowing outside the growing season (i.e. between October 1 and May 1) to avoid cutting blooming plants, and reducing pollinator forage. However, a recent Michigan study found monarch butterflies laid more eggs on patches of milkweed mowed in mid-June or mid-July, suggesting this form of management could be beneficial at sites where milkweed comprises a significant proportion of flowering species. Of course, the timing of mowing will also be dependent on plant height, and the necessity of avoiding panel shading. We recognize that during the establishment period (first 3-5 years), multiple mowings during

the active season may be required to reduce growth of invasive plants, weeds, or other plants growing high enough to shade panels. During the establishment period, a botanist or other individual with vetted plant identification skills should visit the site prior to management activities to flag invasive plants for removal. Selective weed-whacking of invasive species or plants growing tall enough to over-shadow the panels may continue throughout the lifetime of the facility, on an as-needed basis.

Array perimeter – Within the array perimeter, the ultimate goal of management should be to create conditions such that no more than 1/3 of the area is mowed each year. We recognize that during the establishment period (first 3-5 years), multiple mowings during the active season may be required to reduce growth of invasive plants or other plants growing high enough to shade panels. During the establishment period, a botanist or other individual with vetted plant identification skills should visit the site prior to management activities to flag invasive plants for removal. Selective weed-whacking of invasive species, weeds, or plants growing tall enough to over-shadow the panels may continue throughout the lifetime of the facility, on an as-needed basis.

Trim zone – This part of the facility should not require frequent mowing, but may require weed-whacking or mowing in selected locations to control invasive species. Keep vegetation in this area trimmed only to the height necessary to avoid shading of the array, and to successfully manage for desirable native species established or preserved at the site.

Recommended Practices in Areas of High Weed Pressure

During the first two years of establishment, pollinator vegetation establishment guides recommend mowing annual and biennial weeds to 5-8 inches with a flail-type mower or stalk chopper before seed is allowed to set (usually as weeds reach 12-14 inches). Mowing will likely be required at least twice in the first season and at least once during the second season to successfully control weeds. This is important to provide sunlight and decrease competition for wildflower seedlings. Mowing height should be raised, and mowings become less frequent, as native plants establish. Spot mowing of weeds, with a weed-whacker or other hand-held equipment, may still be needed after the first two years to prevent weed growth and spread. This should be conducted early in the season to prevent weed seed set. Sites with low weed competition due to sandy soils or other factors may not require as frequent mowing during the establishment phase.

Mowing of annual and biennial weeds is also beneficial in wetland areas, but should only be conducted if rutting and soil compaction can be avoided. Pressure from annual and biennial weeds is generally lower in these areas, where soil saturation is higher and the water table is closer to the surface. Hand-held equipment is often the most efficient way of controlling weeds in wetland areas at smaller sites.

Pesticide Use

For the purposes of this document, we follow EPA practice, and use the term “pesticides” broadly to refer to chemicals intended for control of animals, plants, and fungi.

Insecticides

Insecticides pose a danger to a variety of pollinator species, as well as other native insects that do not play a role in pollination. Application of these chemicals is incompatible with the goals of the pollinator-friendly solar program, and *insecticides cannot be used at certified pollinator-friendly solar PV facilities in Massachusetts*. This restriction applies both to insecticides regulated as "restricted use" by the EPA, and to minimum risk pesticides labeled for use as insecticides.

For facilities located within a Mosquito Control Project or District, the facility owner must submit an annual Exclusion Request, to ensure the facility property is not included in a Wide Area Pesticide Application. To determine if your property falls within a Mosquito Control Project or District, contact your regional program: https://www.mass.gov/service-details/mosquito-control-projects-and-districts. An Exclusion Request expires on December 31 of each calendar year, so the request should be submitted within the first two months of each calendar year to ensure that exclusion applies throughout the entire mosquito activity season. The Exclusion Request can be submitted on-line through this website: https://www.mass.gov/how-to/how-to-request-exclusion-from-wide-area-pesticides-application. In order to ensure exclusion, the property must also be properly posted with signs displaying the words "No Spray." Signs should be at least 9 inches across, and the words clearly legible from the nearest road, or at least 50 feet away. Signs must be placed on trees, stakes, or poles easily visible from the street, at least every 50 feet along the property boundary adjacent to the road. These signs should be checked annually for visibility, and replaced as needed.

