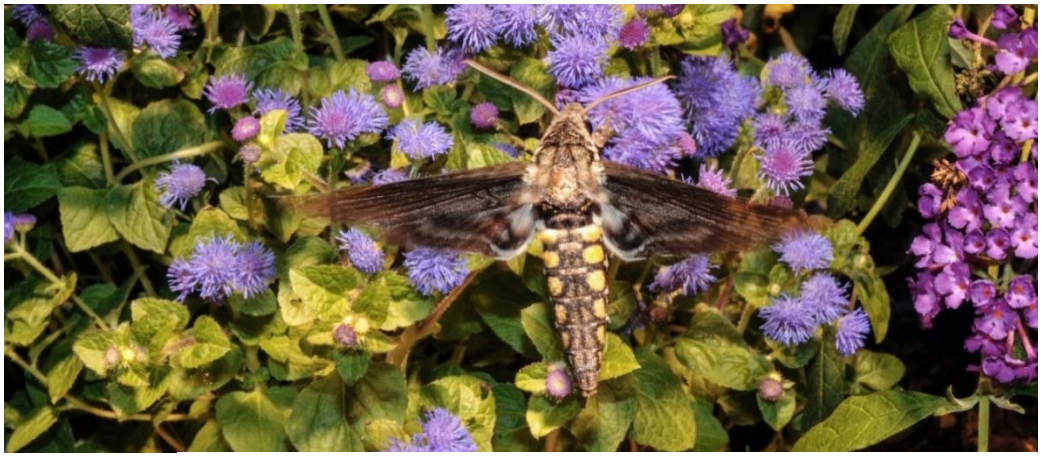
Supporting the Health of Honey Bees and Other Pollinators

October 2014

FOREWORD

To address a requirement in the Presidential Memorandum, *Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators*, the Council on Environmental Quality and the General Services Administration facilitated the creation and tasks of a working group to prepare an addendum to guidance for designed landscapes. The working group included representatives from the United States Department of Agriculture and Forest Service, the Smithsonian Institution, United States Botanic Garden, the General Services Administration, United States Geological Survey, the Department of Transportation, the Department of Defense, the Department of Education, the Department of Veterans Affairs, the National Science Foundation, the Department of Interior's Office of Planning and Management, with assistance provided from the White House Office of Science and Technology Policy.

This document is an addendum to the *Sustainable Practices for Designed Landscapes* guidance and includes new information on landscape design and maintenance as part of the National Pollinator Health Strategy. The use of or reference to any specific private entities, commercial products, processes, or service by trade name, trademark, manufacturer, or otherwise is intended to serve as an example and resource for users and does not constitute an endorsement by CEQ. Similarly, non-Federal hyperlinks that appear in the Addendum are intended to provide information and awareness. Reference to such hyperlinks does not constitute CEQ's endorsement of the linked web sites, or the information, products or services contained therein. CEQ does not contribute to, maintain, or exercise any editorial control over the information you may find at these locations.



Carolina Sphinx Moth (*Manduca sexta).* Photo courtesy of the Smithsonian Institution

CONTENTS

1 INTRODUCTION 4

1.1 APPLICABILITY 5
1.2 BACKGROUND 5
1.3 SCOPE 6
1.4 PERFORMANCE MEASUREMENT 7
1.5 PARTNERSHIPS AND CITIZEN ENGAGEMENT 7
1.6 FRAMEWORK AND OBJECTIVES 7

2 PROCEDURES 9

2.1 PROJECT INITIATION, DESIGN, AND CONSTRUCTION 9
2.1.1 Planning and Preparation 10
2.1.2 Plant Species for Pollinators 14
2.2 MAINTENANCE AND MANAGEMENT 21
2.2.1 Landscape Management Principles 22
2.2.2 Integrated Pest Management (IPM) 24
2.2.3 Integrated Vegetation Management (IVM) 25

3 OUTREACH 32

3.1 STAFF EDUCATION 32
3.2 SIGNAGE AND VISITOR OUTREACH 33
3.3 COMMUNITY MANAGED POLLINATOR HABITAT 33
3.4 INVENTORY, MONITORING AND CITIZEN SCIENCE 35

4 EDUCATIONAL POLLINATOR GUIDES 36

4.1 BEES 36
4.1.1 Honey Bees 36
4.1.2 Native Bees 37
4.2 BUTTERFLIES AND MOTHS 42
4.3 BIRDS (HUMMINGBIRD AND HONEYCREEPER) 43
4.4 FLIES 44
4.5 BATS 45

5 RESOURCES 47

1 Introduction

Pollinators are essential to the United States economy. Honey bees, native bees, birds, bats, butterflies, and other species contribute substantially to our food production systems, the economic vitality of the agricultural sector, and the health of the environment. Honey bee pollination alone adds more than $15 billion in value to agricultural crops in the United States each year, and pollination by other species adds another $9 billion. In addition, pollinators support the success and vigor of flowering plants, making ecosystems stronger, more resilient, and enhancing the environment for human populations.

Decades of stressors have severely and adversely altered the health and numbers of pollinator populations. Pollinators have been impacted by the loss, degradation, and fragmentation of habitat, reduction in the number and quality of food sources, reduction in the availability of sites for breeding, nesting, and roosting, and improper use of pesticides and herbicides. In some case these stressors have made pollinator populations more susceptible to existing disease, predators, and parasites. The status of many pollinators is serious and efforts to improve their health through action on Federal facilities will support both the sustainability of our nation's food production systems and the health of the environment.

On June 20, 2014, the President issued a memorandum[1] directing the heads of executive departments and agencies to create a Federal strategy promoting the health of honey bees and other pollinators. The Presidential Memorandum envisioned broad engagement to improve the management of Federal buildings, landscapes, rangelands and forests to increase and improve pollinator habitat nationally. The expectation is for facility managers to actively examine their current buildings, grounds, and practices for opportunities to transition to a richer diversity of pollinator-friendly plant species, improving the sustainability of Federal landscapes and serving as an exemplar for public-private partnerships, outreach, and education.

Section 3(d) of the Presidential Memorandum instructs the Council on Environmental Quality (CEQ) to revise its guidance for Federal agencies to incorporate pollinator-friendly practices into site landscape performance requirements. Through the support and efforts of a multi-agency working group, this addendum to the *Sustainable Practices for Designed Landscapes* (*Sustainable Landscapes*)[2] provides guidance and recommendations for creating and maintaining quality habitats for pollinators in new construction, building renovations, landscaping improvements, and in facility leasing agreements at Federal facilities and on Federal lands.

[1]Presidential Memorandum — Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators. The White Office of the Press Secretary. www.whitehouse.gov/briefing-room/presidential-actions/presidential-memoranda

[2] Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes. The White House Council on Environmental Quality. www.whitehouse.gov/administration/eop/ceq/sustainability/landscaping-guidance. www.WhiteHouse.gov

The recommendations in this document should be considered in conjunction with the Sustainable Landscapes guidance, and with regard to the sustainability goals set forth in Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance. The Addendum is an integral companion to parallel instructions in the Presidential Memorandum to the General Services Administration (GSA) to incorporate pollinator friendly practices into its guidance documents for public building construction, and to the U.S. Departments of Agriculture and Interior to develop best management practices to enhance pollinator habitat on Federal lands.

1.1 Applicability

These guidelines apply to all Federal agencies and activities that are subject to the provisions of Executive Order 13514. They do not supersede laws, regulations or applicable agency requirements that may be more specific or more stringent. The Addendum applies to agencies constructing new or rehabilitating existing owned or leased facilities, or otherwise implementing landscaping practices on agency-owned or leased land or space. It supports pollinator habitat, beyond the building footprint, in agency efforts to meet the goals of the National Pollinator Health Strategy.

1.2 Background

The breadth, severity, and persistence of pollinator losses poses significant challenges. The combination of stressors upon pollinator populations, including loss of natural habitat and forage, mite infestations and introduced diseases, reduced genetic diversity, and exposure to pesticides and other chemicals[3] have amplified the situation.[4] For example, 2014 revealed a record low population of migrating monarch butterflies and the lowest number of honey bee colonies in the United States in 50 years. For these reasons, the Presidential Memorandum commits agencies to make swift changes to counteract risks and, most importantly, restore pollinator populations.

Landscaping can be a powerful tool to help our Nation's pollinators. A multitude of daily decisions are made regarding the planning, preparation, design, maintenance of the approximately 43 million acres[5] of designed landscape associated with Federal facilities. These decisions range from local pathway and flower bed designs, building and facility landscapes, to acres of right-of-way, rangeland, and forest habitat under management. All of these routine, or not so routine, decisions by Federal agency managers provide valuable opportunities to advance pollinator health and habitats, and to support natural ecosystem functions.

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[3] For the purposes of this document, "pesticides" and "chemicals" broadly refers to the use of insecticides, herbicides, and fungicides.

[4] Presidential Memorandum — Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators. The White Office of the Press Secretary. www.whitehouse.gov/briefing-room/presidential-actions/presidential-memoranda. www.WhiteHouse.gov

[5] *FY 2012 Federal Real Property Report.* General Services Administration. www.gsa.gov/portal/mediaId/179655/fileName/FY_2012_FRPP_intro_508.action

The Presidential Memorandum states that: "future landscaping projects at all Federal facilities shall, to the maximum extent appropriate, use plants beneficial to pollinators." Plants carry specific traits that attract pollinators to the available pollen and nectar. In turn, pollinators help the plants to reproduce by carrying pollen from one flower to the next. This Addendum aims to empower facility managers with sufficient understanding and expert resources to re-appraise existing practices. The objective is to promote the overall lifecycle of pollinators at Federal facilities - improved foraging, reproduction, shelter, and hibernation - while removing barriers that may block an agency's ability to create and maintain quality habitats. These improvements can be achieved within existing facilities' budgets, such as transitioning from a barren monoculture (i.e., lawns) with expensive maintenance needs to a low-maintenance, wild-flower, meadow or prairie.

1.3 Scope

Recommendations within this document concern "designed" sites, paths, walkways, and spillways adjacent to a facility owned and/or operated by the Federal government. An applicable outdoor area may include, but is not limited to, the following:

- Building entryway systems
- Tree boxes and planters
- Pedestrian pathways
- Courtyards
- Campuses or facilities with accumulated acreage in open space or access roadsides
- Spillways adjacent to facilities

The intended audience is Federal landscape designers, Federal contracting officers, Federal facility managers, and other applicable team members who may be involved in the management of designed Federal landscapes. Lease construction should incorporate requirements as feasible. As noted earlier and emphasized in the Presidential Memorandum, parallel Federal guidance and best management practices have also been prepared for Federal building construction (GSA) and range/forest land management (USDA, Interior).[6]

Agencies should strive to balance practices to improve pollinator health with other needs, e.g., security and sustainability, while considering cultural, esthetic, recreational, and environmental resources inherent to the landscape. The guidelines are intended to enhance, and not to inhibit or restrict, planning, operations, and maintenance of landscapes surrounding Federal buildings.

