

# Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes

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## Table of Contents\_

Forward.....	3
I. Introduction .....	4
II. Applicability .....	4
III. Background .....	5
IV. Site Selection & Planning.....	6
V. Soils .....	8
VI. Water .....	11
VII. Vegetation .....	13
VIII. Materials Selection .....	15
IX. Human Health and Well-Being .....	16
X. Existing Historic Facilities and Cultural Landscapes.....	18
XI. Construction .....	20
XII. Operations and Maintenance .....	21
XIII. Additional References.....	22
Agencies Represented in Working Groups and Advisors.....	24
Advisors Representing Local and Regional Constituents.....	25
Glossary.....	26

## Forward

In late summer 2010, at the request of the Chair of the Council on Environmental Quality, the United States Botanic Garden (administered by the Office of the Architect of the Capitol), coordinated a working group to prepare recommendations for Guidance on Sustainable Practices by Federal Agencies for Designed Landscapes. The working group included representatives of the Environmental Protection Agency, the General Services Administration, the Department of the Interior, the Department of Agriculture, the National Capital Planning Commission, the Advisory Council on Historic Preservation, the Department of Homeland Security, the Department of Defense, and the Department of Veterans Affairs, and benefited from technical assistance provided by the Lady Bird Johnson Wildflower Center at the University of Texas at Austin.

The United States Botanic Garden was asked to lead the effort in part because in 2009, the Sustainable Sites Initiative or SITES™, (a partnership of the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at the University of Texas, Austin, and the United States Botanic Garden) issued a document describing best practices and performance goals for the design, construction, and maintenance of sustainable landscapes. *The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009* focuses on the area beyond the building footprint and any built landscape. A companion document, *The Case for Sustainable Landscapes*, provides economic and environmental arguments in support of sustainable landscape practices.<sup>1</sup> Knowledge gained in developing the Sustainable Sites Initiative served as background for many of the recommendations provided by the working group.

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<sup>1</sup> <http://www.sustainablesites.org/report/>.

# Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes

## I. Introduction

On October 5, 2009, President Obama signed Executive Order (E.O.) 13514, “Federal Leadership in Environmental, Energy and Economic Performance.” The E.O. states that it is “the policy of the United States that Federal agencies shall increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution;...[and] strengthen the vitality and livability of the communities in which Federal facilities are located.”

To help achieve these policy goals, this document provides guidance to improve the sustainability of Federal landscape practices. This guidance should be used by Federal agencies for landscape practices when constructing new, or rehabilitating existing, owned or leased facilities or when landscaping improvements are otherwise planned.

The Federal government controls or owns more than 41 million acres of land<sup>2</sup> and 429,000 building assets, comprising 3.34 billion square feet of space in the United States.<sup>3</sup> Consequently, landscaping practices by Federal agencies can have significant impacts on the environment. Decisions regarding the development and maintenance of Federal real property under Federal control and jurisdiction can provide an opportunity to promote the sustainable use of water and land, conserve soils and vegetation, support natural ecosystem functions, conserve materials, promote human health and well-being, and ensure accessibility for all users, including those with disabilities.<sup>4</sup>

## II. Applicability

These guidelines apply to all Federal agencies and activities that are subject to the provisions of Executive Order 13514. They do not supersede statutes, regulations or applicable agency requirements that may be more specific and/or more stringent. These guidelines apply to agencies constructing new, or rehabilitating existing owned or leased facilities or otherwise implementing landscaping practices on agency owned or leased land or space. These guidelines are intended to support improved environmental performance of a site beyond the building footprint in agency efforts to meet the goals of E.O. 13514.

Agencies should strive to balance natural resource management priorities with development needs (energy, security, infrastructure) while considering cultural, recreational, and environmental resources inherent in the landscape. These guidelines are intended to enhance, not inhibit, planning, operations and maintenance.

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<sup>2</sup> Federal Real Property Council’s FY2008 Federal Real Property Report [www.gsa.gov/graphics/ogp/FY\\_2008\\_Real\\_Property\\_Report.pdf](http://www.gsa.gov/graphics/ogp/FY_2008_Real_Property_Report.pdf)

<sup>3</sup> Federal Real Property Council’s FY2009 Federal Real Property Report [http://www.gsa.gov/graphics/ogp/FY2009\\_FRPR.pdf](http://www.gsa.gov/graphics/ogp/FY2009_FRPR.pdf)

<sup>4</sup> See Architectural Barriers Act of 1968, as amended, 42 USC 4151, et seq., and Section 504 of the Rehabilitation Act of 1973, as amended, 29 USC 794.

### III. Background

The best practices and performance goals for the design, construction, and maintenance of sustainable landscapes described in this document were drawn from Federal agency subject matter experts and from the *2009 Sustainable Sites Initiative or (SITE<sup>SM</sup>)*. The following principles served as a foundation for the recommendations in this guidance.

- **Do no harm:** Avoid changes to the site that will degrade the natural environment and promote reuse and improvement of sites with previous disturbance or development.
- **Precautionary principle:** Do not create risk to human and environmental health. Examine a full range of alternatives—including no action.
- **Design with nature and culture:** Create and implement designs that are responsive to economic, environmental, and cultural conditions at local and regional levels.
- **Use a decision-making hierarchy of preservation, conservation, and regeneration:** Maximize and mimic the benefits of ecosystem services by preserving existing environmental features, conserving resources in a sustainable manner, and regenerating lost or damaged ecosystem services.
- **Use a systems thinking approach:** Understand and value the relationships in an ecosystem and sustain ecosystem services; strive to re-establish the integral and essential relationship between regenerative systems (natural processes) and human activity.<sup>5</sup>
- **Provide regenerative systems:** Provide future generations with a sustainable environment supported by regenerative systems and resources.
- **Support a living process:** Continuously re-evaluate assumptions and adapt to demographic and environmental change.
- **Use a collaborative and ethical approach:** Encourage direct and open communication among colleagues, clients, other agencies, manufacturers, and site users to link long-term sustainability with environmental stewardship.
- **Maintain integrity in leadership and research:** Implement transparent and participatory leadership, develop research with technical rigor, and communicate new findings that foster sustainable landscapes in a clear, consistent, and timely manner.
- **Foster environmental stewardship:** In all aspects of site development and maintenance, foster an ethic of environmental stewardship with the understanding that healthy ecosystems improve the quality of life for present and future generations.

The recommendations in this document describe goals and strategies to achieve sustainable outcomes rather than specifying prescriptive solutions and technology. They are intended to inspire flexibility, innovation, and a culture change. They apply equally to new construction, major renovations, and existing sites and to a lesser extent alterations to existing small scale landscaping efforts. The recommendations accommodate regional differences and can be adapted to support diverse agency missions and policies. In addition, they assume that the user is aware of and will follow other related guidance documents such as the [\*Instructions for Implementing Sustainable Locations for Federal Facilities\*](#) and [\*Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the\*](#)

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<sup>5</sup> 1958, "Industrial Dynamics--A Major Breakthrough for Decision Makers", in: *Harvard Business Review*, Vol. 36, No. 4, pp. 37–66. Professor Jay W. Forrester Sloan School of Management, Massachusetts Institute of Technology

[Energy Independence and Security Act \(EISA\)](#) and any related instructions or guidance issued under E.O. 13514.

The recommendations are organized into nine sections based on the process of site development and guide an integrated team through the project phases. Agencies are strongly encouraged to develop and maintain a comprehensive sustainable landscape plan that encompasses the following elements.

- Site Selection and Planning
- Soils
- Water
- Vegetation
- Materials Selection
- Human Health and Well-Being
- Existing/Historic Facilities and Cultural Landscapes
- Construction
- Operations and Management

#### **IV. Site Selection & Planning**

For guidance on the siting of facilities, agencies should refer to [Instructions for Implementing Sustainable Locations for Federal Facilities](#).<sup>6</sup> The *Sustainable Locations* document includes information on how site selection can promote transit-oriented development, walkability and bikeability, and support development in existing central business districts and town centers.

The planning stage of a sustainable landscape begins with an assessment of existing site conditions, resources, and opportunities by an integrated design team with expertise in landscape design, site engineering, and sustainable construction and maintenance practices. The information gathered during this stage can be used to evaluate opportunities and to incorporate existing resources into the site design. For example, microclimate conditions may influence building orientation and existing landscape materials may be reused or recycled.

Elements of the site selection and planning stage should reflect the complexity of the proposed action and include the following recommendations.

- a. **Assess opportunities for site sustainability:** This assessment should include environmental, economic, and social equity analyses and should inform decisions on site design, construction, operations, and maintenance. The assessment should determine if the site is a designed historic landscape and identify any contributing historic elements. Moreover, opportunities should be identified to protect and improve ecosystem services and sustainable strategies to guide the design, construction, operation, and maintenance of the site.

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<sup>6</sup> *Instructions for Implementing Sustainable Locations for Federal Facilities*  
[http://www.fedcenter.gov/Announcements/index.cfm?id=19448&page\\_id=1854](http://www.fedcenter.gov/Announcements/index.cfm?id=19448&page_id=1854)

- b. **Use an integrated site development process:** A multidisciplinary team experienced in sustainable practices, historic buildings, and cultural landscapes should be included in an integrated design, planning and implementation process. The team should document the integrated site development process, develop a communications process, identify site sustainability principles and goals, create a program plan, engage stakeholders and user groups, develop and manage construction oversight strategies, and create a landscaping maintenance and monitoring plan. In addition, the team should conduct an assessment of cultural, historic, and archaeological resources and options for sustainable outcomes that minimize adverse effects to those resources.
- c. **Engage users and other stakeholders in the site design:** Stakeholders include site users, affected government agencies at the Federal, state, and local levels, and members of the affected community. Stakeholders should be engaged during the site design process to identify their needs and concerns, and local knowledge from the community should be utilized. Supplemental outreach and engagement may be required under the National Environmental Policy Act (NEPA),<sup>7</sup> Section 106 of the National Historic Preservation Act (NHPA)<sup>8</sup> and *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*.<sup>9</sup>
- d. **Avoid development of prime farmland:** Protect soils designated by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) as prime farmland, unique farmland, or farmland of statewide importance.<sup>10</sup> Additional information on the preservation of agricultural land is available in Section III, Soils, of the *Sustainable Sites Initiative Guidelines and Performance Benchmarks 2009*.
- e. **Preserve areas with permeable soils** (Hydrologic Soil Group Class A and B, as defined by the National Cooperative Soil Survey) to the extent possible, for use in storm water infiltration and groundwater recharge.
- f. **Protect floodplain functions:** Protect floodplain functions of the site by avoiding or limiting development within the 100-year floodplain.<sup>11</sup>
- g. **Protect and conserve existing landscapes, forest and wilderness areas:** In urban settings, use existing buildings and building sites, and introduce trees and other vegetation on available lands. In rural and suburban settings, conserve forest and wilderness areas, and re-forest on available lands.
- h. **Preserve wetlands:** Coordinate with the Army Corps of Engineers to ensure all activities that impact wetlands are in compliance with Clean Water Act requirements. Avoid development of areas that contain wetlands, including isolated wetlands.<sup>12</sup> Enhance degraded wetlands to compensate for any wetland or other natural values lost as part of site development.
- i. **Preserve or restore continuous riparian buffer widths:** When feasible and appropriate, preserve or restore continuous riparian buffer widths for natural drainages including ephemeral and first order streams. When feasible and appropriate, use the most stringent recommended buffer width for the applicable stream order and ecoregion.

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<sup>7</sup> National Environmental Policy Act (NEPA): 42 U.S.C. § 4321 et seq. <http://ceq.hss.doe.gov/nepa/regs/nepa/nepaeqia.htm>

<sup>8</sup> National Historic Preservation Act under Section 106 <http://www.nps.gov/history/local-law/nhpa1966.htm>

<sup>9</sup> National Historic Preservation Act (NHPA): 16 U.S.C. § 470 et seq., and Section 106: 36 C.F.R. Part 800

<sup>10</sup> Also see the Farmland Protection Act: [http://www.nrcs.usda.gov/programs/fppa/pdf\\_files/FPPA\\_Law.pdf](http://www.nrcs.usda.gov/programs/fppa/pdf_files/FPPA_Law.pdf)

<sup>11</sup> Also see Executive Order 11988 <http://water.epa.gov/lawsregs/guidance/wetlands/eo11988.cfm>

<sup>12</sup> Also see Executive Order 11990: <http://water.epa.gov/lawsregs/guidance/wetlands/eo11990.cfm>

Recommended buffer widths for water quality generally range from 50 feet to 175 feet, although smaller buffer widths may be applied to lower order streams. Riparian buffer widths of 300 feet or more have been recommended to maintain wildlife corridors along streams and rivers.