We recognize that facility owners have no control over aerial spraying conducted as part of mosquito control programs.

Exceptions for Mosquito Control in Stormwater Basins

Given recent outbreaks of EEE and other mosquito-borne diseases in Massachusetts, residents and municipal officials are understandably concerned about standing water as a potential source of mosquitoes. Many stormwater basins do not retain standing water, but if your stormwater basin does, and is a concern to federal, state, or local health officials, exceptions to the "no insecticide" rule are allowable. In cases where mosquito control at your site has been requested by a health official, *Bacillus thuringiensis* ssp. *israelensis* and *Bacillus sphaericus* may be used in stormwater basins.

Bacillus thuringiensis ssp. *israelensis* (typically labeled as Bti) and *Bacillus sphaericus* are both bacteria that are commonly used as a treatment in water bodies to attack mosquito larvae. These bacteria are fairly specific to mosquitoes, although they may also affect midges and blackflies (which are pollinators). This EPA website provides basic information about Bti as a mosquito control: https://www.epa.gov/mosquitocontrol/bti-mosquito-control

If it is necessary to use a *Bacillus* strain at your site, please report it in your Annual Maintenance Log. Include a copy of the request from the relevant government health official, and report the product, amounts used, and dates of treatment. Be sure to use a product that only contains Bti or another *Bacillus* strain, and that does not combine Bti with more broad-spectrum pesticides.

Fungicides

Fungicides also pose a danger to pollinator species. *Fungicides cannot be used at certified pollinator-friendly solar PV facilities in Massachusetts*. The effects of fungicides on pollinators are not thoroughly understood, but recent research has shown an association between fungicide applications and bee range contractions at a landscape scale. In some cases, fungicides have been shown to increase the toxicity of certain insecticides to honeybees, and may increase their susceptibility to infection with certain pathogens.

Herbicides

Herbicides are intended for control of unwanted plant species, but may have non-target effects on native animals and preferred plant species. *Herbicides may be used at pollinator-friendly solar PV facilities but only in limited applications for the control of non-native, invasive plant species*. In order to understand when herbicide use is warranted at a particular pollinator-friendly site, please see the section below *Invasive Species Control*.

Invasive Species Control

Choosing the Right Treatment

In planning invasive species control efforts at the solar array facility, determine first whether invasive plants threaten conservation targets or management goals on the site. Herbicides should be used ONLY in circumstances in which alternative, preferred methods of mechanical control are impracticable. Mowing, cutting, pulling, girdling and covering invasive plants are all methods of mechanical control that may be appropriate, depending on the invasive species involved and the size of the infestation. Spot-burning using a propane torch with a backpack-mounted tank may also be a practicable approach, depending on the proximity of the infestation to the solar array. Mechanical control of large infestations can be challenging, but opportunities may be available to partner with local conservation or environmental organizations to mobilize volunteers. Corrections units with individuals required to complete community service can also be recruited to mechanically control large invasive plant infestations. In these cases, inexperienced individuals may require clear direction regarding which plants to remove; invasive plants must be property flagged or easily identifiable. Biological controls, if available, are another alternative for control of large infestations that avoid the use of herbicides.

When no practical alternatives exist for control of large infestations of invasive plants that threaten the management goals of the facility, herbicides may be considered. Facility managers should note, however, that some municipalities may specifically ban herbicide use on-site as a Special Condition within the Order of Conditions permitting development of the site for solar PV electricity generation.