[6] Presidential Memorandum — Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators. The White Office of the Press Secretary. www.whitehouse.gov/briefing-room/presidential-actions/presidential-memoranda. www.WhiteHouse.gov

1.4 Performance Measurement

Goals, targets, milestones, and measures assess progress and provide useful insights on the success and opportunities available for a site. Managers should utilize a team to identify these performance measures at the design stage. Examples of metrics could include: square footage or acreage converted to pollinator-friendly habitat for nesting or foraging, capital and maintenance costs pre and post planting, number of plant species, diversity and abundance of pollinators, frequency of visits, periods of bloom for the plant species, and external collaborations including volunteer support. Multiple measures allow for a comprehensive assessment of progress. Facility managers should look to agency leads to identify additional measures.

1.5 Partnerships and Citizen Engagement

Federal action can do much to increase pollinator habitat acreage and quality, but Federal action alone is not sufficient to restore populations to healthy levels. Recognizing this, the Presidential Memorandum on Pollinator Health emphasizes the importance of developing new public-private partnerships and strengthening citizen engagement. Federal facility managers are encouraged to identify appropriate partnerships and engagements with local, state, regional, and/or national organizations as valuable enhancements to direct Federal action.

Partnerships can include agreements, contracts, or memoranda of understanding, and may help to overcome performance challenges, connect a facility to the broader pollinator effort, and/or facilitate access by volunteer groups to leverage community resources. Citizen scientists and groups such as Master Gardeners can provide valuable knowledge on regional native cultivars, training, pollinator assessments, evaluation measures, restoration efforts, research, and education outreach. Participation with community groups and in citizen science efforts also serves to amplify Federal actions to improve pollinator health through linkages to the broader community.

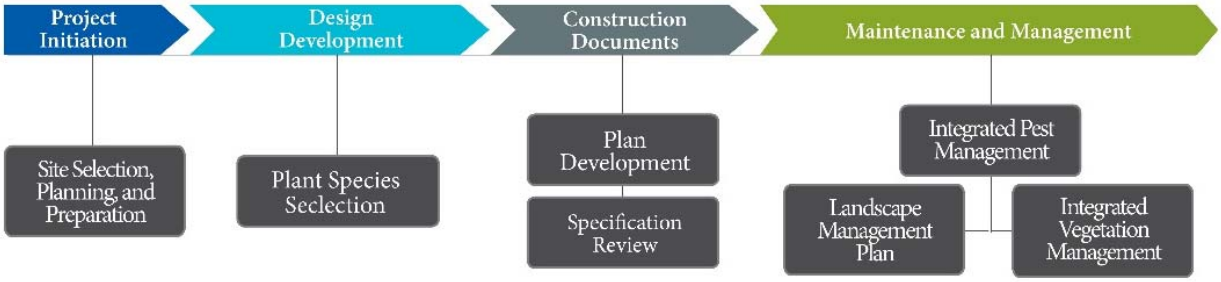
1.6 Framework and Objectives

The intent of this document is to provide Federal landscape designers and architects, contracting officers, facility managers, and other team members who may be involved in the management of Federal landscapes, with the administrative resources and tools to navigate the breadth of research available on pollinator habitat, and to make better decisions to support pollinator populations. This document covers a small window to some of the most common pollinators found throughout the continental United States. It is focused on those pollinators with the greatest potential for recognition, attraction, and/or that are currently listed as endangered.[7] In addition, best management practices are integrated throughout the guidance to serve as examples and resources for users.

[7] Pollinators Federally Listed as Endangered or Threatened Species. United States Fish and Wildlife Service. www.fws.gov/pollinators/Programs/Endangered.html

The framework for the Addendum is as follows:

1. **Procedures** details pollinator-friendly practices and is organized by project phase – planning, design, construction, maintenance and management. At the design phase, project objectives should be clearly communicated to staff and the project team to facilitate decisions related to the long-term sustainability and goals of the agency. New strategies for a pollinator habitat should be addressed as soon as possible to allow for timely and balanced incorporation into annual planning and construction cycles. During the ongoing maintenance and management phase, active engagement provides the opportunity for tracking performance metrics and responding to results. The team may also find additional opportunities to enhance and support the pollinator habitat.



2. **Outreach** presents communication strategies for public-private partnerships and increased citizen engagement. Facilities managers are encouraged to identify appropriate partnerships and engagements with clubs and associations as valuable enhancements to direct Federal action.
3. **Educational Pollinator Guides** includes snapshots of familiar pollinator species and examples of the plant species that support them. Use this section as a tool to help identify: pollinators, potential plant species, habitats, and behavioral characteristics.
4. **Resources** provides an aggregation of documents and websites referenced throughout the Addendum, as well as additional resources for further information.

2 Procedures

The objectives and targets below recommend actions to support sustainable pollinator habitats and promote environmentally responsible designed landscape decisions. Agencies should develop targets that best align with the scope of the project, as well as consider going beyond the following basic criteria to implement an ambitious pollinator habitat agenda.

2.1 Project Initiation, Design, and Construction

The design and construction of pollinator friendly habitats requires effective communication, the building of partnerships, and the development of clear, achievable goals. An example of this could be the creation of a pollinator habitat highlighted by signage that creates positive emotional responses by occupants and visitors.

Facility managers should, at a minimum, involve appropriate subject matter experts with necessary skills to develop goals and support the project. These skills can include strategic planning, asset or project management, landscape design and architecture, construction management, and facility maintenance and operations.

The project team should:

- Be aware of, and reflect on, the agency's mission, design guidelines, sustainable design goals, and climate-related or other vulnerabilities for the site.
- Identify and coordinate existing and applicable documents, plans, and guidelines into design requirements.
- Know the habitat, paying attention to current conditions to develop a sense for changes and growth in pollinator numbers.
- Develop goals, milestones, and metrics for comprehensive performance evaluation, communicating these goals and metrics to appropriate parties and team members.
- Reconfirm measures and benchmarks and, if applicable, ensure their inclusion in final construction documents.

The importance of communication cannot be overstated. Many stakeholders are unfamiliar with the plight of pollinators. Personnel and building occupants can be both supporters and beneficiaries of a project's outcomes, so early engagement with these groups is the most critical time to influence the project's success.

During the construction phase of a project, the project team should review and confirm project specifications, budget requirements, and pollinator habitat improvements. It should also request the use of high-quality, durable, non-toxic products and materials. For example, avoid materials containing paints and other surface coatings which contain toxic substances. Understanding ingredients and materials within products is critical to improving pollinator habitat.

The *Sustainable Landscapes* guidance provides additional actions and strategies related to design and construction. Review the following sections within the existing guidance: Site Selection and Planning, Soils, Water, Vegetation, Materials, Human Health and Well-being, and Construction. The recommendations below are pollinator-driven strategies that should be implemented in conjunction with the original Federal sustainability guidance.[8]

2.1.1 Planning and Preparation

Planning

A Federal designed landscape is one that is professionally laid to fulfill a specific function. Begin with a project assessment including: site function, existing conditions, site resources, and opportunities for developing a pollinator-friendly habitat. Consider the availability of water, amount of sunlight, current and desired vegetation diversity. This preliminary review helps to identify site constraints, opportunities, and sensitive conditions that can be incorporated into the decision-making process.

As a general point, many native pollinator plant species thrive in full sunshine and local soils, providing valuable opportunities to capitalize on sunny, hot, and exposed locations. By gathering as much information as possible during the start of the design process, project teams can understand the site's human-environmental-pollinator relationships and create opportunities for the health and well-being of pollinators.

Opportunity for Improved Design

Following the construction of a security wall, this Smithsonian Institution site relied on planning and preparation to restore a high profile area. Compost was tilled into the soil to address compaction. Small plugs and one gallon containers of native plants were added. Once complete, all plants were labeled as a resource and point of inspiration for visitors.

Photos courtesy of Smithsonian Gardens.

[8] Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes. The White House Council on Environmental Quality. www.whitehouse.gov/administration/eop/ceq/sustainability/landscaping-guidance www.WhiteHouse.gov.

Preparation

Site preparation is critical. Prior to sowing, it is important to determine whether the project site will support suitable growing conditions. In particular, emphasis must be placed on removing competing vegetation and breaking the existing growing cycle of invasive species. Thriving invasive species will burden attempts to grow a prosperous pollinator habitat.

Depending on a project size, first determine if it is possible to physically remove the undesirable plants – pulling, mowing, burning, or tilling. In some cases, such as with larger facility acreage, invasive species can only be killed using herbicides that often require more than one season of effort.[9] Implementation strategies can range from small-scale grassland conversion (weeding, plastic coverage, herbicides, cover crop, mulch) to larger facility acreage (herbicides, interspersing within monoculture grass). Sometimes a combination of removal methods is most effective.

Whichever method is chosen, proper site preparation must be taken before sowing native seeds, as non-selective herbicides should not be applied after seeds are sown. It is likely that the site may appear a bit lean for a couple of years until native grasses and species lay deep roots. Signage or other efforts to communicate the project and progress reporting should be incorporated in the preparation process. This helps to keep people informed and aware of any risks, next steps, and objectives for the project. Refer to Section 3, "Outreach", for additional guidance on signage materials.

Refer to Section 2.2.1, "Landscape Management Principles" for continued guidance on the removal and management of invasive species and refer to the original *Sustainable Landscapes*[10] guidance for further information on site planning and soils.

[9] *New Jersey Installation Guide and Job Sheet.* Conservation Cover (327) for Pollinators. The Xerces Society for Invertebrate Conservation. Natural Resources Conservation Service (NRCS). United States Department of Agriculture. Rutgers. The State University of New Jersey. September 2013. www.xerces.org/pollinator-conservation/agriculture/pollinator-habitat-installation-guides/. www.xerces.org

[10] Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes. The White House Council on Environmental Quality. www.whitehouse.gov/administration/eop/ceq/sustainability/landscaping-guidance. www.WhiteHouse.gov.