- j. **Minimize site disturbance:** Minimize the need to grade the site by concentrating development in areas with minimal non-engineered slopes and existing infrastructure and mitigate any construction disturbance. Avoid mass grading in favor of disturbing areas only as they are worked and stabilized before grading the next area.
- k. **Preserve historic properties, including landscapes and archaeological sites:** Protect properties and landscapes listed on, or eligible for, the National Register of Historic Places. Additional information on this type of development can be found in Section VIII of this document or in *Sustainable Strategies for Existing and Historic Facilities*.<sup>13</sup> Where culturally significant buildings and landscapes exist, consider reuse of the buildings to minimize new materials use, waste, and negative effects on the landscape that can occur through construction, such as compaction and vegetation removal. Where possible, designate protection zones for areas containing archaeological sites and contributing features. Where adverse effects are unavoidable, minimize or mitigate those effects as required by law in the National Historic Preservation Act under Section 106.
- l. **Preserve threatened or endangered species and their habitats:** Avoid development of areas containing habitat for threatened or endangered plant and animal species.<sup>14</sup>
- m. **Improve linkages and connections to surrounding destinations and neighborhoods:** New development should connect to existing open space corridors, sidewalks, transit, bike lanes, trails, and street networks. It should also incorporate urban design features and elements from surrounding neighborhoods (streetscaping, wayfinding, etc) to ensure new development compliments existing community characteristics.
- n. **Develop a network of complete streets:** Where a project involves the development of a street network, the street design should support multiple modes of transportation in addition to ecosystem services.<sup>15</sup> Streets should be designed to promote and facilitate safe pedestrian and bicycle activity.
- o. **Incorporate security design opportunities:** Thoughtful use and design of setback space can provide an opportunity to activate underutilized space, while increasing the safety of employees and integrating the building with the local community. Setback space can be used to enhance employee and community morale by preserving or enhancing open space, creating outdoor spaces for social interaction such as pedestrian plazas, gardens or amenity areas for employees and visitors. Permanent landscape security features such as tables, benches, seating walls, planters, and changes in topography may be incorporated instead of bollards or fences.

## V. Soils

Soils are complex, dynamic, living systems with both biological and non-biological components. Soil provides a physical anchor for plants; a medium for water retention, infiltration, and

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<sup>13</sup> National Historic Preservation Act: <http://www.achp.gov/docs/nhpa%202008-final.pdf>; and Section 106 Regulations: <http://www.achp.gov/regs-rev04.pdf>

<sup>14</sup> Endangered Species Act: 16 U.S.C. § 1531-1544: <http://water.epa.gov/lawsregs/guidance/wetlands/eo11990.cfm>

<sup>15</sup> For additional information on the concept of complete streets, see: <http://www.completestreets.org>



availability; a site for exchange and retention of air, water and soluble nutrients; and a host for mycorrhizal association that aids water and nutrient uptake and the breakdown of plant organic matter.

Ecosystem services and environmental values associated with the soil ecosystem include water infiltration, water filtration, carbon sequestration, optimization of the vegetative biomass, and significant reductions in the use of potable irrigation water, fertilizers, and pesticides. Adverse influences such as compaction, chemical contamination, excessive slopes, and reduced organic matter and biological activity can negatively affect physical and biological conditions and thereby inhibit healthy soil processes. Where feasible, landscape practices should conserve, restore, and manage these essential processes and reflect the elements addressed below.

### Soil Conservation

Existing native soils are highly valued and should be conserved. Soil physical integrity and chemical viability should be maintained over the long-term. Beyond being critical reservoirs of biological soil communities, pristine soil is usually the host for high-quality plant communities. Agencies should consider the following site design principles to address conservation of soil resources.

- a. **Identify and protect Vegetation and Soil Protection Zones (VSPZs):** As feasible, healthy soil should be conserved by mapping soils on site, performing tests of disturbed soils and reference soils,<sup>16</sup> conserving the healthiest soils in topsoil salvage areas, and limiting work to appropriate sites for building construction. During construction, VSPZs should be protected with a fence or physical barrier that cannot be easily moved. Agencies should educate construction personnel regarding required protective measures and construction documents and specifications should explicitly state the consequences to construction personnel/contractors if boundaries are not respected and/or damage occurs. A VSPZ can encompass one plant or include groups of plants. To ensure adequate protection, boundaries for trees should extend out from the trunk, to a distance of two-foot radius (measured at ground level) per inch of diameter at breast height (DBH) or the full lateral extent of the actual root system.
- b. **Prevent Soil Compaction:** VSPZs should be considered as a method to avoid soil compaction during construction and maintenance. In addition, construction planning should be designed to preclude parking of all heavy equipment, vehicles, and materials storage within the footprint of the site to the extent possible.
- c. **Prevent/Mitigate Soil Erosion:** An erosion control plan should be implemented during construction so as to prevent damage or loss of critical soils during and after site construction. Where excessive slopes cannot be avoided, special provisions should be used to limit and mitigate soil losses.

### Soil Management

The easiest method to ensure future soil health and integrity is the creation and implementation of a management plan that 1) identifies areas of highest soil quality and permeability, 2) limits damage to those soils, 3) protects salvaged topsoil, and 4) facilitates restoration of desired

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<sup>16</sup> U.S. Department of Agriculture Natural Resources Conservation Service <http://websoilsurvey.nrcs.usda.gov>

conditions for damaged soils. Agencies should consider the following site design principles to address management of soil resources.

- a. **Create a soil management plan:** A soil management plan protects on-site soil from contamination and compaction and establishes soil management and conservation priorities. It consists of a site plan including a soils map and grading plan, and indicates designated soil conservation areas. The soils management plan should be communicated to all construction contractors prior to construction in order to limit disturbance, assist soil restoration efforts, and define VSPZ locations and boundaries. Actions/techniques required for soil restoration should be included in site drawings and written into contract specifications.
- b. **Minimize soil disturbance in design and construction:** Identify and protect areas designated as VSPZs and other off-limit areas to construction and enforce construction limits with fences and on-site monitoring.
- c. **Salvage healthy top soil:** The term topsoil refers to the uppermost soil horizon and includes decayed organic and other materials capable of supporting vegetation. In order to conserve topsoil from site construction and excavation areas, topsoil should be completely removed prior to all construction. All topsoil removal should be done at the same time if possible to minimize compaction. In small areas where topsoil cannot be removed mechanically, removal should be performed manually. Topsoil containing hard soil, or large rock should be considered unsuitable and should be buried as fill. Topsoil should not be mixed with subsoil.
- d. **Topsoil contaminated with toxic substances:** Identify any contaminated soils prior to excavation through a Phase I or Phase II type of environmental assessment. Topsoil contaminated with toxic substances should be segregated from non-contaminated soils at all times. If regulated levels of toxic substances are present, determine if a regulatory response is required and if an assessment is warranted to identify the source and extent of the contamination. Remediation of contaminated soils may be required prior to or concurrent with site development.
- e. **Restore soils disturbed during construction and/or previous development:** Restoration techniques that improve disturbed soil conditions include amendment with organic matter (e.g., compost), reduction of compaction (by aerating, tilling or ripping) and restoration of nutrient profile. These techniques will positively affect infiltration rates, soil biology, and soil chemistry.<sup>17</sup> Prior to construction, restoration goals should be established by using a reference site and soil testing should be completed for nutrient and textural characteristics. Techniques that preserve the functional and biological characteristics of the soil including soil salvage, soil amendment, and replacement topsoil should be considered as well as actions and techniques required for soil restoration in construction specifications.
- f. **Amend topsoil or provide topsoil as needed:** Compost is the best source of organic matter, because of its stability, biological activity, and soil structure building qualities. Organic compost materials should be selected from sustainable and renewable sources to amend topsoil on-site. A qualified horticultural or soil professional should be considered when selecting and balancing amendments for healthy plant growth. Quality guidelines for compost are a carbon-to-nitrogen ratio below 25:1, pollutant concentration limits

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<sup>17</sup> For additional information see SITES prerequisite 7.2

below U.S. EPA<sup>18</sup> or applicable local regulations, and no viable weed seeds or invasive plant propagules.

- g. **Prepare areas for topsoil placement:** When preparing areas for topsoil placement, the area should be clear of construction debris. If severe compaction exists, where aerating or tilling the soil is not possible, then 6-18 inches of compacted soil should be removed. Soil composition, percolation testing, auguring, and other soil indicators will help determine the need for tilling or ripping.
- h. **Salvage on-site soil:** Site design should include plans for on-site soil salvage prior to construction. Wherever possible, balance cut and fill, and reuse existing soils in design instead of importing new materials to the site. Always protect stockpiled soils during construction by either covering over or seeding stockpiles to prevent erosion.

## VI. Water

Conserving and protecting water resources through water efficiency, reuse, and stormwater management are vital to the goals of sustainable landscape practices. Integrating facility design with landscape design can conserve water, reuse properly treated wastewater and greywater (in accordance with local codes and regulations), harvest and use rainwater and snowmelt, reduce energy use, and protect and restore surface and ground water resources. Agencies should consider the following site design principles to address protection and conservation of water resources.

- Reduce or eliminate use of potable water for landscape irrigation and water features.
- Manage stormwater on-site to the extent practicable while protecting ground and surface receiving waters and ecosystems.
- Design water features to use harvested runoff or snowmelt and avoid use of potable water.
- Design structures with dual plumbing and backflow protection to allow for the use of harvested rainwater, greywater, or reclaimed wastewater for non-potable water use (e.g., toilet flushing).
- Protect and enhance on-site water resources such as streams, lakes, and wetlands.
- Protect riparian and shoreline buffers.
- Rehabilitate on-site aquatic resources to restore ecosystem functions.
- Where feasible, use drip irrigation and soil amendments to conserve water.
- Choose plant species which are native to the area and therefore likely to require less irrigation water.

### Water Resource Goals

- a. **Reduce, with aim to eliminate, the use of potable water, natural surface water (such as lakes, rivers, and streams), and groundwater withdrawals for landscape irrigation:** Agencies should set significant goals for reduction of water use and take measures to ensure they are using amounts of supplemental irrigation appropriate to the facility's local climate. To ensure the designed landscape's water requirement meets a

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<sup>18</sup> US EPA 40 CFR Part 503 Biosolids Rule, section 503.13 table 3 "Pollutant Concentrations" [water.epa.gov/scitech/wastetech/biosolids/503pe\\_index.cfm](https://www.water.epa.gov/scitech/wastetech/biosolids/503pe_index.cfm)

basic measure of water efficiency, use the U.S. EPA's WaterSense Water Budget Tool.<sup>19</sup> Although generally employed for residential landscapes, the EPA's WaterSense Water Budget Tool can be used as a guide for these purposes.

- b. **Manage stormwater on-site:** Strive to replicate the hydrologic condition of the undeveloped site using historic data and undeveloped ecosystems within the region. The design process should consider all components of the hydrologic cycle (evapotranspiration, runoff, and infiltration), minimize impervious cover, and maximize use of soil- and vegetation-based methods.<sup>20</sup>
- c. **Design rainwater/stormwater features to provide a landscape amenity:** The design, construction and location of rainwater/stormwater management features should consider amenities so they are visible and/or accessible from high-use portions of the site to maximize interaction, educational and human health and well-being opportunities. Where appropriate, use rainwater capture features that allow future use of the water for irrigation.
- d. **Maintain water features to conserve water and other resources:** Design and maintain water features created in the landscape with minimal or no make-up water from potable sources or other natural surface or subsurface water resources. Design systems to use gravity for water movement and recirculation where possible. Consider use of cisterns to capture roof runoff as a source for irrigation and water features.
- e. **Protect and enhance on-site water resources and receiving water quality:** Implement Low-Impact Development (LID) technologies, and to treat discharge from developed areas using soil and vegetative systems as a watershed pollution prevention strategy, such as silt and pollution barriers. When necessary, provide appropriate stormwater treatment for common stormwater pollutants. For best practices, see EPA's LID website <http://www.epa.gov/owow/NPS/lid/>.
- f. **Protect and restore riparian, wetland, and shoreline buffers:** Existing riparian, wetland, or shoreline buffers should be preserved or disturbed buffer areas should be restored in order to improve flood control, water quality, stabilize soils, control erosion, and provide wildlife corridors and habitat.<sup>21</sup> Where practical, buffer widths of 300 feet or greater should be established with intent to provide protection of wildlife migration corridors and habitat for threatened, endangered, and sensitive species.
- g. **Rehabilitate streams, wetlands, and shorelines:** Rehabilitate lost or degraded stream channels and shorelines to stable geomorphological conditions. Where practicable, rehabilitate native plant communities, aquatic habitat, floodplain connections, and existing degraded wetlands.