In all cases, herbicide applications must be made by qualified personnel with a commercial pesticide applicator license, and following label directions, as required by law. Herbicide application is best conducted in the early morning or late evening when pollinators are not active. Applications should be postponed if wind speeds exceed 10 mph. Applications should be made during the season that is most effective for control of the targeted invasive plant species, but whenever possible, avoid timing herbicide applications to coincide with bloom

times for native flowering plants preferred by pollinators. Given that the goal of pollinator-friendly plantings is to provide a habitat with plants blooming throughout the season, it may be difficult to apply herbicides during periods when no native plants are blooming on-site. However, efforts should be made to avoid applying herbicides to invasive species infestations in immediate proximity to native pollinator-friendly plantings that are currently in bloom. *Any herbicide applications made on certified pollinator-friendly solar PV facilities must be recorded in the Monitoring Log and reported as part of the Annual Report.*

Applications of herbicide should be carefully considered in terms of method, active ingredient, formulation, and timing, to effectively meet management objectives. Herbicides should be selected to be the most target-specific and applied on the smallest area practicable to meet management needs. A strong preference should be shown for chemicals that are non-toxic to people and other organisms, not persistent in the environment, not likely to drift, not likely to leach to groundwater or wash into streams, and easy to apply. In some circumstances, a single application of a more toxic or persistent chemical effective in killing the invasive plant, may be preferable to use of a less persistent, less toxic compound that must be applied repeatedly. Strive to do the job with the smallest total negative impact to the environment.

Stem and Stump Applications

Whenever possible, herbicides should be applied as a targeted stem or stump application, rather than a foliar spray. Stem and stump application techniques include the following:

- Cut stump - Cut off the weed completely at its base (no higher than 6 inches from the ground) using a chainsaw, axe, brushcutter, machete, or loppers. Then spray or paint an herbicide solution onto the exposed surface of the cut stump, with the objective of destroying the stump and the root system. It is essential that the herbicide solution is applied as soon as the trunk or stem is cut. A delay of more than 15 seconds for water-based herbicides and 1 minute for diesel-soluble herbicides will give poor results.
- Hack and squirt - Chop into the trunk at chest height, being sure to penetrate the cambium layer below the bark. The cut should form a “cup” that will hold the herbicide. If the bark splits on either side of the cut, or if the angle of the cut is too shallow, herbicide will leak out. This will not only reduce the effectiveness of the application, it could kill nearby non-target plants if the herbicide is soil active and is washed into the soil by rain. With the blade still in the cut, twist the blade downward to open the cut and spray 1 milliliter of herbicide mix (1 trigger pull) from a common utility spray bottle into the cut. The number of cuts made in the tree will vary depending on the herbicide used. Always read the label for appropriate dosages, cut spacing, and mixing instructions. For large trees requiring multiple cuts, space the cuts evenly around the trunk. For trees and shrubs with multiple trunks, be sure to treat every trunk.
- Injection - Drill or cut through bark into the sapwood tissue of woody plants and trees to transport the herbicide throughout the plant. Needle injections can also be effective for control of Japanese knotweed. It is essential to apply the herbicide immediately (within 15 seconds of drilling or cutting), as stem injection relies on active uptake by the plant to move the herbicide through its tissue.

Foliar Applications

If a foliar application must be used, select methods that reduce the risk of overspray onto non-target species. This has the additional beneficial effect of reducing the total amount of herbicide used on-site. Selective foliar application methods include:

- Wick (wipe-on) application - Use a sponge or wick on a long handle to wipe herbicide onto foliage and stems. Use of a wick eliminates the possibility of spray drift or droplets falling on non-target plants. However, herbicide can drip or dribble from some wicks. "Paint sticks" and "stain sticks" sold at local hardware stores have been used successfully for wick application. These sticks have a reservoir in the handle that can hold herbicide, which soaks a roller brush at the end of the handle. The brush is wiped or rolled across leaves and stems.
- "Glove of death" - This technique allows for application of herbicide with little risk of contamination to preferred plants. Spray herbicide directly onto a heavy cotton glove worn over a thick rubber/latex or nitrile glove. The applicator can then grip individual invasive plants to easily apply herbicide to unwanted species.
- Spot applicators – These tools allow for herbicide to be sprayed directly onto target plants, avoiding overspray onto desirable plants. These applicators include motorized rigs with spray hoses, backpack sprayers, and hand-pumped spray or squirt bottles.