Resources

The link below contains multiple documents that address region specific information:

- *Monarch Habitat Development Manuals on Corporate Lands* (Southeast, Southwest, Northwest, Northeast). Pollinator Partnership. 2013. See "Monarchs" under "Useful Resources" on the navigation bar at www.pollinator.org

The link below is the homepage for multiple resources:

- *New Jersey Installation Guide and Job Sheet.* (September 2013). *Pollinator-Friendly Parks. How to Enhance Parks, Gardens, and Other Greenspaces for Native Pollinator Insects* (2008). *Pollinator Habitat Assessment Form and Guide. Farms and Agricultural Landscapes.* (April 2014). The Xerces Society for Invertebrate Conservation. www.xerces.org/pollinator-conservation/agriculture/pollinator-habitat-installation-guides/

The links below are additional resources:

- *Attracting Native Pollinators*. Mader, E, Shepherd, M., Vaughan, M., LeBuhn, G., and Black, S. 2011. Storey Publishing. North Adams, MA. 371 pp. www.xerces.org/announcing-the-publication-of-attracting-native-pollinators/

- Insects and Pollinators Publications. USDA Natural Resources Conservation Service. Plant Materials Program. Insects and Pollinators Publications. www.nrcs.usda.gov/wps/portal/nrcs/detail/plantmaterials/technical/publications/?cid=

Project Kick-Off:

Use a project kick-off meeting to ask the right questions and launch an integrated process to support the long-term effectiveness of a project. Such a meeting should:

- Define purpose and goals.
- Build facility ownership through communication and partnerships.
- Design a business plan with budget and funding options.
- Include “Protection of Flora and Fauna” specifications in any general project specifications.
- Prepare turf/landscape protection plan with established tree protection zones in project drawings.
- Estimate landscape restoration requirements such as tree replacement costs.
- Consider habitat or landscaped areas when planning for a laydown area.
- Identify pollinator education needs to raise environmental consciousness.

2.1.2 Plant Species for Pollinators

Landscapes that supports healthy pollinator populations can be functional and aesthetically pleasing. Pollinator-friendly landscapes may be formal or naturalistic in appearance. Good design and proper maintenance help to improve the landscape aesthetic and provides a focal point filled with color, texture, and seasonal interest as well as a rich and diverse wildlife habitat.

Plant Selection

1. Choose plants that support the forage, reproduction, shelter and/or hibernation of pollinators specific to your ecoregion.

2. Choose plants that are best for your ecoregion; preferably native plants to which pollinators are most accustomed. Native plants evolved along with native pollinator species and are well adapted to thrive in local conditions. Pay particular attention to sunlight, moisture, and soil quality needs, as many native pollinator species thrive in direct sunlight without the need for irrigation or soil enhancement. These actions may prove detrimental by encouraging unwanted weed species. Using some non-native plants is acceptable as long as they are not considered invasive.

3. Seasonal variety is a major consideration. Choose plants that bloom at different times across seasons. <u>While it is important to consider periods of peak pollinator activity in an ecoregion, also have pollen sources available when little else is in bloom.</u> For example, common witch hazel (*Hamamelis virginiana*) blooms October to December.

4. Consider all types of plants. There are trees, shrubs, vines, perennials, and annuals that contribute to pollinator habitats. With some planning it is easy to match your plants to the needs in the landscape. For example a hot and sunny entrance to a building may benefit greatly from a large shade tree with blooms to attract pollinators. Or a small highly visible area can be planted with attractive pollen rich flowers in display beds or containers.

White House Pollinator Garden located on the South Lawn

5. Acquire seeds and plants from nurseries that do not treat their plants with systemic insecticides.

6. Take care when selecting plant cultivars. Some plants are selected for traits attractive to humans but not pollinators (size, color, shape). Sometimes these selections or cultivars of plants lose the traits/indicators on which pollinators rely. For instance the coneflower (*Echinacea purpurea*) and many of its cultivars are excellent for pollinators, whereas a number of double-flowered *Echinacea* cultivars have little appeal for pollinators. Therefore, prioritize the original native species whenever possible.

Habitat Strategies: Water

Access to clean, shallow, water is necessary for a pollinator habitat. During the design phase, determine water accessibility on a project site. If naturally occurring water is unavailable, consider alternative sources such as reclaimed water or rainwater. Granite boulders with shallow depressions hold water from the irrigation each morning and dry from evaporation by the end of the day. This method requires little maintenance, reduces concerns of long-term standing water, and their hefty weight keeps them free from vandalism or theft.

Photo courtesy of Smithsonian Gardens.

Photos courtesy of: Smithsonian Gardens

Monarchs and Milkweeds

Milkweeds are obligate host plants for the monarch butterfly. Rose/swamp milkweed (*Asclepias incarnata*), common milkweed (*Asclepias syriaca*), and butterfly milkweed (*Asclepias tuberosa*) are widely distributed and easily grown species for attracting monarchs. The monarch must lay its eggs on plants within the milkweed family (top, left image).

The adult monarch (below, left) visits many different flowers for nectar, including milkweed, on its annual migration across North America. Here, the adult monarch feeds from the boneset plant (*Eupatorium perfoliatum*).

Spring breeding for monarchs encompasses areas in most of Texas, Oklahoma, and part of Arkansas and Kansas. Monarchs arriving in this area during the annual migration from Mexico (in March) must lay eggs on milkweeds. The adults that develop as a result of this reproduction move northward into the summer breeding range in May and early June. This summer breeding area includes the upper Midwest (the eastern Dakotas, Minnesota, Wisconsin, Iowa, Illinois, Michigan, and parts of Indiana).

Resources: *Milkweeds: A Conservation Practitioner's Guide. Plant Ecology, Seed Production Methods, and Habitat Restoration Opportunities.* The Xerces Society. www.xerces.org/milkweeds-a-conservation-practitioners-guide

Monarch Fueling Planting Guide. Pollinator Partnership. www.pollinator.org/monarchs.htm#fueling

Monarch Watch. www.monarchwatch.org/blog

A local resident examines the new interpretive panel at the Glidden Office pollinator garden. Photo courtesy of U.S. Forest Service

Federal Agency. USDA, U.S. Forest Service

Site. Eastern Region Forests

To date a total of 58 Native Plant and Pollinator Gardens have been established in the U.S. Forest Service's Eastern Region national forests and tall-grass prairies.

All 15 Eastern Region Forests have developed at least one garden; some Forests have as many as 14 gardens, with one at each District Office. Selected gardens offer docent tours and all are interpreted via signs. The gardens vary in size from 10 feet by 10 feet to 10 acres and serve a multitude of purposes. The native plants featured serve to illustrate nectar and larval food sources for both common and uncommon insect species – such as Monarch butterflies feeding on milkweeds and Karner Blue butterflies feeding on sundial lupine. The native plants propagated in these gardens significantly aid in the control of non-native invasive plants in rehabilitation and restoration efforts.

Resource: *Eastern Region Native Plant Materials Accomplishment Report.* United States Department of Agriculture. United States Forest Service.
www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5427015.pdf

Photos courtesy of Smithsonian Gardens

Federal Agency. Smithsonian Institution

Site. Smithsonian Gardens' Urban Bird Habitat at the National Museum of Natural History

For this project, an understory of American Elms was converted from an existing lawn area (upper left) into an aesthetically beautiful habitat (left). Site preparation included the use of herbicide to kill the existing turf (upper middle). To protect the roots of the historically significant trees, an air spade was used to cultivate the soil instead of a tiller. Signage welcomes visitors and provides information about proper land stewardship with regards to birds and other pollinators (upper right).

Resource: http://gardens.si.edu/our-gardens/urban-bird-habitat.html

Federal Agency. General Services Administration

Site. Domenici Federal Courthouse
New Mexico

Photos courtesy of the General Services Administration

Water scarcity drove the U.S. General Services Administration to turn a resource consumptive turf "yard" into an efficient and evocative "garden" at Albuquerque's Pete V. Domenici U.S. Courthouse.

The project was initially envisioned as a water conservation effort, but quickly evolved to become a comprehensive sustainable site works project. This Sustainable Sites Initiative (SITES)[11] certified project rediscovered and reinterpreted the historical approach to clever and careful water stewardship, through water harvesting, storage, and redistribution. This allowed a new purpose-built landscape to emerge and be sustained through forethought and sensitivity to local conditions, rather than importing inappropriate landscape practices and overconsumption.

The original mono-cultural plant palette was replaced by a diverse range of high desert pollinator friendly native plants with prolonged seasons of bloom. Large expanses of site pavement materials were removed and crafted into site furnishings, and select building systems were integrated into the site. The result is a project that reclaimed an under-utilized interstitial space rendering it more useful and satisfying for both people and the environment.

[11] Sustainable SITES Initiative. www.sustainablesites.org/

Resources

The links below address plant selection:

- Gardening for Pollinators. United States Forest Service. United States Department of Agriculture. www.fs.fed.us/wildflowers/pollinators/gardening.shtml

- Native Plant Societies. American Horticultural Society. www.ahs.org/gardening-resources/societies-clubs-organizations/native-plant-societies

- Plant Species of Special Value to Native Bees. Lady Bird Johnson Wildflower Center. The University of Texas at Austin. www.wildflower.org/collections/collection.php?collection=xerces_native

- Providing Wildflowers for Pollinators. Bring Back the Pollinators. A Xerces Society Conservation Campaign. The Xerces Society for Invertebrate Conservation. www.xerces.org/providing-wildflowers-for-pollinators/

- *Selecting Plants for Pollinators.* Free Pollinator Friendly Planting Guides. Pollinator Partnership. www.pollinator.org/guides.htm

The links below address growing regions:

- North America Ecological Regions. www.cec.org/Page.asp?PageID=122&ContentID=1329

- International Resources: for facilities outside of the continental United States. http://www.xerces.org/pollinator-conservation/plant-lists

- USDA Plant Hardiness Zone Map. (2012). http://planthardiness.ars.usda.gov/PHZMWeb

2.2 Maintenance and Management

Pollinator habitats require a maintenance approach that may differ from conventional landscape efforts. Comprehensive maintenance practices should be developed that support the needs of the pollinators and provide for the landscape. Potential conflicts may arise between the needs of the pollinators and conventional aesthetic. For example, plants in a garden or habitat designed to promote pollinator health and food for caterpillars and other larvae are expected (and encouraged) to tolerate insect damage to plant leaves.

Damage to leaves identifies the presence of leaf-cutter bees. Photo courtesy of Smithsonian Gardens

White-lined Sphix moth (*Hyles lineata)* visiting a dandelion flower. Photo courtesy of David Inouye, University of Maryland

This section covers various tasks and timeframes that should be considered based on site objectives and needs. Maintenance and management activities could have a potential effect on the health and well-being of pollinators as well as the long-term sustainability and care of the pollinator habitats. Agencies should work with contractors, Federal maintenance staff, and landscapers to ensure the adoption and implementation of maintenance practices that enhance the health of pollinators and minimize risks from maintenance activities.