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<sup>19</sup> EPA's WaterSense is a partnership program that seeks to protect the future of the nation's water supply by promoting water efficiency and enhancing water-efficient products, programs, and practices. WaterSense helps consumers identify water-efficient products and programs that meet efficiency and performance criteria. WaterSense also partners with irrigation professionals and irrigation certification programs to promote water-efficient landscape irrigation practices. [www.epa.gov/WaterSense/about\\_us/index.html](http://www.epa.gov/WaterSense/about_us/index.html)

<sup>20</sup> For additional information about managing stormwater on-site, please see the Section X, Additional References and [Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act \(EISA\)](#) as well as any subsequent related instructions or guidance issued under E.O. 13514.

<sup>21</sup> Buffer widths can be based on literature review of current sources from local, state, and federal agencies, as well as resources from the Center for Watershed Protection, [www.cwp.org/](http://www.cwp.org/)

## VII. Vegetation

Appropriate vegetation provides ecosystem services such as pollutant interception and water management as well as habitat for desirable pollinator species. Plants that are adapted to regional conditions and climate, and that meet design intent ultimately require fewer resources and less maintenance. The use of native and appropriate non-native plants can enhance biodiversity, reduce pesticide use, conserve water, and reduce energy costs. Vegetation can have a positive impact on response to local climate stress, such as providing heat energy savings when used as windbreak and cooling benefits through shading and evapotranspiration and mitigating the effects of urban heat islands. In addition, native plants can provide habitats for wildlife that support recreational and ecotourism activities, such as fishing and birdwatching, and opportunities for environmental education. Native and appropriate non-native plants also support important pollinator species that are necessary for plant reproduction, including cultivation of crops. Up to 80% of the world's food plant species are dependent on pollination by animals. A healthy vegetation cover will also inhibit the establishment of invasive plants. Invasive species compete with and harm plant and animal communities. Approximately 5,000 plant species (approximately 60% from horticulture) have escaped into natural ecosystems, resulting in billions of dollars in damage, loss of productivity and control costs.

Correct management of plants and plant products reduces risks to local ecosystems, property, and human life. In wildfire prone areas for example, designing a defensible space around structures protects facilities from damage by reducing flame heights and making fires easier to extinguish.

When addressing vegetation issues as part of sustainable landscape practices agencies should consider the following actions.

- a. **Preserve existing native vegetation:** especially mature trees, to the extent possible. The functions of mature trees are difficult to replace with new plantings that will not reach maturity for several years.
- b. **Use appropriate, non-invasive plants<sup>22</sup>:** Plants that are non-invasive and appropriate for local site conditions, climate, and design intent should be used to improve landscape performance and reduce resource use. Plants/seeds that are appropriate for site conditions, climate, and design intent and are nursery grown, legally harvested, or salvaged for reuse should be used.
- c. **Prevent, detect, control, and manage invasive plants:** As feasible, identify and remove all invasive species on-site and develop and implement an active management plan to prevent new introductions. Develop a comprehensive invasive plant management plan (either as a separate plan or as part of a larger natural resources or operations management plan) that addresses early detection, removal, prevention, and long-term management. This plan should also incorporate Integrated Pest Management Plan (IPM) practices and guidelines including treatments, long-term control (including monitoring), and best management practices for disposal of invasive plant materials to prevent spread. Invasive and/or non-invasive plants may be a character-defining part of

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<sup>22</sup> Executive Order 13112 requires each Federal agency to the extent practicable and permitted by law to identify such actions and not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species.

a historic landscape or planting. If invasive non-native plants are to be maintained for historic reasons, they should be actively managed so that they do not spread or cause harm to the region.

- d. **Maintain existing historic landscapes and plantings:** Existing plantings and landscapes should be maintained if they are historic in their existing form and/or protect historic properties, extend the life cycle of existing stock, conserve resources, or reduce waste. In some cases invasive plants may have cultural or historic value and are appropriate to be used in a new design, but should be actively managed to prevent spread. During construction protect using VSPZ methods.
- e. **Use native plants:** Where practicable, use vegetation native to the ecoregion.
- f. **Protect and preserve all vegetation designated as special status:** Identify, protect, and preserve all vegetation designated as special status by local, state, or Federal entities, including historic designation and protect using VSPZ methods.<sup>23</sup>
- g. **Conserve plant communities native to the ecoregion:** Plant communities native to the ecoregion of the site that contribute to regional diversity of flora and provide habitat for native wildlife should be conserved. As feasible, the area containing native plant communities within VSPZ should be protected and habitat corridors connecting to off-site natural areas or buffers adjacent to off-site natural areas for migrating wildlife should also be protected.
- h. **Restore plant communities native to the ecoregion:** As feasible, restoration of the vegetated area should be pursued. Restoration of plants and plant communities native to the ecoregion of the site contributes to regional diversity of flora and provides habitat for native wildlife.
- i. **Use vegetation to minimize building heating and cooling requirements:** Vegetation and/or vegetated structures should be placed in strategic locations to shade buildings during the cooling season, thereby reducing energy consumption associated with indoor climate control. Windbreaks for buildings should be established to effectively block wind, but also not result in winter shading. Staggered rows of trees and dense shrubs that extend for the full length of the building's walls facing the prevailing winter wind should be considered. Strategically placed vegetation can lower energy use associated with indoor climate control. Deciduous vegetation or vegetated structures can shade surface areas of the west, southwest, southeast, and east walls and the roof area during summer months.
- j. **Use trees and other vegetation to offset emissions of greenhouse gases from operations:** Trees and other vegetation should be planted to promote long-term storage of carbon.
- k. **Reduce urban heat island effects:** Use vegetation to reduce heat island effect, minimizing effects on microclimate. Design options in addition to vegetative shade include covering structures with solar photovoltaic panels, installing vegetated roofs and/or surfaces with a solar reflectance index (SRI) of at least 29, using paving materials with an SRI of at least 29, and using an open-grid pavement system (e.g. concrete-grass lattice).

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<sup>23</sup> For more information on Vegetation and Soil Protection Zones (VSPZ) see glossary and the *Sustainable Sites Initiative Guidelines and Performance Benchmarks 2009* Credit 4.3



- l. **Reuse salvaged materials and plants:** Salvaged materials and appropriate plants (where feasible) should be reused to conserve resources. Recycle useful materials to divert waste from landfills.
- m. **Support sustainable practices in plant production:** Where practicable, plants and materials should be purchased from businesses and providers that reduce resource consumption and waste and employ sustainable practices including, but not limited to, use of sustainable soil amendments, reduced irrigation runoff, reduced greenhouse gas emissions, reduced energy consumption, use of Integrated Pest Management (IPM) practices, reduced water consumption, reduced waste, and recycling of all organic matter.
- n. **Use regional materials:** When acquiring and using materials, plants, soils, select those that are grown or produced locally or within the geographic region of the project in order to reduce energy use for transportation and increase demand for local goods. Source materials, plants, and soils within distances specified (soils – 50 miles, aggregate – 50 miles, plants – 250 miles, all other materials – 500 miles) should be considered.
- o. **Reduce the risk of catastrophic wildfire:** To reduce the risk of catastrophic wildfire both on-site and in adjacent landscapes, the management of potential fuels should be considered in the design, building, and maintenance of site landscaping. Design, build, and maintain sites to manage fuels to reduce the risk of catastrophic wildfire both on site and in adjacent landscapes. Although used for residential landscapes, the Firewise™<sup>24</sup> Guide to Landscape and Construction can be used as a guide for these purposes.
- p. **Use vegetation to promote community/employee morale and well-being activities:** Rooftop gardens, community gardens, and vertical gardens inside or outside of buildings, adjacent or connecting to the landscape should be considered in order to promote educational programs, food access, and gardening activities for morale and community engagement.
- q. **Allow space for proper growth:** When placement of landscaping is determined, allow for full mature growth of the species to permit the natural beauty of the plant and diminish the possibility of disease.

## VIII. Materials Selection

*Sustainable materials management*<sup>25</sup> promotes the use of material resources in a manner that protects economic growth, environmental quality, and social development throughout the life-cycle of the product. This means ensuring materials are sourced and managed sustainably and used efficiently throughout their life-cycle, including considering wastes as potential resources that can be used as inputs for new products. Sustainable materials management helps reduce the negative environmental impacts associated with the production, consumption, and end-of-life management of material resources.

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<sup>24</sup> [Firewise Guide to Landscape and Construction](#)

<sup>25</sup> [www.epa.gov/osw/inforesources/pubs/vision2.pdf](http://www.epa.gov/osw/inforesources/pubs/vision2.pdf)

While the following recommendations aim to increase the use and management of sustainable materials, Federal agencies must work within Federal and agency procurement specifications, criteria and regulations (see <http://www.fedcenter.gov/programs/buygreen/>). When addressing materials management issues as part of sustainable landscape practices agencies should consider the following actions.

- a. **Reuse salvaged materials:** Where feasible, a minimum of 20% of all materials (including plants) used on-site for landscaping should be salvaged materials. Check within your own facility, installation, or agency for materials that may already be available and/or excess. For modernization or renovation projects, it may be feasible to reuse many of the existing materials on-site for landscaping, which reduces the project cost by cutting down on the amount of waste being trucked off-site. Contact the General Services Administration (GSA) or the Defense Reutilization and Marketing Service (DRMS)<sup>26</sup> to determine if excess Federal materials are available for transfer or purchase.
- b. **Use regional materials:** Where feasible, materials, plants, and soils should be sourced within the distances specified in the following list. Soils – 50 miles, aggregate – 50 miles, plants – 250 miles, all other materials – 500 miles.
- c. **Use sustainably harvested, certified wood:** Do not use wood species listed as threatened or endangered by the Convention on International Trade in Endangered Species (CITES)<sup>27</sup> and the International Union for Conservation of Nature (IUCN).<sup>28</sup> Use wood that is harvested in a sustainable manner.
- d. **Maintain existing structures:** Where feasible, maintain or reuse in their existing form existing structures, hardscapes, and landscape amenities on-site.
- e. **Design for deconstruction:** Design material assemblies, products, and/or product components used for construction to facilitate reuse and deconstruction.
- f. **Use recycled content materials:** The Comprehensive Procurement Guideline (CPG)<sup>29</sup> requires Federal agencies to buy products containing recovered materials. For non-CPG designated items, materials with recycled content should be used. While compost and fertilizer made from recovered organic materials are included in this element, plants and soils are not.
- g. **Develop and implement a materials waste management plan:**<sup>30</sup> Encourage the salvage and recycling of all construction, demolition, land clearing, and operational waste. For example, existing vegetation that is removed from a site can be mulched and added back as a soil amendment.

## IX. Human Health and Well-Being

In addition to environmental functions, sustainable landscapes provide restorative value and health benefits to the user. Outdoor physical activity contributes to overall health and can help people control obesity and associated chronic diseases such as diabetes, cardiovascular issues,

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<sup>26</sup> For more information on the Defense Reutilization and Marketing Service program, see [www.drms.dla.mil/](http://www.drms.dla.mil/)

<sup>27</sup> Convention on International Trade in Endangered Species (CITES) [www.cites.org](http://www.cites.org)

<sup>28</sup> International Union for Conservation of Nature (IUCN) [www.iucn.org](http://www.iucn.org)

<sup>29</sup> [www.epa.gov/epawaste/conservation/cpg/index.htm](http://www.epa.gov/epawaste/conservation/cpg/index.htm)

<sup>30</sup> [www.epa.gov/wastes/nonhaz/municipal/pubs/ghg/f02026.pdf](http://www.epa.gov/wastes/nonhaz/municipal/pubs/ghg/f02026.pdf)



and high blood pressure. Outdoor spaces that encourage social interaction can promote social connection among site users, which is important for human health, while providing quiet outdoor spaces for site users to enjoy. Moreover, such features can enhance employee morale and retention.

Incorporating natural systems and garden settings should be a goal for integrated site design. Single sites in a built setting can serve both social and environmental functions. Knowledge about the microclimates of a space (where and when the sun hits, amount of rainfall, the natural water levels, soil types, wind, and exposure to sound and light pollution) can be used to achieve ecological design goals, enhance human comfort, and provide a restorative setting. For instance, rain gardens for stormwater management can be designed to create a social space, or a roof garden can serve as a break room. Other human health considerations should include access to transit and affordable housing as well as promotion of the ability to walk and bike to and around the site.

When addressing human health issues as part of sustainable landscape practices agencies should consider the following actions.