If you must use a foliar application, select an herbicide of low toxicity to vertebrate and invertebrate species. Note that different formulations (including surfactants) can significantly alter toxicity of a specific herbicide – it is not just the active ingredient which determines the toxicity of a particular formulation. Manufacturers are required to conduct toxicity tests of herbicides on honeybees as part of the pesticide registration process, but toxicity data for other invertebrate species are often unavailable. Field studies of herbicide effects on invertebrate biota often do not differentiate between direct (e.g. toxicity) and indirect (e.g. loss of preferred host plants) mechanisms, so it can be difficult to assess the effects of targeted herbicide use on native pollinators and other wildlife.

In the absence of a more complete or authoritative information on effects of herbicides on native wildlife, we recommend reviewing the ***Summary of Herbicide Effects to Wildlife*** in order to determine the formulation expected to have the minimum negative effect on native species, while still meeting management objectives. This document, compiled by the U.S. Forest Service, provides a summary of risk assessments and other data regarding toxicity of common herbicide formulations. This document has not been updated since 2008, and plan preparers are encouraged to augment the information included in this report with more recent studies and data, if available.

NESTING HABITAT FOR BEES

In addition to providing foraging habitat, pollinator-friendly sites can also provide nesting habitat to bees and other pollinators. Depending on the species, bees will nest in soil, wood, or vegetation. At all sites, dead limbs and trees should be left in place in the trim zone to support pollinators and other wildlife. Planting shrubs with pithy or hollow stems can provide habitat to

cavity-nesting bees. Raspberry and blackberry species are one group that provide nesting habitat to these bees and other insects. Bunch grasses can also provide cavity-nesting habitat. Artificial nesting habitats can be created to benefit cavity and soil-nesting bee species.

For cavity nesting bees, nesting sites can be created by erecting sections of logs upright, attached to solar PV array mounting structures or the security fence. Positioning logs upright will ensure they stay dry. Provide at least three 6 ft sections of log per acre, with logs at least 9 inches in diameter. We do not recommend pre-drilling holes for bees, unless the nesting sites are expected to be actively monitored, sanitized and maintained.

Ground-nesting bees prefer patches of bare ground for nesting. To provide artificial nesting habitat for these species, clear at least one 3 ft x 3 ft plot of bare ground per acre. Each plot should be in well-drained soil on level or south-facing land in a sunny, unshaded area. If soil is compacted or primarily composed of heavy clay, dig a pit 2 ft deep and fill with a mixture of pale-colored, fine-grained sand and loam. If soil is not well-drained and the water table is high, or as an alternative, a 3 ft by 3 ft raised bed can be created instead, using pale-colored, fine-grained sand and loam, and untreated wood lumber to frame the perimeter.

The following resources provide more information about creation of nesting habitats for bees. We do not recommend constructing nest boxes or habitats with large numbers of holes and nesting sites for cavity-nesting bees, unless you are working in partnership with a local volunteer or organization to provide routine maintenance and sanitation. Unnatural crowding of bees in artificial habitats that are not annually cleaned or sanitized can further the spread of disease.

- **Nests for Native Bees:** http://www.xerces.org/wp-content/uploads/2008/11/nests_for_native_bees_fact_sheet_xerces_society.pdf
- **Tunnel Nest Management** http://www.xerces.org/wp-content/uploads/2009/11/tunnel-nest-management-xerces-society.pdf
- **Managing Alternative Pollinators** https://www.sare.org/Learning-Center/Books/Managing-Alternative-Pollinators

WATER SOURCES

Creation of a clear, perennial water source is beneficial to pollinators and other wildlife. Sometimes a stormwater retention basin can fill this role. The water source should have shallow or gently sloping sides so that insects can easily approach the water without drowning.