In general, the use of natural and mechanical strategies are preferred to the use of pesticides. However, for projects that involve extensive conversions of large land areas (e.g. waste sites, right of ways, and lawns) to natural grasslands and meadows, a well-managed plan likely includes the use of non-selective herbicides in order to remove invasive species. In such cases it is extremely important to involve a specialty consultant who is aware of ultra-low volume practices for invasive and pesticide application, and the ability to identify selective herbicides for the pest species

Use the Operations and Maintenance section of the existing Sustainable Landscapes guidance in conjunction with following strategies to promote the health of pollinators.

2.2.1 Landscape Management Principles

A least toxic approach to pest management should be employed. Chemical controls that can adversely affect pollinators should not be applied in pollinator habitats. This includes herbicides, broad spectrum contact and systemic insecticides, and some fungicides. The management of pollinator-friendly habitats should be guided by the following principles.

1. An integrated pest management (IPM) program with reliance on physical, cultural, and biological controls should be used with a goal of managing pests not eradicating them. Review section 2.2.2 for further guidance.

2. If applicable, the site may need a strategic integrated vegetation management (IVM) plan. Similar to IPM, IVM relies on different types of controls to manage noxious plant species. Review section 2.2.3 for further guidance.

3. Allow for clover and other desirable plant material in turf and lawn areas. Limit mowing of turf areas to every other week.

4. Ensure proper timing for garden clean-up, cut-backs, and pruning. Because pollinators overwinter in different life-cycle stages and use plant material for overwintering sites, care should be taken to leave some structures in place to encourage full pollinator life-cycle in managed habitats. This includes timing cutbacks and garden cleanup to occur after pollinator emergence.

5. Care should be taken to source plant material from suppliers that can verify no insecticide treatments to their nursery stock. Insecticides can persist in plant material (leaves, flowers, nectar, and pollen) and lead to disruptions in a pollinator lifecycle once planted in the pollinator habitat.

6. Protect pollinator habitats from disturbances and stressors such as pesticide use, mowing or other site management operations. As above, this could include longer intervals between mowing to allow for clover and other lawn flowers to bloom, or setting aside areas of habitat that are only treated once or twice a year.

Habitat Highlights

When a pine tree died at the Smithsonian National Museum of Natural History, the trunk of the tree (snag) was kept as a wildlife habitat. The snag provides valuable habitat for insects and birds within a landscaped habitat. An interpretive sign teaches visitors that this dead tree is actually an asset, providing important resources for the local ecosystem.

Photos courtesy of Smithsonian Gardens.

Non-noxious species that do not need to be removed or controlled can enhance habitat for pollinator and other beneficial insect species.[12] When weeding activities need to occur, use physical weeding methods and other strategies, such as:

1. Accepted mulching practices (1-3" of mulch) to minimize the prevalence of weeds, thereby lessening the need for chemical control.

2. Use of perennial ground covers, which can be a suitable substitute for mulch and also help deter weeds.

3. Proper soil nutrition management in the form of soil nutrient testing prior to fertilizer application, which can help minimize issues of soil over-fertility that can lead to excessive weeds. Managers should keep in mind that native plants are likely adapted to the local soils and climate, and that increased fertilizer and water application may favor growth of undesirable weedy species.

Resources

- Invertebrate Conservation Fact Sheet. Pollinators in Natural Areas. A Primer on Habitat Management. www.xerces.org/wp-content/uploads/2008/11/pollinators_in_natural_areas_xerces_society.pdf

- Conserving Bumble Bees: Guidelines for Creating and Managing Habitat for America's Declining Pollinators. Xerces Society. www.xerces.org/bumblebees/guidelines

- Forest Service National Strategic Framework for Invasive Species Management. United States Forest Service. United States Department of Agriculture. www.fs.fed.us/publications/invasive/invasive-framework-2013.pdf

[12] *Insects and Pollinators Publications.* USDA Natural Resources Conservation Service. Plant Materials Program. Insects and Pollinators Publications. www.nrcs.usda.gov/wps/portal/nrcs/detail/plantmaterials/technical/publications/?cid=

2.2.2 Integrated Pest Management (IPM)

IPM is a pest management approach which includes biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. IPM is site-specific in nature, with individual tactics determined by the particular crop/pest/environment scenario. IPM places an emphasis on the reduction of pesticide use and the implementation of preventative and alternative control measures. Among these IPM practices, this subsection highlights biological controls as these are often overlooked.

Biological Controls

Biological Control is the reduction of plant pest populations by natural enemies and involves an active human role. Natural enemies of insect pests, also known as biological control agents, include predators, parasitoids, and pathogens. Biological control agents work most effectively when pest populations are relatively low. They should be released at the first sign of pests in order to manage pest populations.

The adult stage of many insects with predaceous larvae (such as green lacewings and syphid flies) and many adult parasites feed only on pollen and nectar. Because pollinator landscapes have a variety of sequentially flowering species, they provide natural enemies with nectar, pollen, and shelter throughout the growing season. Biological control agents can be ordered online and applied as needed. Once released, many biological control agents (green lacewings, parasitic wasps, lady beetles, etc.) become established in pollinator landscapes particularly if you eliminate applications of harmful insecticides.

Resources

- Integrated Pest Management (IPM) Principles. U.S. Environmental Protection Agency. www.epa.gov/pesticides/factsheets/ipm.htm
- Forest Service National Strategic Framework for Invasive Species Management. United States Forest Service. United States Department of Agriculture. www.fs.fed.us/publications/invasive/invasive-framework-2013.pdf
- Reducing Risks to Pollinators from Pest Control. US Fish and Wildlife Service.www.fws.gov/pollinators/pdfs/Reducing_Risks_to_Pollinators_from_Pest_Control_factsheet.pdf

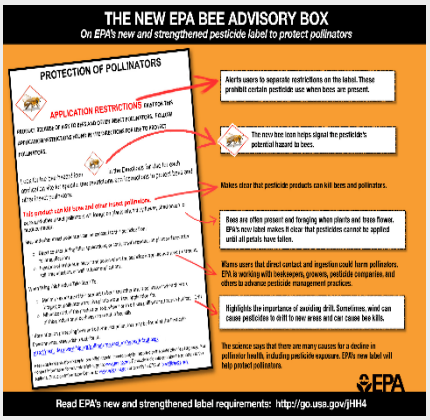
2.2.3 Integrated Vegetation Management (IVM)

IVM is a closely related concept to IPM. It can be viewed as a systematic approach to address undesirable plant species. An IVM program is generally defined as the practice of planning and promoting desirable, stable, plant communities that resist invasion by undesirable plants. These methods can include a combination of treatments, ultimately supplementing the competitive vitality of the desired plants with the most environmentally and cost effective methods to limit undesirable species.

This section touches on a variety of IVM methods: chemical, biological, cultural, and mechanical. The project team should consider all maintenance options during the selection, planning, and preparation phase of the project (Section 2.1.1). Method effectiveness, environmental impact, site characteristics, worker and public health concerns, security, and budget all play a role and should be considered, as appropriate.

When IVM is used, create a strategic vegetation management plan that identifies appropriate standards, site assessment, control, best management practices, criteria trained and licensed personnel, evaluation, and a tactical long-term maintenance plan. Agencies should refer to the *Accreditation Standards for Assessing IVM Excellence* by the Right-of-Way Stewardship Council.[13]

EPA Labeling Program



The EPA's Pollinator Risk Assessment Guidance is part of a long-term strategy to advance the science of assessing the risks posed by pesticides to bees, giving risk managers the means to further improve pollinator protection in our regulatory decisions. Among other things, the EPA anticipates the guidance will allow the Agency to assess effects from systemic pesticides quantitatively on individual bees as well as on bee colonies.

Resource: www2.epa.gov/pollinator-protection

Chemical Control

Within IVM programs, herbicides are judiciously applied in a focused, selective manner. Herbicides are used to eliminate invasive plants proven difficult to manage by hand or mechanical maintenance methods. Use herbicides that are approved by the U.S. Environmental Protection Agency (EPA) as safe and effective methods for controlling plants. No single

[13] *Accreditation Standards for Assessing IVM Excellence.* Right-of Way Stewardship Council. www.dovetailinc.org/reports/Accreditation+Standards+for+Assessing+IVM+Excellence_n567?prefix=%2Freports

application method works as each situation requires advanced assessment to ensure that the safest, most efficient, and cost-effective chemical control program is chosen.

Biological Controls

This type of control uses living organisms to manage unwanted vegetation – often through destruction or competition. Biological control measures reduce interfering plant populations to manageable levels, rather than eradicating them completely.

Examples of biological control include: animals, plants, fish, insects, and disease organisms (e.g., bacteria, viruses, parasites, fungi, etc.). Selective application of herbicides that conserve grasses, herbs, shrubs, and compatible trees can also facilitate biological/ecological control.[14]

Cultural Control

Cultural control is the practice of using regeneration methods that create conditions appropriate for chosen species. Within IVM programs, this involves the introduction of specific plants or mulches to control vegetation growth or promote a desirable plant community. Examples of cultural control include:

1. Reintroduction of native species,
2. Use of weed barriers, such as hardscapes and weed mats, and
3. Use of mulch and compost.[15]

Select and plant only native species adapted to the site conditions. Agencies should monitor property frequently and eradicate small infestations before they become major problems. Active communication with neighbors can assist through educating them about the importance of learning how to identify and control interfering plants (see Section 3, “Outreach”, for additional information).[16]

Mechanical and Manual Controls

This approach involves targeted hand or machine removal of interfering plants. This can include, but is not limited to: mowing, cutting, grubbing, hand-pulling, girdling, tilling, and thermal control (i.e., prescribed burns).

[14] Integrated Vegetation Management. Fact Sheet. United States Environmental Protection Agency. www.epa.gov/pesp/publications/landscaping/ivm_fact_sheet.pdf
[15] Ibid.
[16] Penn State Extension. Penn State College of Agricultural Sciences. www.extension.psu.edu/

Resources

- Accreditation Standards for Assessing IVM Excellence. Right-of Way Stewardship Council. www.dovetailinc.org/reports/Accreditation+Standards+for+Assessing+IVM+Excellence_n567?prefix=%2Freports

- Integrated Vegetation Management. Fact Sheet. United States Environmental Protection Agency. www.epa.gov/pesp/publications/landscaping/ivm_fact_sheet.pdf

- IVM Partners. Managing Ecosystems together. The Right Paths for Pollinators. www.ivmpartners.org/

- Penn State Extension. Penn State College of Agricultural Sciences. www.extension.psu.edu/

Pollinator Protection Site Form

Integrate a pollinator protection plan into existing or new documents in order to minimize harm to pollinators and help to protect nearby habitats, food and water sources. Some pollinator protection practices could be to:

- Become familiar with markings and indications that designate the presence of pollinators. For example, flag areas that contain pollinator damage to leaves so that insecticides aren't applied by mistake. Pollinators such as butterflies (caterpillars) and leaf-cutter bees use plants for feeding and habitat purposes.
- Adhere to all pesticide label instructions and treat only the target areas.
- Observe pollinator activity to minimize exposure. Avoid applications to flowering plant species since this is when pollinators are actively foraging. Target very early morning or late in the evening applications.
- Use an IPM approach that includes a pollinator protection plan. IPM is a pest management approach that includes biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. IPM places an emphasis on the reduction of pesticide use and the implementation of preventative and alternative control measures.
- Cooperate and communicate with others. This includes neighboring sites that may be home to sensitive occupants or pollinator habitats, such as beehives. Monitor environmental conditions and use equipment that minimizes spray drift to adjacent sites.
- Follow notification requirements if pollinator toxic pesticides (PTPs) are planned for application in close vicinity to hives or active pollinator activity, and become familiar with applicable regulatory agencies to report suspected pollinator pesticide poisonings.