- a. **Promote equitable site development and use:** Where appropriate, agencies should engage with the local communities and stakeholders (e.g., residents, users, agency employees) to identify and develop options for sharing economic and social benefits of the site's landscape development. Select options that allow development of the site to benefit a wide range of users, beyond the primary user groups.
- b. **Enhance community development:** Quality landscape design that enables positive effects for local residents can promote the long-term economic stability of local families and businesses. Providing community accessibility and on-site facilities that address the needs of local residents is recommended when feasible (e.g., farmer's markets, community gardens). The development of a community benefits agreement for post-construction site use can be a helpful way to engage with the local community. Community events should not interfere with agency mission or public safety or lead to damage of the landscape. Rooftop gardens, community gardens, and vertical gardens inside or outside of buildings, adjacent or connecting to the landscape should be considered in order to promote educational programs, food access, and gardening activities for morale and community engagement.
- c. **Review parking and design:** Where feasible, locate parking areas in underground parking structures in order to reduce impervious surface stormwater runoff. Moreover, underground parking provides opportunities for green space, gardens, park space, or a facility on top of the structure, providing good urban design and efficient use of the land and built environment. Alternative parking structures, such as above grade parking garages should blend aesthetically with the built environment and as feasible, incorporate green roofs and/or solar panels. If surface parking must be built, trees and grass or other types of vegetation and sustainable materials should be incorporated to mitigate impervious surface stormwater runoff.
- d. **Promote sustainability education:** Consider developing interpretation programs and activities to educate site users and the public about the sustainability of the landscaping and site. Programs could include talks, demonstrations, web sites, on-site descriptive

signage etc. Consider partnerships to extend sustainability education to local community groups or schools.

- e. **Increase user ability to understand and safely access outdoor spaces:** Optimum site accessibility, safety, and wayfinding should be provided for all users, including those with disabilities, without compromising sensitive site features such as wetlands, archaeological sites, or heritage trees. Wayfinding should be implemented to create an environment that makes it easy and intuitive for all users to orient themselves and navigate from place to place. Where feasible, incorporate accessibility into site selection, planning, design, and development so that all elements and features, including paths, trails, facilities, and signage, are equally usable by people with physical, sensory, cognitive, or developmental disabilities.
- f. **Encourage outdoor activities:** On-site amenities such as community gardens, bike trails, playgrounds, and workout stations should be provided to encourage outdoor activities. Appropriate support services, such as drinking fountains, emergency call boxes, and safety lighting should also be included. To the extent possible, on-site systems, such as trails and paths, should be connected to local and regional systems and access to parks and open space within 0.25 mile.
- g. **Create quiet outdoor spaces for relaxation and restoration, small group interaction, and views:** Creating visual and physical connections to the outdoors optimizes the well-being of site users. Plantings that use rich species diversity should be utilized in the landscape design. Where possible, seating areas with unique or beautiful views and minimal noise should be provided, while taking into consideration an understanding of the microclimate and other site-specific conditions (e.g., sun, shade, wind, etc.). In addition, outdoor gathering spaces should accommodate groups for the purpose of education, building community and improving social ties.
- h. **Reduce light pollution:** “Light trespass” from landscaping on Federal sites should be minimized to reduce sky-glow, increase nighttime visibility, minimize negative effects on nocturnal animals, and improve human health and functioning. Site lighting criteria should be formulated to minimize energy use and to avoid off-site lighting and sky pollution, while maintaining safe light levels. The direction and spread of light can be controlled by choosing appropriate light fixtures.
- i. **Create a safe environment:** Gardens and landscaping located around the perimeter of a Federal facility can double as a security measure to help protect workers and visitors inside the building. Incorporate permanent hardscape features such as benches and raised planters to help deter unwanted access to the building. Agencies should consider principles and strategies developed from Crime Prevention Through Environmental Design (CPTED).<sup>31</sup>

## X. Existing Historic Facilities and Cultural Landscapes

When working with historic or cultural landscapes it is critical to understand the characteristics that make the site historic or give it cultural significance.<sup>32</sup> Changes to the characteristics and features of the site should only occur after careful consideration of whether the change will affect

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<sup>31</sup> Crime Prevention Through Environmental Design (CPTED). <http://www.cpted.net/>

<sup>32</sup> For an overview of working with historic and cultural landscapes, see *Preservation Briefs 36 - Protecting Cultural Landscapes: Planning, Treatment and Management of Historic Landscapes*, National Park Service, 1994 [www.nps.gov/history/hps/tps/briefs/brief36.htm](http://www.nps.gov/history/hps/tps/briefs/brief36.htm).

the site's cultural and historic integrity. This may require a Cultural Landscape Report (CLR)<sup>33</sup> with analysis of characteristics such as spatial organization, vegetation, circulation, water features, structures, site furnishings, and objects.<sup>34</sup> CLR direction on site significance and treatment will inform all aspects of management, operations, and maintenance. For example, a CLR will include a list of features that are historically significant and denote which landscape features are not contributing to the historic significance. Where appropriate, a landscape architect specializing in historic preservation should be consulted in order to assist in meeting sustainability goals while protecting the integrity of the cultural landscape. For more information on landscape preservation, see the *Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*.<sup>35</sup> When evaluating existing and historic facilities as part of sustainable landscape practices, agencies should consider the following recommendations.

## Water

For cultural landscapes, it is important to reduce water usage by focusing irrigation on significant vegetation features, using native plants for replacement plantings as necessary and appropriate, and upgrading irrigation systems. When preserving or restoring riparian, wetland, and shoreline buffers, it is necessary to work with preservation specialists to determine whether and how this goal can be implemented without adversely affecting site integrity. Water features should be maintained in cultural landscapes using sustainable non-potable water forces for required make-up water.

## Vegetation

In the cultural or historic setting, plants often provide a historic connection indicating a sense of place or regional identity. Maintaining cultural integrity through cultural landscapes, including historic properties, is an important consideration when designing sustainable landscapes. While the recommendations included in the Vegetation section are generally applicable, additional recommendations are required when dealing with a cultural landscape. Plant materials in cultural landscapes and designed historic sites may be non-native, naturalized and in some cases managed invasive species. Plants that are character-defining features of a cultural landscape should be preserved. On tribal lands, special consideration should be given to culturally significant species. When replacement of character-defining vegetation is necessary, a historical landscape architect should be involved in order to determine whether a change to native species is appropriate. Additionally, potential changes should be communicated to the public to allow for stakeholder input. Any existing plants and plantings that have been determined to have special status should be maintained, such as state champion trees, rare species (i.e. American chestnut), threatened and endangered species, trees with other special status or especially desirable characteristics (e.g., National Park Service's "witness trees" and disease-resistant elms on the National Mall), and all vegetation that contributes to a cultural landscape, including controllable invasive plants.

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<sup>33</sup> A *Guide to Cultural Landscape Reports: Contents, Process, and Techniques*, National Park Service, 2005. [http://openlibrary.org/books/OL344308M/A\\_guide\\_to\\_cultural\\_landscape\\_reports](http://openlibrary.org/books/OL344308M/A_guide_to_cultural_landscape_reports) or [www.nps.gov/oclp/clr\\_main.htm](http://www.nps.gov/oclp/clr_main.htm)

<sup>34</sup> Cultural Landscape Inventories are also used within the National Park Service. Unlike a CLR, this document does not include treatment recommendations on how to preserve the landscape.

<sup>35</sup> Available at [www.nps.gov/history/hps/hli/landscape\\_guidelines/index.htm](http://www.nps.gov/history/hps/hli/landscape_guidelines/index.htm)

## XI. Construction

Construction practices at Federal facilities should reflect the goals outlined below and other goals outlined in this document. An Integrated Design Team, made up of architects, landscape architects, horticulturalists, designers, specification writers, and contracting officers, should use the following recommendations during the design process and apply them through construction specifications and contractor bidding requirements process.

- a. **Control and retain construction pollutants:** The discharge of construction site pollutants and materials should be prevented to protect receiving waters (including surface water, groundwater, and combined sewers or stormwater systems), air quality, and public safety. A Stormwater Pollution Prevention Plan (SWPPP)<sup>36</sup> and Erosion and Sedimentation Control Plan (ESC)<sup>37</sup> should be developed for all construction activities and implemented per applicable EPA and/or location regulations. The project should conform at a minimum to erosion and sedimentation requirements of the most current EPA Construction General Permit or local erosion and sedimentation control standards and codes, whichever is more stringent. In addition, agency policy should encourage designers to incorporate long-term, post-construction stormwater pollution and sedimentation control measures into site designs to both enhance this goal and assist in meeting goals for water and vegetation.
- b. **Restore soils disturbed during construction:** Soils disturbed during construction should be restored to pre-development conditions for organic matter, compaction, infiltration rates, soil biological function, and soil chemical characteristics to ensure the ability to support healthy plants, biological communities, and water storage and infiltration.
- c. **Restore soils disturbed by previous development:** Where possible, soil function in areas of previously disturbed topsoil and subsoil should be restored to support healthy plants, biological communities, and water storage and infiltration. For areas to be re-vegetated, consider a benchmark of at least 90% restoration of the total surface area of soil disturbed by previous development or use.
- d. **Divert construction and demolition materials from waste stream:** Divert construction and demolition (C&D) materials generated by site development from disposal in landfills and/or combustion in non-energy producing incinerators. As feasible, all non-hazardous structural materials and infrastructure/road materials should be recycled, reused, and/or salvaged and coordinated between designers and contractors. Designers should be aware of this goal during initial design phases of a project, to support the objective of a zero-waste site.
- e. **Reuse or recycle vegetation, rocks, and soil generated during construction:** Reuse or recycle vegetation, soils, and mineral/rock waste generated during construction to achieve a zero-waste site. To the extent practicable, materials from on-site land clearing activities with the exception of contaminated soils and diseased and/or invasive plant materials, should be retained and reused on-site. Site design should encourage balance of cut and fill wherever possible. All excess vegetation and recyclable materials shall be taken to composting and/or recycling sites.

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<sup>36</sup> For more information on Stormwater Pollution Prevention Plans <http://cfpub.epa.gov/npdes/stormwater/swppp.cfm>

<sup>37</sup> For more information on Erosion and Sedimentation Control Plans [www.epa.gov/owow/NPS/ordinance/erosion.htm](http://www.epa.gov/owow/NPS/ordinance/erosion.htm)

## XII. Operations and Maintenance

Ongoing landscape maintenance can have a significant impact on the environment. Federal agencies should work to reduce intensive landscape maintenance operations with the goal of having a self-sustaining landscape where possible. Federal agencies should implement sustainable landscape practices both contractually and in-house when performing facility operations and maintenance. When addressing operations and maintenance as part of sustainable landscape practices, agencies should consider the following actions.

- a. **Plan for ongoing sustainable landscape improvements:** A development strategy for the site to meet the goals listed in this Guidance document should be prepared with an outline and identification of the long-term strategies (10-year desired outcome) and short-term actions to achieve sustainable design goals.
- b. **Monitor performance of sustainable design practices:** Sustainable design practices should be monitored and documented in order to evaluate performance over time and improve the body of knowledge on long-term site sustainability. The design team should monitor and evaluate results such as water consumption, chemical usage, and fossil fuel-intensive maintenance. Overall plant vigor should be monitored on at least an annual basis to provide a measure of sustainable landscape planting success. The review and research of new practices in the landscape industry can assist Federal agencies in maintaining cost effectiveness and becoming leaders in sustainability.
- c. **Implement sustainable site maintenance:** Prepare a site maintenance plan and ensure that site managers and any maintenance contracts commit to educating maintenance personnel on the goals and implementation of the plan. Examples of plan actions include, but are not limited to, mandating an Integrated Pest Management (IPM) approach and use of organic fertilizer (consider using BioPreferred fertilizer and pesticides), seasonal performance-based mowing (spring 3", summer 4-5", fall 4"), and annual pruning practices as opposed to regular shearing. IPM plans should be put in place for maintenance, so that risks from both pests and pesticides are minimized. In addition, maintenance staff should consider and address excessive and/or poorly timed watering and frequent mowing. When maintaining historic or cultural landscapes, the maintenance plan should also address managing historic resources to prevent loss of integrity. Staff and contractors should be required to attend annual training on sustainable practices.
- d. **Recycle organic matter generated during site operations and maintenance:** The site maintenance plan should incorporate composting and/or recycling 100% of vegetation trimmings and appropriate compostable organics on-site, where feasible. Proper composting of materials from the recycling of vegetation trimmings and, where appropriate, food waste supports nutrient cycling, improves soil health, and reduces transportation costs and materials going to landfills.
- e. **Reduce outdoor energy consumption for all landscape operations:** In new construction, energy-efficient outdoor fixtures, vehicles, and equipment should be selected to reduce environmental impacts and costs associated with site operations. The following actions can help Federal agencies reduce petroleum use associated with landscaping operations.
  - Increase fuel economy through acquisition of smaller vehicles, hybrid-electric vehicles, and alternative fuels vehicles and landscape equipment.