WILDLIFE-FRIENDLY MANAGEMENT PRACTICES

While the focus of the pollinator-friendly certification program is on pollinators and native plant establishment, opportunities to provide habitat for other native wildlife should also be considered.

In areas of priority or estimated habitat for rare species, incorporating special features to increase habitat value for listed species potentially present in the area should be a particular focus. In these areas, specific pollinator-friendly criteria can be waived if they run contrary to

management objectives for a rare species likely to be present. For example, maintaining bare ground as nesting habitat for rare turtles may result in a need to keep more land open and unvegetated than would be required under the higher tiers of Pollinator-Friendly Certification.

Wildlife Passage

At all arrays, fencing should be designed to the extent possible to not impede movement of wildlife through the array. For new arrays, a 6-12 inch gap should be left at the bottom of the fence for wildlife passage. For existing arrays adopting pollinator-friendly management practices, a hole at least 6 inches high and 18 inches wide should be cut in each corner of the array fencing, or every 100 yards, to allow for wildlife passage through the array.

Amphibians and Reptiles

In priority or estimated habitat for rare turtle species, mowing guidelines to protect rare turtles should be strictly followed. Maintenance and management staff should be instructed to drive slowly through the facility during the active season for turtles, and Turtle Crossing signs should be posted at the entrance to the facility.
MassWildlife Turtle Mowing Guidelines:
https://www.mass.gov/files/documents/2016/08/uw/mowing-guidelines.pdf

Creation of turtle nesting habitat is one way to provide habitat value to wildlife in rare turtle habitat. Follow guidance available from MassWildlife.
MassWildlife Turtle Nesting Site Management Guidelines:
https://www.mass.gov/files/2017-08/creating-turtle-nesting-sites.pdf

For other reptile and amphibian species, determine if any relevant management practices can be applied from the Partners in Amphibian and Reptile Conservation guide.
Habitat Management Guidelines for Amphibians and Reptiles of the Northeastern United States:
http://www.fwspubs.org/doi/suppl/10.3996/092015-JFWM-085/suppl_file/092015-jfwm-085.s5.pdf

Birds

In priority and estimated habitat for rare bird species, consider opportunities to plant any preferred plant species, such as fruit-bearing trees and shrubs preferred by frugivorous birds. At sites 5 acres in size or greater, erect one kestrel nestbox per 5 acres. At all sites, erect nestboxes for bluebirds, or other relatively uncommon species that utilize bird boxes, at a rate of 1 nestbox per acre.

Specifications for bird nestboxes are available at these links:

Kestrel Nestbox Plans

- https://kestrel.peregrinefund.org/nest-monitoring
- https://www.hawkmountain.org/data/streamfile.aspx?id=NzYzMTA%3D&name=Kestrel+Nestbox.pdf
- https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_063830.pdf

Bluebird and Other Birds Nestbox Plans

- https://nestwatch.org/learn/all-about-birdhouses/

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Appendix A

Plantings for Specialist Bees

from Jarrod Fowler, Xerces Society

(Some of these are wetland plants which may not be appropriate for planting beneath solar arrays – e.g. pickerelweed. However, many large arrays have to have a stormwater retention basin, where such species could be planted.)

*Note that P=Plant, S=Shrub, ST=Shrub/Tree, and T=Tree; *s show degree of pollen/nectar resource, number is number of specialist species which utilize the plant species.*

Spring (April)
Erythronium americanum, American trout lily, P, */*, 1
Salix discolor, Pussy willow, ST, ***/**, 9
Salix eriocephala, Heart-leaved willow, S, ***/**, 9
Salix nigra, Black willow, T, ***/**, 9