Organization. American Horticultural Society (AHS)

Site. André Bluemel Meadow River Farm; Alexandria, VA

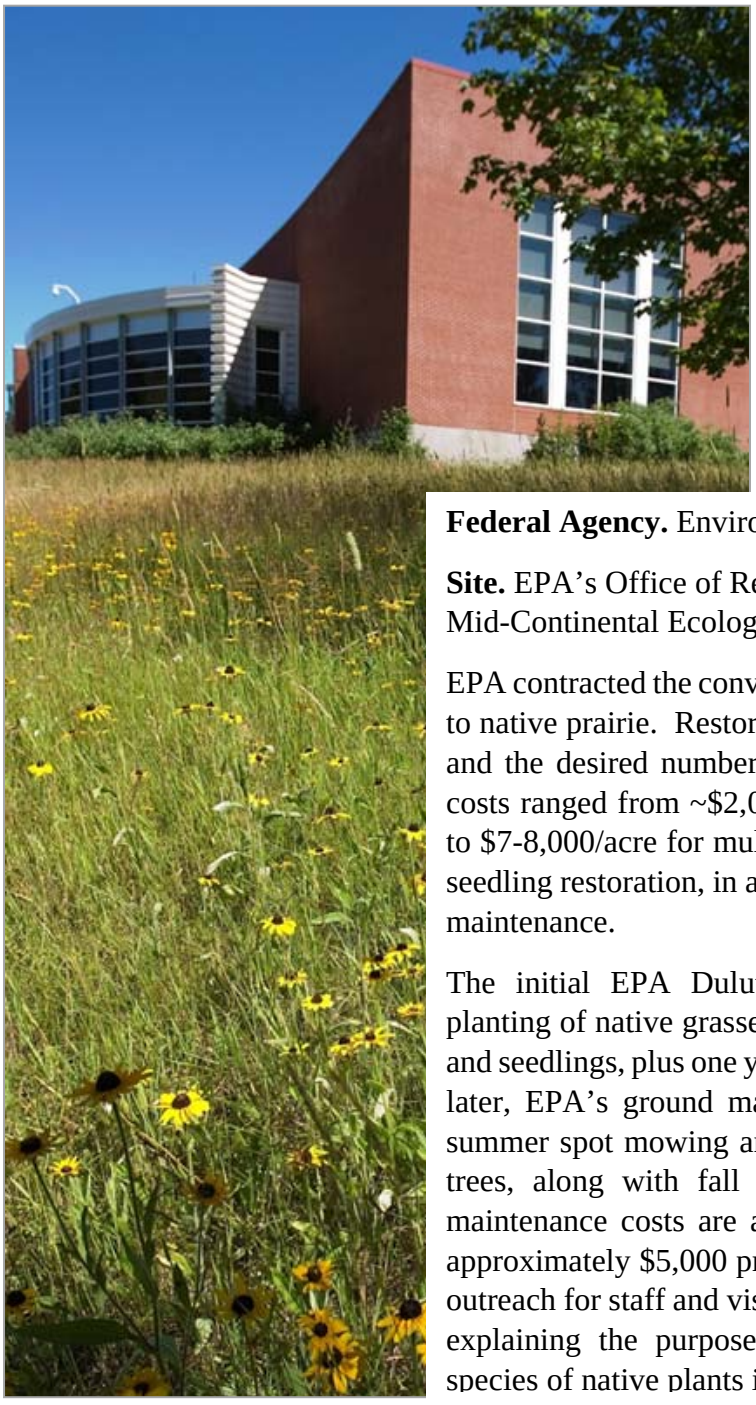
Photos courtesy of AHS

In 2003 AHS began a five year process to turn four acres of lawn at its River Farm headquarters into a meadow. Most of the nearly 100 different species of grasses and herbaceous perennials planted in the meadow are native to eastern North America. By including a great variety of plants, the meadow attracts and hosts a diverse array of insects, birds, reptiles, amphibians, and mammals throughout the year. AHS used a four step method to establish the meadow:

- **Step 1. Eliminate Weeds**
  Weeds can be eradicated by a variety of methods, including repeated tilling, smothering with newspaper, solarization, and herbicides.
- **Step 2. Sow Seeds and/or Plant Plugs**
  Once the meadow site is cleared of weeds, it's time to sow seeds or plant the meadow.
- **Step 3. Water and Weed**
  In the first growing season, the meadow must be watered and weeded regularly.
- **Step 4. Mow/Burn Periodically**
  Mowing or prescribed burning is used to deter the natural process of forest succession. After a meadow has become established, it should be mowed only once or twice a year.

Resources: André Bluemel Meadow. American Horticultural Society. www.ahs.org/meadow

The Allure of the Meadow Garden. Ottesen, Carole. (June 2006). The American Gardener. www.ahs.org/uploads/pdfs/Meadow_TAG_MJ06.pdf



Federal Agency. Environmental Protection Agency (EPA)

Site. EPA's Office of Research and Development.
Mid-Continental Ecology Division Lab. Duluth, Minnesota

EPA contracted the conversion of 1.9 acres of manicured lawn to native prairie. Restoration costs vary by location, acreage, and the desired number of plant species. In Duluth, initial costs ranged from ~$2,000/acre for grassland restoration, up to $7-8,000/acre for multiple grass and wildflower seeds and seedling restoration, in addition to site preparation and annual maintenance.

The initial EPA Duluth work included site preparation, planting of native grasses and 15 species of wildflower seeds and seedlings, plus one year of annual maintenance. Ten years later, EPA's ground maintenance is reduced to spring and summer spot mowing and removal of non-native weeds and trees, along with fall dormant mowing. Current annual maintenance costs are approximately $1,500, reduced from approximately $5,000 prior to the prairie restoration. Project outreach for staff and visitor support was facilitated by a flyer explaining the purpose of the prairie restoration and the species of native plants included.

Photos courtesy of EPA

Resources

- *Accreditation Standards for Assessing IVM Excellence*. Right-of Way Stewardship Council. www.dovetailinc.org/reports/Accreditation+Standards+for+Assessing+IVM+Excellence_n567?prefix=%2Freports

- *Establishing Pollinator Meadows from Seed*. The Xerces Society for Invertebrate Conservation. 2013. www.xerces.org/establishing-pollinator-meadows-from-seed

- Integrated Vegetation Management Partners. www.ivmpartners.org/cases.html

- National Pesticide Resource Center. Oregon State University. http://npic.orst.edu/

- *Pollinators and Pesticide Stewardship.* Pesticide Environmental Stewardship. Promoting Pesticide use and handling. Center for Integrated Pest Management. (2014). www.pesticidestewardship.org/PollinatorProtection/Documents/Pollinators_and_Pesticide_2014.pdf.

- Protecting Honey Bees from Pesticides. University of Florida (IFAS) http://edis.ifas.ufl.edu/pdffiles/AA/AA14500.pdf

- *Protecting Pollinators: Why and How Pesticide Applicators Can Help Them*. North American Pollinator Protection Campaign. https://pollinator.org/PDFs/NAPPC.pesticide.broch.Applicators17.pdf

- *Pollinators and Their Habitat.* Minnesota Department of Agriculture. www.mda.state.mn.us/protecting/bmps/pollinators.aspx

- Reducing Risks to Pollinators from Pest Control. US Fish and Wildlife Service. www.fws.gov/pollinators/pdfs/Reducing_Risks_to_Pollinators_from_Pest_Control_factsheet.pdf

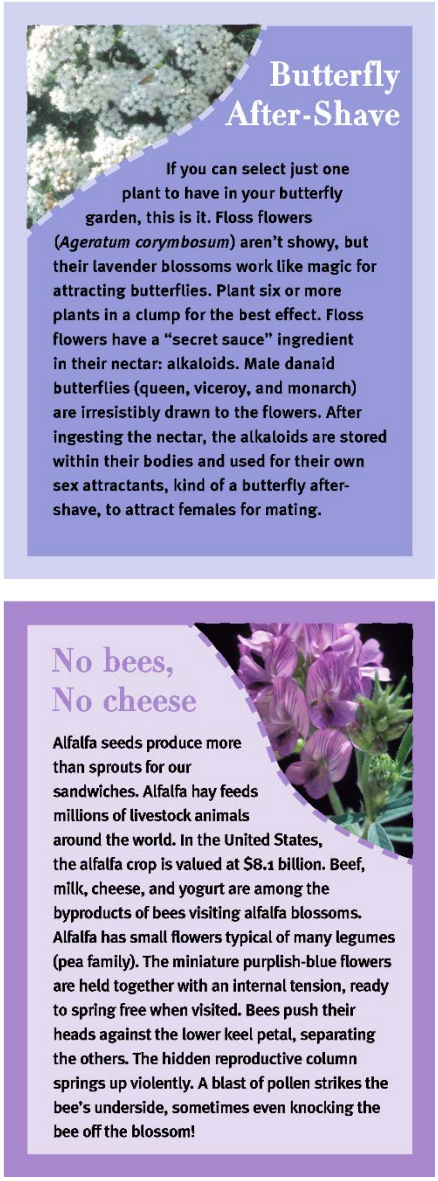
- US EPA Integrated Vegetation Management Fact Sheet. www.epa.gov/pesp/htmlpublications/ivm_fact_sheet.html

3 Outreach

Outreach efforts are central to gaining public acceptance for the change from manicured lawns and formal garden beds to the variety of pollinator habitats anticipated, from ornamental planters of pollinator friendly species to wild meadows and prairies.

Outreach can be executed in a variety of forms depending on the need of a project: educational materials, accessibility, or establishing a connection with target audiences. Signage should illustrate components of the project whether it is to provide progress updates or educate readers.

When preparing a comprehensive signage plan, identify why the outreach is needed and the appropriate methods for implementation.