- Employ efficiency strategies in landscape equipment, such as low-rolling resistance tires, synthetic oil, and other technologies.
  - Conduct annual evaluation of vehicle and equipment practices. Continue to improve program by keeping abreast of new technology advances.
  - Utilize energy-efficient light bulbs (including LEDs), lighting fixtures, and other means to minimize electricity use.
- f. **Use renewable and energy efficient sources for landscape electricity and power needs:** As feasible, agency operations and outside contractors should use on-site renewable energy sources and greenhouse gas emission reduction strategies to minimize air pollution, habitat destruction, and pollution from fossil fuel-based energy production from landscape operations. Agencies can use:
- Energy Star and Federal Energy Management Program (FEMP)-designated energy-efficient products;<sup>38</sup>
  - Water-efficient products, including those meeting EPA’s WaterSense standards;
  - Bio-based products designated by the U.S. Department of Agriculture in the BioPreferred<sup>39</sup> program;
  - Environmentally preferable products and services, including Electronic Product Environmental Assessment Tool (EPEAT) registered electronic products and Energy Star energy efficient electronic products;
  - Alternative fuel vehicles and alternative fuels required by the Energy Policy Act of 1992 (EPAct);
  - Products with low or no toxic or hazardous components;
  - Sustainable products for plant production and lawn care;
  - Alternative fuel vehicles and alternative fuels required by the Energy Policy Act of 1992 (EPAct); and
  - Products with low or no toxic or hazardous constituents.
- g. **Minimize generation of greenhouse gases and exposure to localized air pollutants during landscape maintenance activities:** Maintenance activities should minimize localized air pollutants and greenhouse gas by specifying in the site maintenance plan that power maintenance equipment is powered without the use of gasoline and/or meets emission levels in the U.S. EPA’s *Emission Standards for New Nonroad Spark-Ignition Engines*.<sup>40</sup> Work periods should be specified for use of power equipment to reflect impact on human health and if possible, maintenance equipment such as mowers, leaf blower, trimmers, should operate during hours that have the least impact on building occupants and neighboring communities.

### XIII. Additional References

#### General:

- The Sustainable Sites Initiative (SITES): [www.sustainablesites.org](http://www.sustainablesites.org)
- Executive Order 13514 [www.fedcenter.gov/programs/eo13514/](http://www.fedcenter.gov/programs/eo13514/)

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<sup>38</sup> For more information on Energy Star, a collaboration of the U.S. Department of Energy and the U.S. Environmental Protection Agency [www.energystar.gov](http://www.energystar.gov) and on Federal Energy Management Program [www1.eere.energy.gov/femp/](http://www1.eere.energy.gov/femp/)

<sup>39</sup> For more information on the U.S. Department of Agriculture’s BioPreferred program [www.biopreferred.gov](http://www.biopreferred.gov)

<sup>40</sup> [www.epa.gov/OMS/regs/nonroad/marinesi-equipld/420f08013.htm](http://www.epa.gov/OMS/regs/nonroad/marinesi-equipld/420f08013.htm)



- Instructions for Implementing Sustainable Locations for Federal Facilities, [http://www.fedcenter.gov/kd/Items/actions.cfm?action=ShowItem\\_id=19447&destination=ShowItem](http://www.fedcenter.gov/kd/Items/actions.cfm?action=ShowItem_id=19447&destination=ShowItem)
- LEED for Neighborhood Development (LEED-ND): [www.usgbc.org/leed/nd](http://www.usgbc.org/leed/nd)
- American Society of Landscape Architects: [www.asla.org/sustainablelandscapes/](http://www.asla.org/sustainablelandscapes/)
- Landscape Architecture Foundation: <http://lafoundation.org/research/landscape-performance-series/>
- Biobased products information: [www.BioPreferred.gov](http://www.BioPreferred.gov)

#### Water

- [Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act of 2007 and Section 438](#)
- [www.epa.gov/oaintrnt/documents/epa\\_swm\\_guidance.pdf](http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf)
- Stormwater Guidance for Federal Facilities: [www.epa.gov/owow/NPS/lid/section438/pdf/final\\_sec438\\_eisa.pdf](http://www.epa.gov/owow/NPS/lid/section438/pdf/final_sec438_eisa.pdf)
- Guidance for Federal Land Management in the Chesapeake Bay Watershed [www.epa.gov/owow\\_keep/NPS/chesbay502/](http://www.epa.gov/owow_keep/NPS/chesbay502/)
- Unified Facility Criteria (UFC) Low Impact Development Manual [www.wbdg.org/ccb/DOD/UFC/ufc\\_3\\_210\\_10.pdf](http://www.wbdg.org/ccb/DOD/UFC/ufc_3_210_10.pdf)
- [www.bae.ncsu.edu/stormwater/](http://www.bae.ncsu.edu/stormwater/)
- Center for Watershed Protection, [www.cwp.org/](http://www.cwp.org/)

#### Materials and Energy

- U.S. Department of Agriculture's BioPreferred program [www.biopreferred.gov](http://www.biopreferred.gov)
- Energy Star [www.energystar.gov](http://www.energystar.gov)
- Federal Energy Management Program [www.eere.energy.gov/femp/](http://www.eere.energy.gov/femp/)
- [www.epa.gov/OMS/regs/nonroad/marinesi-equipId/420f08013.htm](http://www.epa.gov/OMS/regs/nonroad/marinesi-equipId/420f08013.htm)
- <http://www.resource-solutions.org/index.php>

#### Soils and Vegetation

- [www.epa.gov/wed/pages/ecoregions.htm](http://www.epa.gov/wed/pages/ecoregions.htm)

#### Green Infrastructure Community of Practice Collaborative Network

- <http://greeninfrastructure.ning.com>
- [www.nps.gov/history/local-law/arch\\_stnds\\_8\\_2.htm](http://www.nps.gov/history/local-law/arch_stnds_8_2.htm)
- [www.nps.gov/history/hps/tps/standguide/](http://www.nps.gov/history/hps/tps/standguide/)
- [www.nps.gov/history/history/online\\_books/hps/contents.htm](http://www.nps.gov/history/history/online_books/hps/contents.htm)
- [www.fs.fed.us/sustainableoperations](http://www.fs.fed.us/sustainableoperations)

#### Human Health

- [www.fs.fed.us/ccrc/topics/urban-forests/ctcc/](http://www.fs.fed.us/ccrc/topics/urban-forests/ctcc/)
- [www.cdc.gov/healthyplaces/](http://www.cdc.gov/healthyplaces/)
- [www.completestreets.org/](http://www.completestreets.org/)
- [www.greenhealth.washington.edu](http://www.greenhealth.washington.edu)

#### Cultural Landscapes

- *Protecting Cultural Landscapes: Planning, Treatment and Management of Historic Landscapes* [www.nps.gov/history/hps/tps/briefs/brief36.htm](http://www.nps.gov/history/hps/tps/briefs/brief36.htm)

- *A Guide to Cultural Landscape Reports: Contents, Process, and Techniques*  
[http://openlibrary.org/books/OL344308M/A\\_guide\\_to\\_cultural\\_landscape\\_reports](http://openlibrary.org/books/OL344308M/A_guide_to_cultural_landscape_reports) or [www.nps.gov/oclp/clr\\_main.htm](http://www.nps.gov/oclp/clr_main.htm)
- *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*
- National Historic Preservation Act (NHPA): 16 U.S.C. § 470 et seq., and Section 106: 36 C.F.R. Part 800 Also see the National Historic Preservation Act: <http://www.achp.gov/docs/nhpa%202008-final.pdf>; and Section 106 Regulations: <http://www.achp.gov/regs-rev04.pdf>

## AGENCIES REPRESENTED IN WORKING GROUP AND ADVISORS

- Advisory Council on Historic Preservation
- General Services Administration, National Capitol Region Fire Protection, Life Safety and Environment Branch
- General Services Administration, Office of Design and Construction, Public Buildings Service, Urban Development/Good Neighbor Program
- General Services Administration, Office of Design and Construction, Public Buildings Service
- General Services Administration, Office of the Chief Architect
- National Capital Planning Commission
- Smithsonian Institution, Office of Facilities Management & Reliability, Smithsonian Gardens
- U.S. Army Corps of Engineers, Institute for Water Resources, Risk Management Center
- U.S. Botanic Garden, Architect of the Capitol, United States Congress
- U.S. Department of Agriculture, Forest Service, Urban and Community Forestry
- U.S. Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division
- U.S. Department of Agriculture, Office of Operations
- U.S. Department of Agriculture, Office of the Secretary
- U.S. Department of Agriculture, U.S. Forest Service Green Cities Research Alliance
- U.S. Department of Agriculture, U.S. Forest Service, Northern Research Station of the Research and Development
- U.S. Department of Defense, U.S. Army Corps of Engineers, Civil Section, Design Branch Omaha District
- U.S. Department of Defense, U.S. Air Force Center for Engineering and the Environment, Technical Support Division, Build Infrastructure Branch
- U.S. Department of Defense, Naval Facilities Engineering Command
- U.S. Department of Homeland Security, Federal Law Enforcement Training Center
- U.S. Department of Interior, National Invasive Species Council
- U.S. Department of Interior, National Park Service, Denver Service Center
- U.S. Department of Interior, National Park Service, Denver Service Center at National Mall and Memorial Parks



- U.S. Department of Interior, National Park Service, National Capital Region, Liaison to the White House
- U.S. Department of Veteran's Affairs
- U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics Environmentally, Preferable Purchasing Program
- U.S. Environmental Protection Agency, Office of Resource Conservation and Recovery
- U.S. Environmental Protection Agency, Office of Sustainable Communities
- U.S. Environmental Protection Agency, Office of Water
- U.S. Environmental Protection Agency, Office of Water, Nonpoint Source Control Branch
- U.S. Environmental Protection Agency, Office of Water, Water Sense Program
- White House, Council on Environmental, Quality, Office of Federal Environmental Executive

## ADVISORS REPRESENTING LOCAL AND REGIONAL CONSTITUENTS

- Arizona State University, Department of Applied Sciences and Mathematics
- City of Albuquerque, Park Management Division
- City of Portland, Bureau of Environmental Services, Sustainable Stormwater Program
- City of Seattle, Resource Conservation Planning, Seattle Public Utilities
- Cornell University, Department of Crop and Soil Sciences
- Cornell University, Department of Horticulture
- Hennepin County, Housing, Community Works and Transit Department
- Lady Bird Johnson Wildflower Center of the University of Texas at Austin
- New Castle County Delaware, Department of Land Use Planning and Design Standards Section
- University of Illinois at Urbana-Champaign, Department of Natural Resources and Environmental Sciences and Department of Psychology
- University of Massachusetts, Amherst Department of Landscape Architecture and Regional Planning
- University of Washington, College of the Environment, Human Dimensions of Urban Greening
- Virginia Tech, Department of Forest Resources & Environmental Conservation and Department of Horticulture

## GLOSSARY<sup>41</sup>

**100-year floodplain** includes all areas below the 100-year flood elevation of waterways of all sizes, including depressional areas, wetlands, areas behind levees, ephemeral and intermittent streams, rivers, lakes, and shoreline and coastal areas. These areas are generally depicted on the current FEMA Flood Insurance Rate Map as Zones A, AE, A1-A30, AH, AO, AR, A99,

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<sup>41</sup> Glossary adapted from *The Sustainable Sites Initiative Guidelines and Performance Benchmarks 2009* [www.sustainablesits.org](http://www.sustainablesits.org)

V, and VE. However, in some areas they may need to be calculated by the site development team.

**Appropriate plant species** are plants adapted to site conditions, climate, and design intent. The following attributes should be considered in determining whether plants are appropriate for the site: cold hardiness, heat tolerance, salt tolerance, soil moisture range, plant water use requirements, soil volume requirements, soil pH requirements, sun/shade requirements, pest susceptibility, and maintenance requirements. Native and non-native plants are appropriate if they meet the above criteria.

**Average buffer width** can be calculated using perpendicular transects every 50 feet along a water body for at least 90 percent of the stream or shoreline length within the boundaries of the site. For final average buffer widths, a minimum buffer width of at least 10 feet must be maintained at all points along the buffer. Buffer widths for rivers, streams, and tributaries are measured on each side of the stream from the top of bank.