Early Summer (May/June)
Arabis pycnocarpa, Hairy rock cress, B, */*, 1
Cardamine pensylvanica, Pennsylvania bitter cress, B, */*, 1
Ceanothus americanus, New Jersey tea, S, **/***, 1
Cercis canadensis, Eastern redbud, ST, **/**, 1
Claytonia caroliniana, Carolina spring beauty, P, */*, 1
Cornus alternifolia, Alternateleaf dogwood, S, **/**, 2
Gaylussacia baccata, Black huckleberry, S, **/**, 1
Geranium maculatum, Spotted crane's-bill, P, */* 1
Heuchera americana, American alumroot, P, */*, 1
Hydrophyllum virginianum, Eastern waterleaf, P, */**, 1
Ilex glabra, Inkberry holly, S, **/****, 1
Ilex opaca, American holly, T, ***/***, 1
Ilex verticillata, Winterberry holly, S, ****/****, 1
Krigia virginica, Virginia dwarf-dandelion, A, */*, 1
Lyonia ligustrina, Maleberry, S, */*, 2
Potentilla canadensis, Dwarf cinquefoil, P, */*, 1
Potentilla simplex, Common cinquefoil, P, ***/***, 1
Rhododendron maximum, Great rosebay, S, N/A, 1
Uvularia sessilifolia, Wild oats, P, */*, 1
Vaccinium angustifolium, Lowbush blueberry, S, ***/***, 5
Vaccinium corymbosum, Highbush blueberry, S, ***/***, 5
Vaccinium stamineum, Deerberry, S, **/**, 2
Viola cucullata, Blue marsh violet, P, ***/***, 1
Zizia aurea, Golden Alexander's, P, **/***, 1

Late Summer (July/August)
Cirsium discolor, Field thistle, B, **/***, 1
Cirsium muticum, Swamp thistle, **/***, 1
Euthamia caroliniana, Slender goldentop, P, ***/***, 3
Euthamia graminifolia, Flattop goldentop, P, ***/***, 3
Helianthus annuus, Sunflower, Herbaceous A, ****/***, 3
Helianthus decapetalus, Thin-leaved sunflower, P, **/**, 3
Helianthus divaricatus, Woodland sunflower, P, ***/****, 3
Helianthus strumosus, Pale-leaved Sunflower, P, ***/****, 3
Hibiscus moscheutos, Swamp rose-mallow, P, ***/***, 1
Lysimachia quadrifolia, Whorled yellow-loosestrife, P, **/None, 3
Lysimachia terrestris, Swamp yellow-loosestrife, P, **/None, 3
Monarda fistulosa, Wild bergamot, P, ***/**, 1
Monarda punctata, Spotted beebalm, P, ***/***, 1
Oenothera biennis, Common evening primrose, B, **/*, 2
Oenothera perennis, Little evening-primrose, B, **/*, 2
Physalis heterophylla, Clammy ground cherry, P, **/**, 3
Physalis longifolia, Longleaved ground cherry, P, **/**, 3
Pontederia cordata, Pickerelweed, P, ***/**, 2
Solidago canadensis, Canada goldenrod, P, ***/****, 11
Solidago juncea, Early goldenrod, P, ***/**, 11
Symphyotrichum novi-belgii, New York aster, P, **/**, 7
Vaccinium macrocarpon, American cranberry, S, **/****, 1
Verbena hastata, Blue vervain, B, */**, 1

Fall (September/October)
Helianthus maximilianii, Maximilian's sunflower, P, ***/**, 3
Solidago altissima, Late goldenrod, ***/***/ 11
Solidago rugosa, Wrinkle-leaved goldenrod, P, ***/****, 11
Solidago sempervirens, Seaside Goldenrod, P, ***/****, 11
Solidago speciosa, Showy goldenrod, P, ***/***, 11
Symphyotrichum laeve, Smooth blue aster, P, ***/****, 7
Symphyotrichum novae-angliae, New England Aster, P, ***/***, 7
Symphyotrichum puniceum, Purple-stemmed aster, P, **/**, 7
Vernonia noveboracensis, New York Ironweed, P, **/***, 1