Interpretive signs located at the U.S. Botanic Garden (USBG)

3.1 Staff Education

Early engagement and acceptance by facility staff helps to enhance the success of a pollinator-friendly habitat. Make the facility staff aware of the importance of pollinators to both natural and agricultural resources. Design concepts should be shared with applicable team members prior to planning, with clear identification of the project goals. Ideally, staff should have the opportunity to voice concerns and make suggestions during the design process. Their involvement in the implementation and communication of a new landscape helps to build a sense of shared purpose.

Identify specific target pollinators and create signage that highlights the benefits of target pollinators. The kinds of plantings that ultimately prove pollinator friendly also possess many other attributes of sustainability. Staff should be made aware of the total benefits the landscape aims to achieve, which may include improvements to water quality, habitat for a variety of species and human health, as well as decreased expenditures in time, money and other resources for maintenance. Both facilities maintenance staff and other users of the facilities can benefit from a short course or presentation of the goals of sustainable landscapes, such as those presented in the Landscape for Life program (landscapeforlife.org).

3.2 Signage and Visitor Outreach

Signage display and urban garden located at the USBG

Signage should communicate the intentionality of the project (e.g., why some areas may have decreased mowing frequency or a tolerance for 'weeds'). To those habituated to monoculture landscapes, the addition of diverse pollinator friendly plantings may be perceived as 'untidy' or 'under-maintained'. Signage is critical in these areas, and has been proven to mitigate these concerns. In addition, signs can identify target pollinators and the landscape interventions made to provide resources for those pollinators. Finally, signs can explain the overall importance of pollinators. Care should be taken to ensure that signage is aesthetically appropriate for the surroundings. Signs should be easily visible and accessible, without detracting from the beauty of the surrounding landscape. They should be designed for long life spans, as the messages contained within educational signage should last as long as the landscape itself.

In some facilities, especially in the urban context, the amount of landscaped area may be minimal. In these cases, it may be most appropriate to plant a small number of pollinator friendly species and sign specific plants to create a small exhibit. This would be a preferred approach where space or other environmental constraints do not allow for larger landscape intervention.

In addition to signage, efforts should be made to share the approach and techniques of the pollinator friendly landscape with the surrounding community. Enlisting local experts to provide tours, where feasible, represents an excellent opportunity for the facility to create closer bonds with its surrounding community while disseminating specific messages about pollinators and pollinator friendly landscapes.

3.3 Community Managed Pollinator Habitat

Buy-in for an effective, community managed pollinator habitat can take the form of a volunteer program. Determine if a manageable portion of the pollinator habitat can be set aside as a facility-community managed pollinator garden, through outside partnership programs or facility occupant design opportunities.

The U.S. Forest Service with USDA provides numerous examples of participation activities with diverse community groups, encouraging partnerships and engagement with local, state, regional, and/or national organizations such as Master Naturalists, 4H Youth, Boy and Girl Scouts, Garden Clubs, and Audubon Clubs. Partnerships are

constructed as agreements and in the form of memoranda of understanding. The intent is to connect with volunteer groups to leverage and educate community resources.[17]

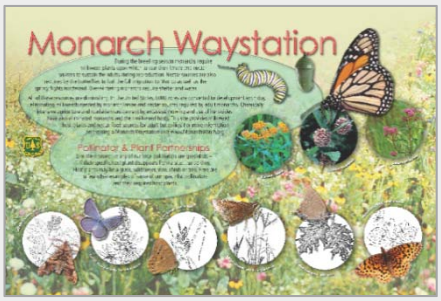
Resources

- North American Pollinator Protection Campaign (NAPPC). http://www.pollinator.org/nappc.htm

The links below provide examples of outreach opportunities for schools and classroom education:

- Monarchs in the classroom (University of Minnesota) – www.monarchlab.org/mitc/
- Schoolyard Ecology Explorations (University of Minnesota) – www.monarchlab.org/see/

Signage Strategies



The USBG and Forest Service developed numerous and varied interpretive signs to inform and engage the public about pollinators. These panels can be downloaded for use by other agencies.

Resource:

USBG. usbg.gov/pollinator-signs

USFS. fs.fed.us/wildflowers/features/panels.shtml

[17] Eastern Region native Plant Materials Accomplishment Report. (2012). United States Department of Agriculture. U.S. Forest Service. www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5427015.pdf

3.4 Inventory, Monitoring and Citizen Science

Pollinator monitoring programs aid in gathering important trends such as appearances, population numbers, habits, and breeding. Federal facilities should aim to take part in programs that engage nearby citizen organizations, farmers or other Federal agencies. Monitoring efforts are numerous and varied, and it's possible for them to be undertaken with a wide variety of organizations.

As is with most components of developing and implementing pollinator-friendly habitats, monitoring pollinators is sensitive to the situation, resources, and staff availability. Some resources are listed below. The list is neither inclusive nor exhaustive, but serves to identify a number of options that focus on inventory, monitoring and engagement.

- Citizen Science. The Xerces Society for Invertebrate Conservation. www.xerces.org/citizen-science/

- Survey and Monitoring. The Great Pollinator Project. http://greatpollinatorproject.org/conservation/surveys-and-monitoring

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- Species lists, Identification Guides, and Maps for all genera in North America, Caribbean, and Mexico are available along with all the species East of the Mississippi, and many of the western species.

  www.discoverlife.org/20/q?search=Apoidea
  www.discoverlife.org/

- Annenberg Learner, Journey North. A Global Study of Wildlife Migration and Seasonal Change. Monarch butterflies.

  www.learner.org/jnorth/monarch/index.html

- Free hi resolution pictures of bees under copyright free creative Commons license. www.flickr.com/photos/usgsbiml/

Bee Smart Phone App

Pollinator Partnership developed the Bee Smart™ Pollinator Gardener app. The smart phone app provides a comprehensive guide to selecting plants for pollinators specific to your area.

Resource

http://pollinator.org/beesmartapp.htm

4 Educational Pollinator Guides

Use this section to help identify and attract specific types of pollinators. Each profile includes detail about the pollinator, its habitat preferences, and attracted plant species. The pollinator and plant species listed are not exhaustive.

4.1 Bees

4.1.1 Honey Bees

Nest: Cavity or available hive

Color: Brown to black and golden to amber.

Region: Thousands of years ago humans began managing honey bees for honey. Approximately 400 years ago honey bees were introduced to the United States for crop pollination and honey production. Honey bees enable the production of at least 90 commercially grown crops in North America, accounting for more than 15 billion dollars through their vital role in keeping fruits, nuts, and vegetables in our diets.

Tropical in origin, honey bees have been distributed worldwide and feral honey bees are now found in all but the coldest habitats. They are not native to the United States and their use is dependent upon management goals. Honey bees typically fly 1-2 miles around their hive to find food. They forage at temperatures between 46°F and 90°F with optimal activity when the air temperature is 72-75°F. A nearby water source is important especially for both brood rearing and hive cooling. Southern or easterly exposures, on dry ground with good drainage are preferred. In the desert Southwest hives require at least partial shade and water. In all climates, shelter from wind is desirable and exposed windy sites should be avoided as this reduces bee flight/foraging.

Honey Bee (*Apis mellifera*) on Alliu.
Photo courtesy of Smithsonian Gardens

Profile: Honey bees are foraging generalists and pollinate a wide variety of plants. Honey bees are especially useful in the agricultural setting because they adjust their foraging to what is blooming and tend to visit only one species of flower in a trip. They build to larger colony sizes than native bees, further predisposing them to crop pollination.

Preferred Plant Species: Besides bumble bees, honey bees are the only bees that collect and store nectar. Honey bees effectively pollinate a wide range of plants including trees (e.g., almond, hazelnut, basswood, linden, oak, tupelo, and willow), herbaceous plants (e.g., tansy, goldenrod, daisy, fireweed, lavender, milkweed, all clovers, heather, poppy, sunflowers), herbs (e.g.,, thyme, mint, coriander, lemon balm) and fruits (e.g., apple, cherry, orange, pear) and typical crops (e.g., buckwheat, alfalfa, soybeans, zucchini, strawberries, cucumbers, melons, beans, tomatoes, peppers etc.).

4.1.2 Native Bees

There are approximately 4,000 species of native bees in the United States. The five most common families can be found throughout North America from Canada and Alaska to Florida and Mexico.

Bumble Bee (*Bombus*)

Nest: Ground; underground cavities.

Color: Covered in black and yellow hair on all body segments with varying patterns of stripes on their abdomen.

Region: There are around 50 species of North American bumble bees and 250 species worldwide. Bumblebees typically inhabit temperate to cooler regions worldwide with only a few species known from the equatorial regions of the Neotropics. They are important in boreal forests, cold prairies, coastal plains, and mountain habitats.

Profile: Bumblebees are foragers and important pollinators of wild plants and crops. Overwintering queens form new colonies in the spring and nest in the ground and cavities in old mouse nests. Plants in the nightshade family, like tomatoes, peppers, and eggplant, benefit from their pollination. Many species of berry (blueberry, cranberry), fruit (apricot, apple) and seed crops (clover, onion) are also benefited by bumble bees. They also perform a special kind of pollination, called 'buzz pollination,' in which they vibrate their wing muscles to shake the pollen out of the plant's anthers. Bumble bees perform 'buzz pollination' on tomatoes, and are raised commercially for this purpose.

Bombus appositus queen visiting a *Corydalis caseana*.
Photo courtesy of David Inouye, University of Maryland

Bombus flavifrons worker visiting a *Delphinium barbeyi*.
Photo courtesy of David Inouye, University of Maryland.

Preferred Plant Species:
Bumble bees can manipulate many kinds of flowers. They will forage on plants such as; *Penstemon, Saliva, Rosa, Helianthus, Phacelia,* and *Aquilegia*.

Carpenter Bees (*Xylocopa*)

Nest: Wood borers: typically a log or tree branch.

Color: The females of all nine Carpenter Bee species on the mainland United States are completely black, with a few sporting patches of light-colored hairs amidst the black ones. All sport black wings with lovely dark iridescent green to purple overtones. Males on the other hand always have significant amounts of white or yellow integument (skin) on their faces and the rest of their robust Bumble Bee-shaped bodies varying from completely amber in to jet black.

Region: Widely distributed throughout the United States.

Profile: Valley carpenter bees establish hovering territories in a non-flowering shrub or tree. Passing females decide which male to mate with based on a particular bee "cologne." Female carpenter bees have powerful mandibles to excavate wide tunnel systems in which they build their nests, hence their common name of carpenter bee. Occasionally, when a flower has a long throat that places the nectar out of reach of its tongue, the carpenter bee uses her sharp mouth parts to cut a slit at the base of the flower where the nectar is stored. She then drinks the nectar without coming near the pollen-dispensing anthers or stigma of the flower.