**Bicycle network** is a continuous bicycle or multi-use facility that is separate from the vehicular right-of-way but can be shared with pedestrians. The standard bicycle network has pavement that is at least 8 feet wide with a 2-foot unpaved clear zone on each side.

**Biomass** is the total amount of living material or formerly living material in a given habitat, population, or sample. Specific measures of biomass are generally expressed in dry weight per unit area of land.

**Brownfield** is an abandoned, idled, or underused industrial and commercial facility/site where expansion or redevelopment is complicated by real or perceived environmental contamination; a site documented as contaminated by means of an ASTM E1903-11 Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment or a local Voluntary Cleanup Program; or a site defined as a brownfield by a local, state, or Federal Government agency.

**Common stormwater pollutants** can adversely impact receiving waters and include, but are not limited to: Landscape chemicals – pesticides, fertilizers, herbicides, detergents, oil, grease; Metals – copper, zinc, lead; Nutrients – nitrogen, phosphorus; Pathogens - bacteria, viruses, protozoa; Regional pollutants – salts, alcohol, temperature; and Solids – soil, tire particles, road abrasion material, etc.

**Control of invasives** is the appropriate eradication, suppression, reduction, or management of invasive species populations, the prevention of the spread of invasive species from areas where they are present and taking steps such as the restoration of native or appropriate species and habitats to reduce the effects of invasive species and to prevent further invasion.

**Cultural landscape** is a geographic area including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values.

**Deconstruction** is a process of carefully taking apart constructed elements with the intention of either reusing or recycling the materials and is accomplished during redevelopment, adaptation, or at the end of use on a site.

**Design for deconstruction**, also called Design for Disassembly, is the design of buildings or products to facilitate future change and the eventual dismantlement (in part or whole) for recovery of systems, components, and materials. This design process includes developing the assemblies, components, materials, construction techniques, and information and management systems to accomplish this goal.

**Diameter at breast height (DBH)** is a standard method for determining the trunk diameter of a standing tree. In the U.S., DBH is typically measured in inches at 4.5 feet (137 centimeters) off the ground on the uphill side. Wounds, branches, multiple stems, and defects may change how diameter is measured. [www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx](http://www.isa-arbor.com/publications/tree-ord/measuringdbh.aspx)

**Ecoregion** refers to areas within which ecosystems (and the type, quality, and quantity of environmental resources) are generally similar. Developed by Omernick (1987) to serve as a spatial framework for the research, assessment, and monitoring of ecosystems and ecosystem components.

**Ecosystem services** describe the goods and services provided by healthy ecosystems—for example, the pollination of crops by bees, bats, or birds; the flood protection provided by wetlands; or the filtration of air and water by vegetation and soils.

**Farmland of statewide importance** refers to soils designated by each state's Natural Resources Conservation Service as "farmland of statewide importance." Farmland of statewide importance is farmland that does not meet all of the prime farmland criteria, but is still able to economically produce high yields of crops when treated and managed according to acceptable farming methods.

**Geomorphological and vegetative methods** focus on the creation of a stable dimension, pattern, and profile for a stream type and channel morphology appropriate to its landform and valley, designed such that over time, the stream is self maintaining (able to transport the flow and sediment of its watershed without aggrading or degrading). This can include a broad range of measures, including the removal of the watershed disturbances that are causing stream instability; installation of structures and planting of vegetation to protect stream banks and provide habitat; and reshaping or replacement of unstable stream reaches into appropriately designed functional streams and associated floodplains.

**Greenfield** is a site that has not been previously developed or graded, including previous agricultural fields.

**Greyfield** is a site that has been previously developed or graded and may have existing infrastructure that can be utilized.

**Greywater** is domestic wastewater composed of wash water from kitchen, bathroom, and laundry sinks, tubs, and washers.

**Impervious surfaces** do not allow stormwater to drain into the soil below. Some examples include concrete sidewalks, driveways and heavily compacted urban soils. Because these surfaces cover the soil, they increase stormwater runoff and should be replaced with more permeable surfaces such as porous pavers, porous asphalt or turf.

**Infill site** is a site that must have at least 75 percent of its perimeter bordering sites that consist of at least 75 percent previously developed land. Any fraction of the perimeter that borders waterfront is excluded from the calculation.

**Integrated design team** consists of the “owner” and/or client along with professionals knowledgeable in landscape design, architecture, engineering, construction, and maintenance of a site. Team members should meet the unique constraints and opportunities of the specific site.

**Integrated pest management (IPM)** is a sustainable approach to managing pests by combining 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. The IPM approach places an emphasis on the reduction of pesticide use and the implementation of preventative and alternative control measures.

**Invasive species** are alien species, with respect to a particular ecosystem, that are not native to that ecosystem and whose introduction does or is likely to cause economic or environmental harm or harm to human health.

**Low Impact Development (LID)** is a more sustainable land development approach that begins with a site planning process that first identifies critical natural resource areas for preservation. Federal agencies can learn more about LID at:  
<http://www.epa.gov/owow/NPS/lid/>

**Management of invasives** is the implementation of control measures to prevent the spread of invasive species or lessen their impacts when they appear to be permanently established. Control and management of invasive species encompasses diverse objectives such as eradication within an area, population suppression, limiting spread, and reducing effects. Complete eradication is not generally feasible for widespread invasive species or where adequate control methods are not available. Integrated pest management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. Consideration of cumulative environmental impacts requires that environmentally sound methods be deployed, especially in vulnerable areas.

**Minimal impact site development** is development that does not significantly alter the existing vegetation and hydrology of the vegetation and soil protection zone, such as trails, picnic areas, or boardwalks.

**Minimal soil disturbance** describes soils that are minimally graded and/or compacted, such that compaction levels exceed the Maximum Allowable Bulk Densities, but not covered with impervious surfaces. Examples of soils that are minimally disturbed include areas with minor modifications or very limited development but not covered with buildings or paved surfaces, such as areas that have been compacted by livestock or heavy foot traffic.

**Moderate soil disturbance** describes soils in which topsoil is compacted such that compaction levels exceed the Maximum Allowable Bulk Densities, but not covered with impervious surface.

**Native plant communities** are plant species, composition, and structure typical of communities native to the EPA Level III ecoregion or known to naturally occur within 200 miles of the site. At least two references (or local reference sites) are needed to determine the dominant plant species, relative species abundances, and other characteristic elements of the plant community/communities to be preserved or restored. Native plant communities include (but are not limited to) wetlands, grasslands, riparian buffers, and habitat for wildlife species of concern within the region.

**Native plants** are plants native to the EPA Level III ecoregion of the site or known to naturally occur within 200 miles of the site. Naturally occurring hybrids and varieties of species native to the ecoregion are acceptable.

**Organic matter** in soil is carbon-containing material composed of both living organisms and formerly living decomposing plant and animal matter. Soil organic matter (SOM) content can be supplemented with compost or other partially decomposed plant and animal material. Soil organic matter content is commonly measured using “loss on ignition” tests that measure the amount of the element carbon, a key constituent of all organic matter.

**Potable water** is municipally treated water or well water that is suitable for drinking.

**Post-consumer material** is waste material generated by households or by commercial, industrial, and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

**Pre-consumer material** is material diverted from the waste stream during the manufacturing process that could be used in a separate and different manufacturing process (e.g., reuse of flue gas desulfurization gypsum in drywall production). Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

**Previously developed site** consists of at least 75 percent of the site area that has preexisting paving, construction, or altered landscapes. This does not apply to a street, roadway, or altered landscapes resulting from current agricultural use, forestry use, or use as preserved natural area.

**Prime farmland** refers to soils designated by the Natural Resources Conservation Service as “prime farmland.” Prime farmland is land that has the best combination of physical and

chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses (the land could be cropland, pastureland, rangeland, forestland, or other land, but not urban built-up land or water).

**Program plan** is a narrative or written design that provides a mechanism for clearly stating the vision and desired outcomes of the project and setting the direction of the design team.

**Rainwater/stormwater features** use rainwater and stormwater as their sole source and function as stormwater management elements. Examples include pools, fountains, stormwater BMPs, water gardens, channels/runnels for local conveyance, raingardens, and water art. Features can include those intended for limited human contact, or for full human contact.

**Receiving waters** include groundwater, creeks, streams, rivers, lakes, or other water bodies that receive treated or untreated wastewater or stormwater. This also includes water from combined sewer systems and storm drains.

**Reclaimed water** is effluent derived in any part from sewage from a wastewater-treatment system that has been adequately and reliably treated, so that as a result of that treatment, it is suitable for a beneficial use, or a controlled use that would not otherwise occur, and is no longer considered wastewater.

**Recycled content** is defined in accordance with the International Organization of Standards document, ISO 14021—Environmental labels and declarations—Self-declared environmental claims (Type II environmental labeling). [www.iso.org](http://www.iso.org)

**Reference soils** are soils native to a site as described in Natural Resources Conservation Service Soil Surveys (refer to soils within the region if the site soils are not mapped). OR undisturbed native soils within the site's region that has native vegetation, topography, and soil textures similar to the site. OR for sites that have no existing soil, undisturbed native soils within the site's region that supports appropriate native plants or appropriate plant species similar to those intended for the new site.

**Regularly occupied building(s)** are buildings where occupants (workers, students, etc.) are seated or standing inside for extended periods of time.

**Rehabilitate** is the action of performing ecological restoration that strives to alter the biota and physical conditions at a site, with an emphasis on the reparation of ecosystem processes, productivity, and services.

**Reuse** is a process of utilizing a used product or material in a manner that generally retains its original form and identity with minor refurbishments. Materials reusable in whole form might include sand-set pavers, segmental retaining walls, or mechanical fasteners, connections, and/or joinery (e.g., avoidance of adhesives and mortar).

**Salvage** is the recovery of materials from existing sites for reuse on other sites.



**Severe soil disturbance** describes soils in which topsoil is removed and/or is not present; subsoils are compacted such that compaction levels exceed the Maximum Allowable Bulk Densities; and/or topsoil or subsoil is covered with impervious cover or is chemically contaminated. Examples of soils that are severely disturbed include areas that are covered with buildings or paved surfaces, or areas that are defined as brownfields by local, state, or Federal agencies.

**Soils disturbed by previous development** are all areas of soils disturbed by previous human development activities. Indicators of disturbed soils may include soil horizons that differ significantly in depth, texture, or physical or chemical properties from the reference soil; bulk densities that exceed the Maximum Allowable Bulk Densities; organic matter content lower than that of the reference soil; soil chemical characteristics (parameters such as pH, salinity, cation exchange capacity, and nutrient profiles) different from that of the reference soil; presence of compounds toxic to the intended plants; and presence of weedy, opportunistic, or invasive plant species.

**Solar reflectance index (SRI)** is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100.

[www.astm.org](http://www.astm.org)

**Special status plants** refers to vegetation designated as important by local, state, or Federal entities. Designations may be for size, species, age, rare or special collections; ecological and environmental value; unique genetic resources; aesthetics; location; or other unique characteristics. Groves/clusters may also be designated special status.

**Stakeholders** may include, but are not limited to, neighbors (e.g., residential, commercial, industrial, institutional-education, religious, government, non-profit), interest groups (e.g., growth management, environmental, transportation), and public officials from local jurisdictions, regulators, community leaders, business organizations, etc.

**Sustainable water sources** are non-potable sources and can include harvested rainwater, surplus water from building or site operations that has been appropriately cleansed and cooled, and surplus site water that is not needed to maintain existing or restored site ecology. Potable water or other natural surface or subsurface water resources are not sustainable water sources.

**Temporary occupants** are occupants such as students, visitors, and customers that are on a site intermittently.

**Unique farmland** refers to soils designated by the Natural Resources Conservation Service is land other than prime farmland and used for the production of specific high-value food and fiber crops.

**Urban Heat Island Effect** describes urban areas that are hotter than nearby rural areas due to being highly developed with buildings, roads, and other infrastructure that replaces open land

and vegetation. Surfaces that were once permeable and moist become impermeable and dry. These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape.

**Vegetated area** describes all portions of the site that will support vegetation.

**Vegetation and soil protection zones (VSPZs)** are areas of soil or vegetation to be protected from construction impacts from overall site development shall not decrease the capacity support the desired vegetation.

**Volatile organic compounds (VOCs)** are a variety of organic compounds that vaporize at room temperature. VOCs are the principal component in atmospheric reactions that form ozone and other photochemical oxidants, causing a variety of negative health effects from dizziness, eye and respiratory tract irritation, nervous system damage, developmental effects, and cancer.

**Walk distance** is the distance that a pedestrian must travel between destinations without obstruction, in a safe and comfortable environment such as on sidewalks, footpaths, or other pedestrian facilities. Sidewalks adjacent to urban roads of 40 mph or higher should at least have a 5' buffer zone between the road and sidewalk.

**Waste audit** is a systematic review of a site and its operations to quantify the types and amounts of waste generated, and the management practices that impact that waste generation. It includes an assessment of purchasing practices and identifies the areas and materials in which waste reduction efforts will be most effective. A waste audit also sets a baseline for measuring future progress of waste reduction efforts.

**Wetlands** are "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Clean Water Act (U.S. Code of Federal Regulations 40 CFR 230.3) [www.epa.gov/lawsregs/laws/cwa.html](http://www.epa.gov/lawsregs/laws/cwa.html)



# Supporting the Health of Honey Bees and Other Pollinators

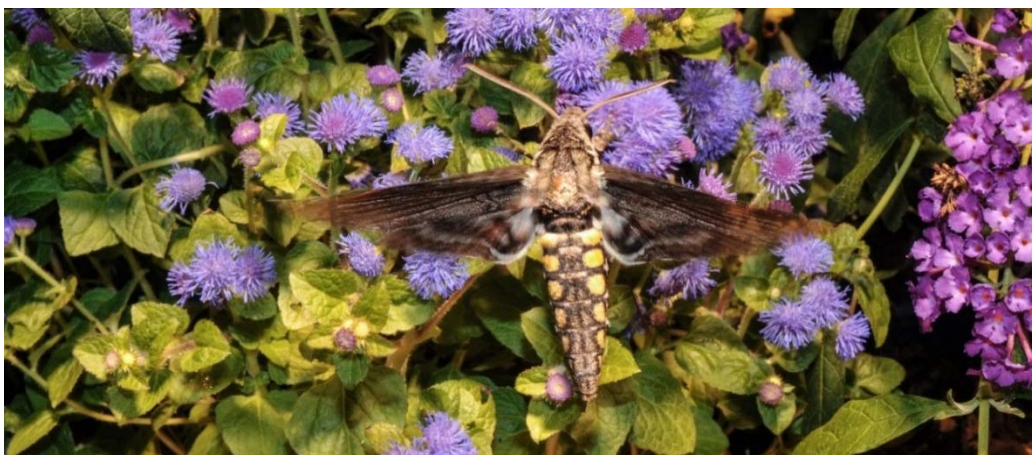
October 2014

## 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.

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

# CONTENTS

<b>1</b>	<b>INTRODUCTION .....</b>	<b>4</b>
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
<b>2</b>	<b>PROCEDURES .....</b>	<b>9</b>
2.1	PROJECT INITIATION, DESIGN, AND CONSTRUCTION.....	9
2.1.1	<i>Planning and Preparation .....</i>	<i>10</i>
2.1.2	<i>Plant Species for Pollinators .....</i>	<i>14</i>
2.2	MAINTENANCE AND MANAGEMENT.....	21
2.2.1	<i>Landscape Management Principles .....</i>	<i>22</i>
2.2.2	<i>Integrated Pest Management (IPM) .....</i>	<i>24</i>
2.2.3	<i>Integrated Vegetation Management (IVM) .....</i>	<i>25</i>
<b>3</b>	<b>OUTREACH .....</b>	<b>32</b>
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
<b>4</b>	<b>EDUCATIONAL POLLINATOR GUIDES .....</b>	<b>36</b>
4.1	BEEES .....	36
4.1.1	<i>Honey Bees.....</i>	<i>36</i>
4.1.2	<i>Native Bees.....</i>	<i>37</i>
4.2	BUTTERFLIES AND MOTHS .....	42
4.3	BIRDS (HUMMINGBIRD AND HONEYCREEPER) .....	43
4.4	FLIES .....	44
4.5	BATS .....	45
<b>5</b>	<b>RESOURCES .....</b>	<b>47</b>

# 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<sup>1</sup> 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)*<sup>2</sup> 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.

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<sup>1</sup>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](http://www.whitehouse.gov/briefing-room/presidential-actions/presidential-memoranda)

<sup>2</sup>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](http://www.whitehouse.gov/administration/eop/ceq/sustainability/landscaping-guidance). [www.WhiteHouse.gov](http://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<sup>3</sup> have amplified the situation.<sup>4</sup> 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<sup>5</sup> 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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<sup>3</sup> For the purposes of this document, "pesticides" and "chemicals" broadly refers to the use of insecticides, herbicides, and fungicides.

<sup>4</sup> 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](http://www.whitehouse.gov/briefing-room/presidential-actions/presidential-memoranda). [www.WhiteHouse.gov](http://www.WhiteHouse.gov)

<sup>5</sup> FY 2012 Federal Real Property Report. General Services Administration. [www.gsa.gov/portal/mediaId/179655/fileName/FY\\_2012\\_FRPP\\_intro\\_508.action](http://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).<sup>6</sup>

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.

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<sup>6</sup> 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](http://www.whitehouse.gov/briefing-room/presidential-actions/presidential-memoranda). [www.WhiteHouse.gov](http://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.<sup>7</sup> In addition, best management practices are integrated throughout the guidance to serve as examples and resources for users.

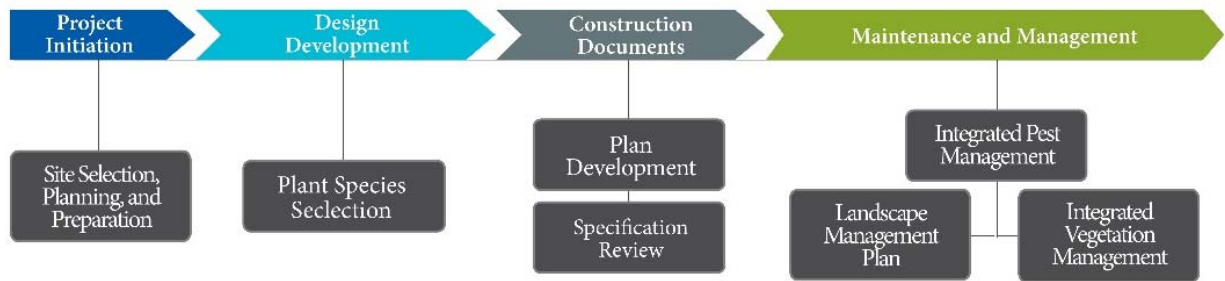
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<sup>7</sup> Pollinators Federally Listed as Endangered or Threatened Species. United States Fish and Wildlife Service. [www.fws.gov/pollinators/Programs/Endangered.html](http://www.fws.gov/pollinators/Programs/Endangered.html)



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.<sup>8</sup>

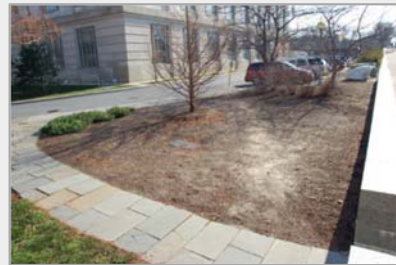
### 2.1.1 *Planning and Preparation*

#### **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.

<sup>8</sup> 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](http://www.whitehouse.gov/administration/eop/ceq/sustainability/landscaping-guidance) [www.WhiteHouse.gov](http://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.<sup>9</sup> 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*<sup>10</sup> guidance for further information on site planning and soils.

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<sup>9</sup> *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/](http://www.xerces.org/pollinator-conservation/agriculture/pollinator-habitat-installation-guides/). [www.xerces.org](http://www.xerces.org)

<sup>10</sup> 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](http://www.whitehouse.gov/administration/eop/ceq/sustainability/landscaping-guidance). [www.WhiteHouse.gov](http://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](http://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/](http://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/](http://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=](http://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. 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. 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.

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## BEST PRACTICES – ALL REGIONS

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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](http://www.xerces.org/milkweeds-a-conservation-practitioners-guide)

Monarch Fueling Planting Guide. Pollinator Partnership.  
[www.pollinator.org/monarchs.htm#fueling](http://www.pollinator.org/monarchs.htm#fueling)

Monarch Watch. [www.monarchwatch.org/blog](http://www.monarchwatch.org/blog)

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## BEST PRACTICES – EASTERN REGION

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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](http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5427015.pdf)



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## BEST PRACTICES – ALL REGIONS

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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>

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## BEST PRACTICES – SOUTH WEST

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**Federal Agency.** General Services Administration

**Site.** Domenici Federal Courthouse  
New Mexico

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)<sup>11</sup> 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.



Photos courtesy of the General Services Administration

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<sup>11</sup> Sustainable SITES Initiative. [www.sustainablesites.org/](http://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](http://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](http://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](http://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/](http://www.xerces.org/providing-wildflowers-for-pollinators/)
- *Selecting Plants for Pollinators*. Free Pollinator Friendly Planting Guides. Pollinator Partnership. [www.pollinator.org/guides.htm](http://www.pollinator.org/guides.htm)

*The links below address growing regions:*

- North America Ecological Regions.  
[www.cec.org/Page.asp?PageID=122&ContentID=1329](http://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.

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.



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



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



### 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.<sup>12</sup> 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](http://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](http://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](http://www.fs.fed.us/publications/invasive/invasive-framework-2013.pdf)

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<sup>12</sup> *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=](http://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 syrphid 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](http://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](http://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](http://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.<sup>13</sup>

#### 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

**EPA Labeling Program**

**THE NEW EPA BEE ADVISORY BOX**  
On EPA's new and strengthened pesticide label to protect pollinators

Read EPA's new and strengthened label requirements: <http://go.usa.gov/jH44>

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](http://www2.epa.gov/pollinator-protection)

<sup>13</sup> *Accreditation Standards for Assessing IVM Excellence*. Right-of Way Stewardship Council. [www.dovetailinc.org/reports/Accreditation+Standards+for+Assessing+IVM+Excellence\\_n567?prefix=%2Freports](http://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.<sup>14</sup>

### **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.<sup>15</sup>

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).<sup>16</sup>

### **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).

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<sup>14</sup> Integrated Vegetation Management. Fact Sheet. United States Environmental Protection Agency. [www.epa.gov/pesp/publications/landscaping/ivm\\_fact\\_sheet.pdf](http://www.epa.gov/pesp/publications/landscaping/ivm_fact_sheet.pdf)

<sup>15</sup> Ibid.

<sup>16</sup> Penn State Extension. Penn State College of Agricultural Sciences. [www.extension.psu.edu/](http://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](http://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](http://www.epa.gov/pesp/publications/landscaping/ivm_fact_sheet.pdf)
- IVM Partners. Managing Ecosystems together. The Right Paths for Pollinators. [www.ivmpartners.org/](http://www.ivmpartners.org/)
- Penn State Extension. Penn State College of Agricultural Sciences.  
[www.extension.psu.edu/](http://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.



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## BEST PRACTICES – MID ATLANTIC

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**Organization.** American Horticultural Society (AHS)

**Site.** André Bluemel Meadow  
River Farm; Alexandria, VA

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.



Photos courtesy of AHS

**Resources:** André Bluemel Meadow. American Horticultural Society. [www.ahs.org/meadow](http://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](http://www.ahs.org/uploads/pdfs/Meadow_TAG_MJ06.pdf)

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## ***BEST PRACTICES – MID WEST***

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**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](http://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](http://www.xerces.org/establishing-pollinator-meadows-from-seed)
- Integrated Vegetation Management Partners.  
[www.ivmpartners.org/cases.html](http://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](http://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](http://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](http://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](http://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.

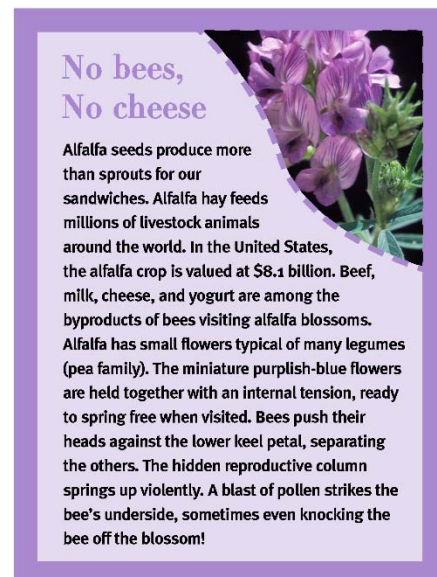
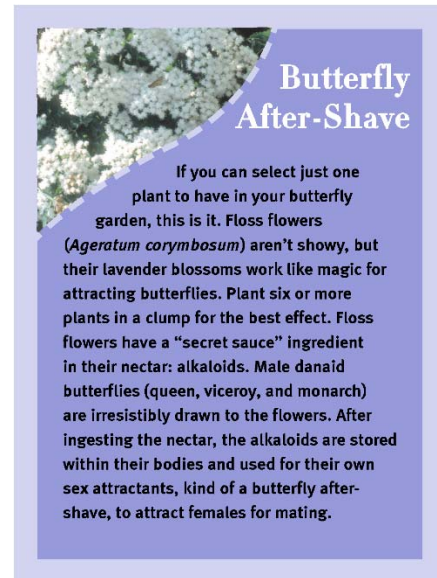
Outreach can be executed in a variety of forms depending on the need of a project: educational materials, accessibility, or establishing a connection with target audiences. Signage should illustrate components of the project whether it is to provide progress updates or educate readers.