Carpenter Bee on *Scabiosa*.
Photo courtesy of Smithsonian Gardens

Preferred Plant Species:
Carpenter bees collect pollen and nectar from large flowers that are either flat or tubular, such as *Catalpa*, *Iris*, *Rosa*, *Salvia*, and *Campsis*.

Mason and Leaf-Cutter Bees (*Osmia and Megachile addenda*)

Nest: The females use leaves and/or mud for construction. Most nest in holes, either in wood, snail shells, or hollow twigs, and a few nest in the ground. Both bees are also known to be associated with sandy areas.

Color: Wide-variety.

Region: Widely distributed throughout the United States.

Profile: Leafcutter bees cut sections of leaves and flowers to wrap brood cells, while mason bees use mud to divide brood cells. Other genera and species may use materials such as plant hairs, resin, pebbles, and wood. An interesting characteristic of the bees of this family is that they don't carry the pollen on their back legs but on the underside of their abdomens.

The blue orchard bee is managed for the pollination of fruit trees (especially sweet cherries and almonds). Farmers provide drilled boards as nesting sites. Already the blue orchard is proving to be an excellent replacement for the beleaguered honey bee on a local level.

Preferred Plant Species:
Mason and leaf cutting bees can manipulate complex flowers. Some plants they forage on include *Mentha, Solidago, Lavendula, Penstemon, Phacelia, Potentilla, Rosa, Salvia, Helianthus, Chelone,* and *Vernonia*

Mason bee.
Photo courtesy of Sam Droege, USGS

Leaf-Cutter bee.
Photo courtesy of Sam Droege, USGS

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Sweat Bee (family Halictidae)

Nest: Ground

Color: Many are metallic green, but others have shades of color from blue to copper or gold, and sometimes even black. The sweat bee refers to a large family of bees.

Region: Throughout the United States.

Profile: The alkali bee (*Nomia melanderi*) of the Western United States prefers to build its nest in alkaline soils. It often lives in dense aggregations (up to tens or hundreds of thousands of individuals). However, it is not social so each female constructs her own burrows and tends to her own brood, but lives compatibly with and in close proximity to other alkali bees.

Some are solitary whereas others share the entrance to their nests. The common eastern sweat bee is *Dialictus zephrum*.

Preferred Plant Species: The alkali bee is a very good pollinator of alfalfa, and some growers take advantage of its nesting habits to manage this species to a limited extent. Once established, these alkali bee beds can remain active for decades.

Sweat bees also forage well on disk-shaped flowers with flat landing pads. Some of these plants include *Helianthus*, *Rudbeckia*, and *Encelia*.

Halictus ligatus.
Photo courtesy of Sam Droege, USGS

Augochloropsis metallica..
Photo courtesy of Sam Droege, USGS

Colletidae or Plasterer Bees.

Hylaeus floridanus. Photo courtesy of Sam Droege, USGS

Nest: Some genera nest in pithy stems, others nest underground.

Color: Slender bodies with mostly dark colors. They are not as hairy as other bees and can easily be mistaken for wasps.

Region: Widely distributed throughout the U.S.; more common in arid regions.

Profile: This is a small family of solitary bees that is considered more primitive than other families of bees. They use a cellophane-like material exuded from glands to line the brood cells where they lay their eggs; so sometimes they are called cellophane bees. Some of them such as the yellow-masked bees, *Hylaeus*, do not have baskets to carry pollen. Instead, these bees carry pollen inside crops.

Preferred Plant Species:
Colletidae will pollinate small flowers with lots of pollen such as *Solidago, Salix, Saxifraga*, *Achillea*, and *Ceanothus.*

Miner Bee (family Andrenidae)

Andrena nida. Photo courtesy of Sam Droege, USGS

Nest: Ground, especially on slopes.

Color: Most are completely black, while some males have yellow on their faces and a few have glints of metallic blue on their abdomens or a dark reddish color.

Region: Widely distributed throughout the United States.

Profile: There are over 500 species of these often shy, small to medium-sized bees on the mainland of the United States and all have lost the ability to sting. They can be distinguished from other bees by the subtle velvety patches (foveae) on the faces of the females, between the eyes and the base of the antennae, though these patches are often visible only under a microscope. Many are active only in the early spring. The next generation remains underground developing through the summer, fall, and winter only to emerge the next spring when their favorite flowers are in bloom.

Preferred Plant Species: Andrenids are among the earliest bees to emerge in the spring. You may observe them visiting willows, maples, violets, and other early blooming spring wildflowers. Some andrenid bees are very good pollinators of apple blossoms.

4.2 Butterflies and Moths

Lycaenid butterfly on a Potentilla flower. Photo courtesy of: David Inouye, University of Maryland

Nest: Butterflies and months do not nest. Butterflies and moths lay their eggs directly on their larval food plants. Place these species in close proximity to nectar sources for adults. To provide egg-laying habitat for local butterflies and moths, you need to become familiar with the food plants required by their larvae.

Color: Wide variety.

Region: Widely distributed throughout the United States.

Dryas iulia Julia Longwing on Pentas. Photo courtesy of Smithsonian Gardens

Profile: Butterflies are very active during the day and visit a variety of wildflowers. Butterflies are less efficient than bees at moving pollen between plants. Highly perched on their long thin legs, they do not pick up much pollen on their bodies and lack specialized structures for collecting pollen.

Butterflies probe for nectar, their flight fuel, and typically favor flat, clustered flowers that provide a landing pad and abundant rewards. Butterflies have good vision but a weak sense of smell. Unlike bees, butterflies can see red and taste with their feet.

Not all moth pollinators are nocturnal; some moths are also active by day. Some moths hover above the flowers they visit whereas others land on the flower.

Hawkmoths are impressive flyers and some have tongues longer than their bodies. These giant moths fly upwind, tracking the airborne fragrance trail to a clump of flowers. Their caterpillars, tobacco and tomato hornworms, are well known to gardeners as voracious feeders. If you want to see their colorful adults, sequester these offspring on a few plants in the corner of your garden.

Preferred Plant Species:
Butterflies are day-flying and are attracted to flowers with long, narrow tubes to accommodate their long, slender mouthparts. They favor flowers in full sun without much wind and prefer flowers that provide a good landing platform, such as Echinacea, Phlox, Salix, and Malva. Milkweed (Asclepias) is a larval food source for monarch butterflies and is essential to the monarch's survival. Active at night, moths prefer late-afternoon or nocturnal blooming flowers that are large, tubular, light-colored, heavily scented, and lack a landing platform. Moth-pollinated plant species include *Datura*, *Silene*, *Oenothera*, and *Yucca*.

4.3 Birds (Hummingbird and Honeycreeper)

Nest: Varies but typically shrubs or trees.

Color: Wide variety.

Region: Widely distributed throughout the United States.

Profile: Hummingbirds are key wildflower pollinators in the continental United States. In the eastern United States, there is only one common kind of hummingbird, the ruby-throated hummingbird. In the southwestern states, birdwatchers can find a dozen species of hummingbirds. In Hawaii, honeycreepers are important pollinators.

Hummingbirds have very good vision and are extremely attracted to red and purple. They thrust their long slender bills deep into the flowers for nectar, withdrawing with bills and heads dusted in pollen.

Although a hummingbird weighs between two and eight grams (a penny weighs 2.5 grams) they eat frequently in order to power

Broadtail Hummingbird on *Delphinium barbeyi*
Photo by David Inouye, University of Maryland.

hearts that pump 1,200 times per minute and wings that beat seventy times each second. To survive, they must eat several times their weight in nectar every day. For protein, they supplement their sugary diet with small insects.

Preferred Plant Species: Hummingbird-visited flowers include *Salvia*, *Penstemon*, *Lobelia*, and *Ipomopsis*. In Hawaii, the flowers of the native Ohia tree (*Metrosideros polymorpha*) are visited by nectarivorous honeycreepers.

4.4 Flies

Bombyliid fly visiting a *Linum lewisii* (flax) flower in Colorado.Photos courtesy of David Inouye, University of Maryland.

Nest: Fly species differ widely in where they lay their eggs. Some fly larvae are parasites on bees, others help to break down detritus. Most are terrestrial, but some are aquatic.

Color: Wide variety

Region: Widely distributed throughout the United States.

Profile: The two-winged insects (flies, gnats, mosquitos) constitute a very large group. Syrphid flies specifically visit flowers. They are not as hairy or efficient as bees in carrying pollen, but some are good pollinators. Bee flies are another important group of flower-visiting flies, but even flies that resemble house flies can be good pollinators. A few plants are also pollinated by mosquitoes.

Muscoid fly on *Pseudocymopterus*. Photo courtesy of David Inouye, University of Maryland.

Flies are attracted to flowers that are small and dull-colored without odor or green, purple, or brown with carrion-like odors. In other areas, including montane and alpine meadows, they commonly visit white or blue flowers. They tend to feed on flowers that are open with easy access to nectar and pollen. Flies primarily pollinate flowers that bloom under shade in seasonally moist habitats.

Preferred Plant Species: Plant species pollinated by flies include the American pawpaw (*Asimina triloba*), dead horse arum (*Helicodiceros muscivorus*), skunk cabbage (*Symplocarpus foetidus*), goldenrod (*Solidago* spp.), and members of the carrot family like Queen Anne's lace (*Daucus carota*). [18]

[18] Pollinator Partnership, *Selecting Plants for Pollinators*

4.5 Bats

Lesser Long-Nosed Bat.
Photo courtesy of USDA, Forest Service website.

Nest: Bats roost in caves, hollow trees, and other dark protected places.

Color: The Lesser Long-Nosed bat is yellow-brown or cinnamon gray, measuring approximately three inches. The Mexican Long-Tongued bat has a leaf-like projection at the tip of its nose. It can be distinguished by the following combined suite of features: short ears, a long, narrow rostrum, and the presence of a tail.

Region: Nectar-feeding bats exist in tropical and desert climates.

Profile: From deserts to rainforests, nectar-feeding bats are critical pollinators for a wide variety of plants. In North American deserts, giant cacti and agave depend on bats for pollination, while tropical bats pollinate incredible numbers of plants. Two species of nectar-feeding bats, the Lesser Long Nosed bat and the Mexican Long-Tongued bat, migrate north a thousand miles or more every spring from southern Mexico into Arizona, New Mexico, and Texas. Both are listed as Federal endangered species.

Bats that drink nectar from flowers pick up a dusting of pollen and move it along to other flowers as they feed. Other species of bats in the United States are not pollinators, but serve an important ecological role as predators of insects, including many pest species.

Preferred Plant Species: Bats are attracted to nocturnal bloomers, with white or pale flowers that emit a strong odor and are large and open with easy access. The flowers they visit produce pollen and nectar in large quantities. Examples include *Agave* and cactus.