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

#### 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](http://landscapeforlife.org)).



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

### 3.2 Signage and Visitor Outreach

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 display and urban garden located at the USBG

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.<sup>17</sup>

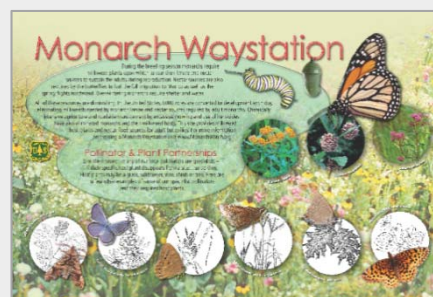
## **Resources**

- 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/](http://www.monarchlab.org/mitc/)
- Schoolyard Ecology Explorations (University of Minnesota) –  
[www.monarchlab.org/see/](http://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](http://usbg.gov/pollinator-signs)

USFS.

[fs.fed.us/wildflowers/features/panels.shtml](http://fs.fed.us/wildflowers/features/panels.shtml)

<sup>17</sup> 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](http://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/](http://www.xerces.org/citizen-science/)

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- 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](http://www.discoverlife.org/20/q?search=Apoidea)  
[www.discoverlife.org/](http://www.discoverlife.org/)

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

[www.learner.org/jnorth/monarch/index.html](http://www.learner.org/jnorth/monarch/index.html)

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- Free hi resolution pictures of bees under copyright free creative Commons license.

[www.flickr.com/photos/usgsbiml/](http://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*, *Salvia*, *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 on *Scabiosa*.  
Photo courtesy of Smithsonian Gardens

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.

### 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



## 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 zephyrum*.

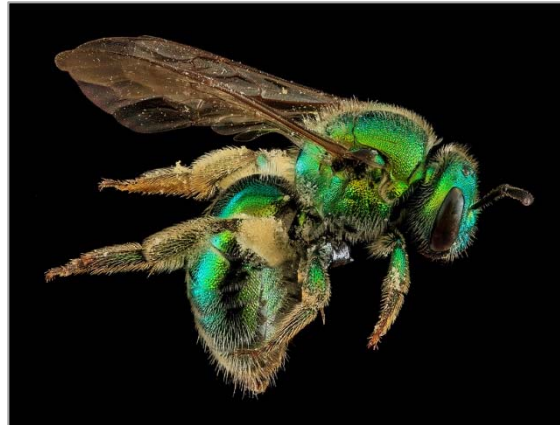
**Preferred Plant Species:** The alkali bee is a very good pollinator of alfalfa, and some growers take advantage of its nesting habits to manage this species to a limited extent. Once established, these alkali bee beds can remain active for decades.

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.**

**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



*Hylaeus floridanus*. Photo courtesy of Sam Droege, USGS

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)**

**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.



*Andrena nida*. Photo courtesy of Sam Droege, USGS

**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

**Nest:** Butterflies and moths 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.

**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*.



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



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



### 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

**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.

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*).<sup>18</sup>



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



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

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<sup>18</sup> Pollinator Partnership, *Selecting Plants for Pollinators*

## 4.5 Bats

**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.



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

**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](http://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](http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5306468.pdf)
- Bee Pollination: General Information.  
[www.fs.fed.us/wildflowers/pollinators/animals/bees.shtml](http://www.fs.fed.us/wildflowers/pollinators/animals/bees.shtml)
- Identifying Native Bees Poster. Pollinator Partnership.  
[www.pollinator.org/PDFs/Identifying\\_Native\\_Bees\\_PosterFINAL.pdf](http://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/](http://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](http://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](http://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/](http://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	<a href="#">BATS</a>	<a href="#">BEES</a>	<a href="#">BIRDS</a>	<a href="#">BUTTERFLIES</a>	<a href="#">FLIES</a>	<a href="#">MOTHS</a>
<b>COLOR</b>	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
<b>NECTAR GUIDES</b>	Absent	Present	Absent	Present	Absent	Absent
<b>ODOR</b>	Strong musty; emitted at night	Fresh, mild, pleasant	None	Faint but fresh	Putrid	Strong sweet; emitted at night
<b>NECTAR</b>	Abundant; somewhat hidden	Usually present	Ample; deeply hidden	Ample; deeply hidden	Usually absent	Ample; deeply hidden
<b>POLLEN</b>	Ample	Limited; often sticky and scented	Modest	Limited	Modest in amount	Limited
<b>FLOWER SHAPE</b>	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](http://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.

<b>POLLINATOR</b>	<b>Food</b>	<b>Shelter</b>
<b>SOLITARY BEES</b>	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.
<b>BUMBLEBEES</b>	Nectar and pollen	Nests are most often underground but can be hollow trees or walls, or under a clump of grass.
<b>BUTTERFLIES AND MOTHS – EGG</b>	Non-feeding stage	Usually larval host plant
<b>BUTTERFLIES AND MOTHS – CATERPILLAR</b>	Leaves of larval host plants	Larval host plant
<b>BUTTERFLIES AND MOTHS – PUPA</b>	Non-feeding stage	Protected site such as a bush, tall grass, or a pile of leaves or sticks
<b>BUTTERFLIES AND MOTHS – ADULT</b>	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
<b>BATS</b>	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
<b>HUMMINGBIRDS</b>	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](https://plants.usda.gov/pollinators/Native_Pollinators.pdf)

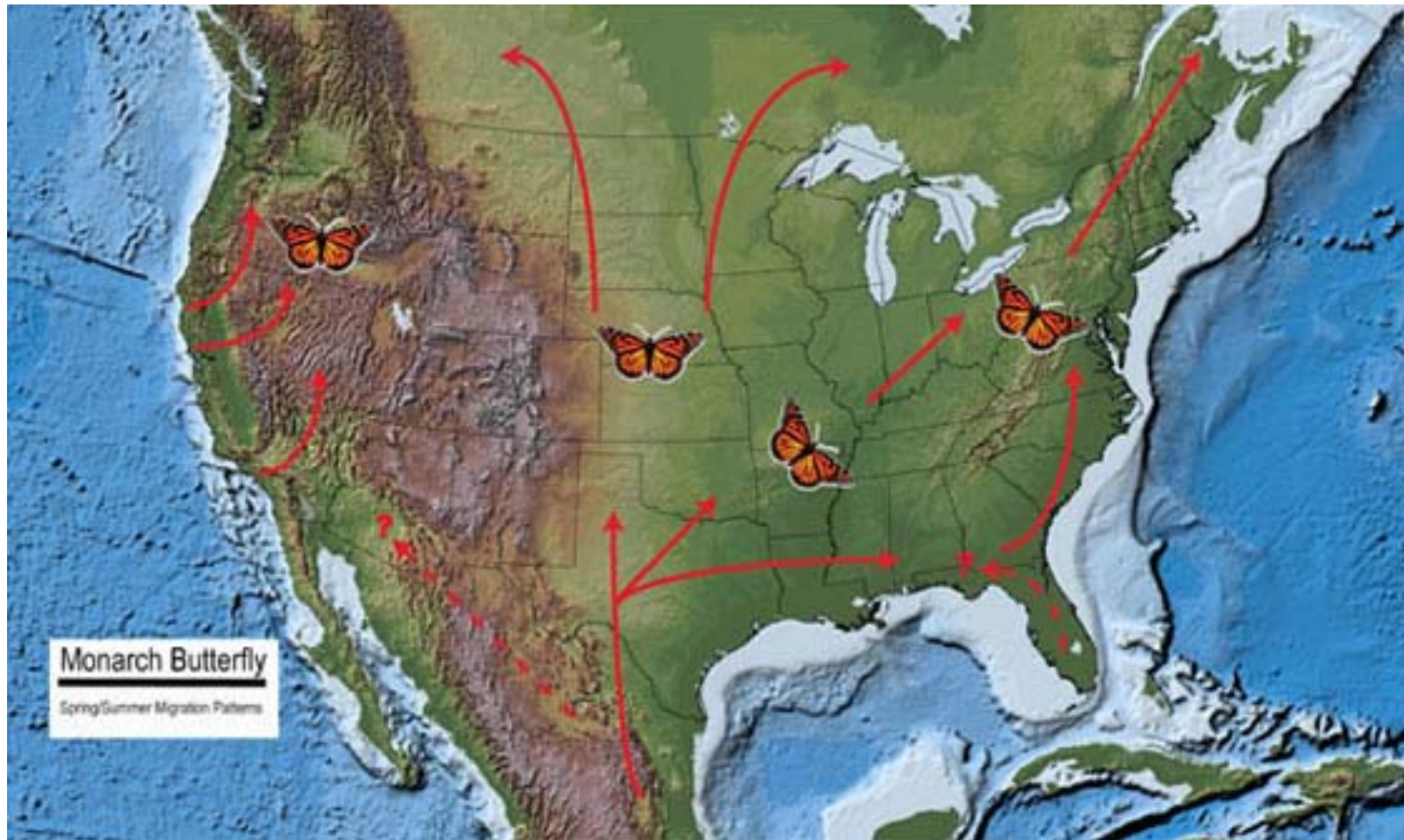
**MAP A:** The map below illustrates the Commission for Environmental Cooperation (CEC) terrestrial ecoregions. The ecoregions identify areas of general similarity in ecosystems aiding in the research, assessment, management, and monitoring of ecosystems and ecosystem components.



Source: North America Ecological Regions. [www.cec.org/Page.asp?PageID=122&ContentID=1329](http://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/](http://www.americanbeejournal.com/)
- American Bee Keeping Federation [www.abfnet.org/](http://www.abfnet.org/)
- Bee Culture Magazine [www.beeculture.com/](http://www.beeculture.com/)
- Bring Back the Pollinators Campaign. [www.bringbackthepollinators.org](http://www.bringbackthepollinators.org)
- Journey North. [www.learner.org/jnorth/monarch/](http://www.learner.org/jnorth/monarch/)
- Lady Bird Johnson Wildflower Center. [www.wildflower.org/plants/](http://www.wildflower.org/plants/)
- Landscape for Life. [landscapeforlife.org](http://landscapeforlife.org)
- Monarch Fueling Project. [www.pollinator.org/monarchs.htm#fueling](http://www.pollinator.org/monarchs.htm#fueling)
- Monarchs in the Classroom (University of Minnesota) [www.monarchlab.org/mitc/](http://www.monarchlab.org/mitc/)
- Monarch Joint Venture. [www.monarchjointventure.org](http://www.monarchjointventure.org)
- Monarch Larva Monitoring Project. [www.mlmp.org](http://www.mlmp.org)
- Monarch Watch. [www.monarchwatch.org](http://www.monarchwatch.org)
- Monarch Butterfly Fund. [www.monarchbutterflyfund.org](http://www.monarchbutterflyfund.org)
- Pollinator Partnership. [www.pollinator.org/posters.htm](http://www.pollinator.org/posters.htm)
- Pocket Guide to the Native Bees of New Mexico.  
[www.nrcs.usda.gov/Internet/FSE\\_PLANTMATERIALS/publications/nmpmcbr10942.pdf](http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/nmpmcbr10942.pdf)
- Spikenard Farm Honeybee Sanctuary. [spikenardfarm.org/](http://spikenardfarm.org/)
- The University of Hawaii Honeybee Project. [www.uhbeepproject.com/](http://www.uhbeepproject.com/)
- USDA's Natural Resources Conservation Service.  
[www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/](http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/)
- US Forest Service. [www.fs.fed.us/monarchbutterfly/](http://www.fs.fed.us/monarchbutterfly/)
- US Forest Service. [www.fs.fed.us/wildflowers/pollinators/index.shtml](http://www.fs.fed.us/wildflowers/pollinators/index.shtml)
- Wildlife Habitat Council. [wildlifehc.conservaionregistry.org/](http://wildlifehc.conservaionregistry.org/)
- Xerces Society Pollinator Conservation Program. [www.xerces.org/pollinator-conservation/](http://www.xerces.org/pollinator-conservation/)