Resources

The following resources provide general information on the common pollinators highlighted above:

- Bat Pollination. United States Forest Service. United States Department of Agriculture. www.fs.fed.us/wildflowers/pollinators/animals/bats.shtml
- *Bee Basics: An Introduction to Our Native Bees.* United States Department of Agriculture Forest Service & Pollinator Partnership. (2011). www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5306468.pdf
- Bee Pollination: General Information. www.fs.fed.us/wildflowers/pollinators/animals/bees.shtml
- Identifying Native Bees Poster. Pollinator Partnership. www.pollinator.org/PDFs/Identifying_Native_Bees_PosterFINAL.pdf
- Native Bee Biology. The Xerces Society for Invertebrate Conservation. www.xerces.org/pollinator-conservation/native-bees/
- Ladybird Johnson Wildflower Center, Special Collections: Value to native bees. www.wildflower.org/collections/collection.php?collection=xerces_native
- Williams, P., et al. (2014). Bumble bees of North America: An identification guide. Princeton, NJ, Princeton University Press.
- Species Profile. Lesser Long-Nosed Bat. United States Fish & Wildlife Service. ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A0AD

The link below is the homepage for multiple resources:

- General Information: Butterfly Pollination. Moth Pollination. Beetle Pollination. Bird Pollination. Fly Pollination. United States Forest Service. United States Department of Agriculture. www.fs.fed.us/wildflowers/pollinators/animals/

5 Resources

TABLE A. POLLINATOR SYNDROME TRAITS TABLE.
The chart below aligns plant traits with various pollinators. Use this table to help support a pollinator by selecting its preference for color, odor, nectar, pollen, and flower shape.

TRAIT	BATS	BEES	BIRDS	BUTTERFLIES	FLIES	MOTHS
COLOR	Dull white, green or purple	Bright white, yellow, blue, or UV	Scarlet, orange, red or white	Bright, including red and purple	Pale and dull to dark brown or purple; sometimes white; flecked with translucent patches	Pale and dull red, purple, pink or white
NECTAR GUIDES	Absent	Present	Absent	Present	Absent	Absent
ODOR	Strong musty; emitted at night	Fresh, mild, pleasant	None	Faint but fresh	Putrid	Strong sweet; emitted at night
NECTAR	Abundant; somewhat hidden	Usually present	Ample; deeply hidden	Ample; deeply hidden	Usually absent	Ample; deeply hidden
POLLEN	Ample	Limited; often sticky and scented	Modest	Limited	Modest in amount	Limited
FLOWER SHAPE	Regular; bowl shaped – closed during day	Shallow; have landing platform; tubular	Large funnel like; cups, strong perch support	Narrow tube with spur; wide landing pad	Shallow; funnel like or complex and trap-like	Regular; tubular without a lip

Source: www.fs.fed.us/wildflowers/pollinators/What_is_Pollination/syndromes.shtml

Nectar Guides. A region of low ultraviolet reflectance near the center of each petal that is invisible to humans. The nectar guide helps a bee quickly locate the flower's center.

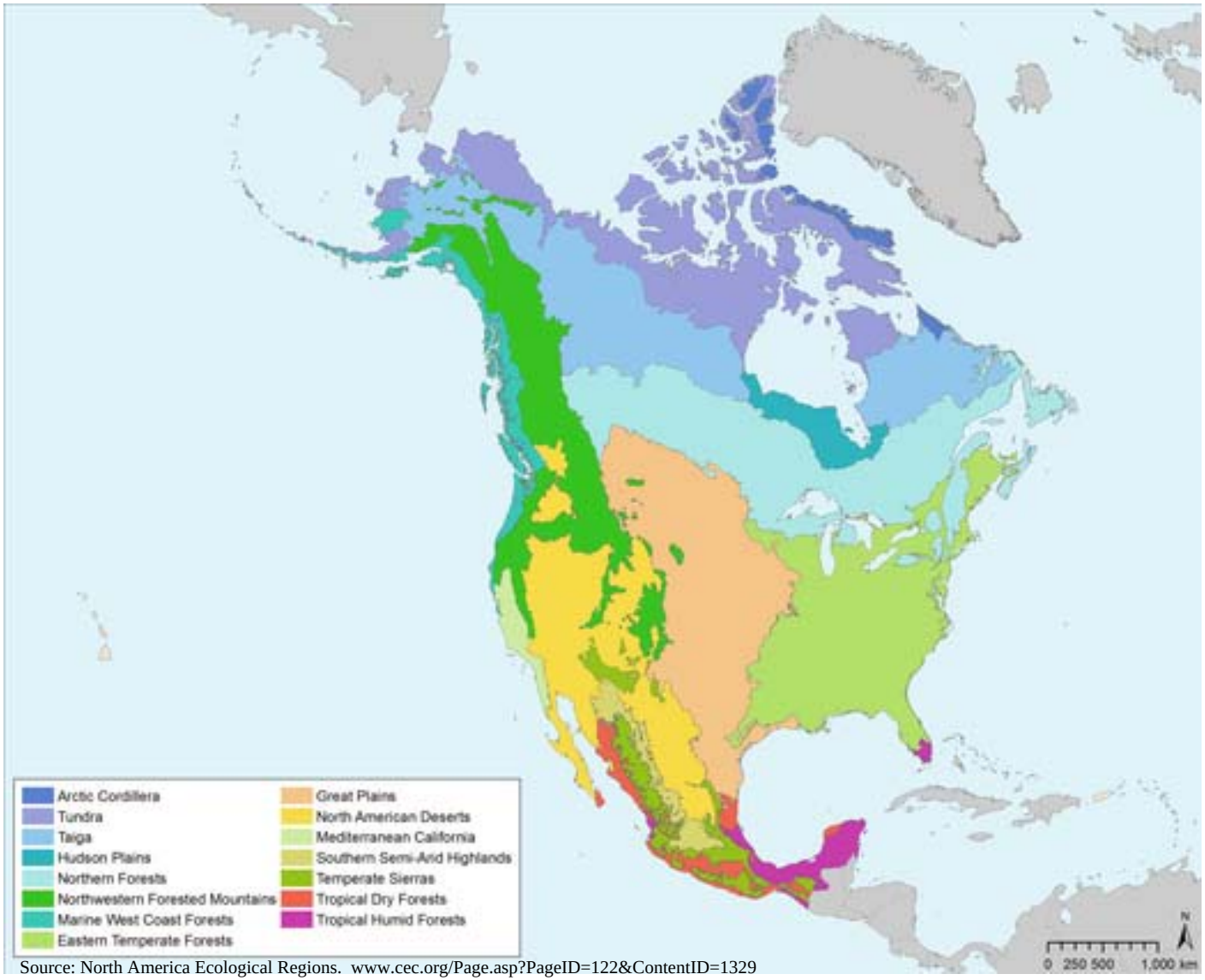
TABLE B. EXAMPLES OF GENERAL NATIVE POLLINATOR HABITAT REQUIREMENTS

The chart below illustrates habitat preferences of pollinators. Habitat needs determine whether a pollinator will choose to forage, nest, reproduce, and seek shelter at a specific site.

POLLINATOR	Food	Shelter
SOLITARY BEES	Nectar and pollen	Most nest in bare or partially vegetated, well-drained soil; can also construct domes nests of mud, plant resins, saps, or gums on the surface of rocks or trees; nest in tunnels in dead standing trees, or excavate nests within the pith of stems and twigs.
BUMBLEBEES	Nectar and pollen	Nests are most often underground but can be hollow trees or walls, or under a clump of grass.
BUTTERFLIES AND MOTHS – EGG	Non-feeding stage	Usually larval host plant
BUTTERFLIES AND MOTHS – CATERPILLAR	Leaves of larval host plants	Larval host plant
BUTTERFLIES AND MOTHS – PUPA	Non-feeding stage	Protected site such as a bush, tall grass, or a pile of leaves or sticks
BUTTERFLIES AND MOTHS – ADULT	Nectar; some males obtain nutrients, minerals, and salt from rotting fruit, tree sap, animal dung and urine, carrion, clay deposits, and mud puddle	Leaves, stems, or branches or larval host plants; also other vegetation and small woodpiles
BATS	Many species are generalists; others eat fruit, pollen, nectar, or night-flying insects	Tree branches, tree cavities, caves, mines, rock crevices, tangled hedgerow thickets, under tree bark, under structures that provide an overhang
HUMMINGBIRDS	Nectar, insects, tree sap, spiders, caterpillars, aphids, insect eggs; will often seek insects on willow catkins	Trees, shrubs, and vines

Source: plants.usda.gov/pollinators/Native_Pollinators.pdf

MAP A: The map below illustrates the Commission for Environmental Cooperation (CEC) terrestrial ecoregions. The ecoregions identify areas of general similarity in ecosystems aiding in the research, assessment, management, and monitoring of ecosystems and ecosystem components.



Source: North America Ecological Regions. www.cec.org/Page.asp?PageID=122&ContentID=1329

MAP B: The map below illustrates the monarch butterfly's spring and summer migration patterns from Mexico into North America. Plant regionally appropriate milkweed to help to support the pollinating species.

Source: USDA and U.S. Forest Service.

For further information on websites and resources:

- American Bee Journal www.americanbeejournal.com/
- American Bee Keeping Federation www.abfnet.org/
- Bee Culture Magazine www.beeculture.com/
- Bring Back the Pollinators Campaign. www.bringbackthepollinators.org
- Journey North. www.learner.org/jnorth/monarch/
- Lady Bird Johnson Wildflower Center. www.wildflower.org/plants/
- Landscape for Life. landscapeforlife.org
- Monarch Fueling Project. www.pollinator.org/monarchs.htm#fueling
- Monarchs in the Classroom (University of Minnesota) www.monarchlab.org/mitc/
- Monarch Joint Venture. www.monarchjointventure.org
- Monarch Larva Monitoring Project. www.mlmp.org
- Monarch Watch. www.monarchwatch.org
- Monarch Butterfly Fund. www.monarchbutterflyfund.org
- Pollinator Partnership. www.pollinator.org/posters.htm
- Pocket Guide to the Native Bees of New Mexico. www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/nmpmcbr10942.pdf
- Spikenard Farm Honeybee Sanctuary. spikenardfarm.org/
- The University of Hawaii Honeybee Project. www.uhbeeproject.com/
- USDA's Natural Resources Conservation Service. www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/
- US Forest Service. www.fs.fed.us/monarchbutterfly/
- US Forest Service. www.fs.fed.us/wildflowers/pollinators/index.shtml
- Wildlife Habitat Council. wildlifehc.conservationregistry.org/
- Xerces Society Pollinator Conservation Program. www.xerces.org/pollinator-conservation/