Figure 1. Orange rumped bumble bee (Bombus melanopygus) nectaring on salmonberry (Rubus spectabilis) along the Puyallup River, Orting, WA.
Photo: Nelson Salisbury

THE NATIVE POLLINATOR HABITAT RESTORATION GUIDE

Best Management Practices for the Puget Sound lowlands

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In memory of Dr. Sarah Reichard

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PURPOSE

This how-to practitioner guide is a set of best management practices (BMPs) for native pollinator habitat restoration in the Puget Sound region. It is geared towards planners, land managers, restoration practitioners, farmers, gardeners, orchardists, teachers, students, and homeowners. It may be used as an educational tool for elected officials, or as a technical resource for citation in official documents, such as grant proposals.

A survey of 49 local restoration ecologists and practitioners informed the direction and contents of this guide. Part 1 provides general information about pollinators and their habitat. Parts 2-4 walk the practitioner through site level restoration considerations. Part 5 provides policy recommendations for municipalities and land managers, as well as BMPs by habitat type. Part 6 includes suggested plant lists. This guide is not comprehensive- practitioners should do further investigation of each BMP for context, as it relates to their specific site.

This guide is based on the 'set the table' concept that by actively restoring the physical structures and plant communities of an ecosystem, species diversity, network resilience, and network function can follow (Kaiser-Bunbury et al. 2017).

The Practice of Ecological Restoration

"Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (SER, 2004).

This developing and dynamic field seeks to actively create a world where humans and nature thrive together. Restoration is evolving on many fronts- in scientific studies, boardrooms, classrooms, and of course, in the field. Educational guides like this one, aim to digest the diverse mix of science, practice, anecdotes, failures, and lessons learned, into a useful resource. More and more, these resources tell us that in most cases, we cannot recover nature to a historical paradise that once was. Instead, what we can 'restore' is connectivity, resiliency, and natural processes, within a context that is always changing.

We Are On Coast Salish Land

We acknowledge that all of the land and water of our region on which we practice restoration is the home of the Coast Salish tribes. With the current challenges our planet faces, we recognize how strongly we draw from the wisdom and traditions of the Coast Salish peoples, who for thousands of years have inhabited and managed these lands. Today, as sovereign nations and co-managers of natural resources in our area, Tribes remain active in the long-term conservation and protection of our natural resources with sustainable principles and practices.

PART 1: WHY NATIVE POLLINATORS?

"Just as a keystone maintains the integrity of a stone arch, a keystone species maintains the integrity of an ecological community; the removal of a keystone in either case can result in a collapse of the entire structure" (Berenbaum, 2007).

Figure 2. Western tiger swallowtail (Papilio rutulus) on mock orange (Philadelphus lewisii). Photo: David Droppers

Pollination - A Love Story

Flowering plants and pollinators literally need each other. The partnership evolved over hundreds of millions of years, developing an enduring and mutually dependent ecological relationship. Put simply, pollination is the transport of pollen from the male anther to the female stigma of the same or of another flower. As flower shape, color, scent, and nectar-sweetness evolved, these traits attracted animal pollinators to do this bidding. Although some plants self-pollinate, and some use wind or water to transport their pollen, most flowering plants rely on animals for genetic exchange. Animal pollinators aid roughly 308,000 flowering plant (angiosperm) species to reproduce, which is 87.5% of all flowering plants worldwide (Ollerton et al. 2011)! In the Pacific Northwest, hummingbirds, bees, butterflies, moths, flies, wasps, and beetles are examples of pollinators that feed on sugary flower nectar and/or protein-rich pollen.

…And we need them! 35% of all human food crops (Klein et al. 2007) are animal pollinated. This puts them at the heart of global food web stability. Not only do plants serve as food for countless organisms, but many invertebrate pollinators themselves provide an important source of fats and proteins for the food web. Also, pollinators are allies in ecological restoration, as they support the natural regeneration process of a native ecosystem. They can also encourage genetic diversity by connecting male and female flowers across distances.

…And they need us! Many pollinating species are on the road to extinction. For example, the Red Lists of Pollinator Insects of North America identifies many imperiled insect species most in need of conservation (Xerces, 2005). To achieve stable plant and pollinator populations we must strive for lots of them (high abundance), lots of types of them (species diversity), and variation within those types (genetic diversity).

Five Threats

The following causes are generalized descriptions of the largest threats to overall pollinator species diversity and abundance:

Habitat Loss and Fragmentation: Natural areas and green spaces, which provide nesting sites and floral resources, are increasingly lost to development, intensive agriculture, and resource extraction. Remaining habitats are often cut off and isolated, which for example in the case of the Taylor's checkerspot butterfly, "results in smaller and isolated populations, thereby increasing the likelihood of extirpation and inbreeding" (Potter, 2016).

Habitat Degradation: Remaining natural areas and green spaces are degraded by factors including air, noise, water, and light pollution, invasive species, intensive soil disturbance, and fire suppression.

Pesticides: Many insecticides and fungicides are directly toxic to pollinators and herbicides can kill the plants they depend on.

Non-Native Species: Non-native plants and pollinators outcompete, introduce disease to, and can ultimately displace many native species, reducing their abundance and diversity. For example, commercial bees threaten several species of native bumble bees with decline and extinction by spreading nonnative fungal and protozoan parasites (Xerces, 2011, p78). Also, large infestations of invasive plants, such as Japanese knotweed (*Polygonum cuspidatum*) or Himalayan blackberry (*Rubus bifrons*) may produce an enormous short-lived bloom for bees, but the varied assemblage of native plants that these invasive monocultures displace would have provided more even, diverse, and sustained food sources throughout the year.

Climate Change: The rapid alteration of rates and patterns of temperature and precipitation directly threatens the survival of some pollinator and plant species. These climatic changes place novel selective pressures on plants and pollinators. For example, climate change can cause a timing mismatch between plant flowering and pollinator arrival, or a spatial mismatch when plants and their coevolved pollinators no longer occur in the same habitat fragments (Burkle et al. 2013; Steltzer & Post, 2009).

A Note on the European Honey Bee

Any introduced species, be it farmed salmon or honey bees, has the potential to displace habitat and transmit disease to native wild populations. Although honey bees (*Apis melifera*) are integral to our industrial food production system, they are not native to the Pacific Northwest (or North America at all), and therefore not the focus of this guide. Furthermore, our native bees also pollinate food crops! In fact, mason bees are more efficient pollinators than honey bees for some crops (Biddinger et al. 2011). That said, many of the same practices outlined in this guide that benefit native bees will benefit honey bees as well.

PART 2: SITE ASSESSMENT

The following six factors will help to paint a basic portrait of your site. The information that follows can guide you in determining the existing habitat qualities found on your site, and help you fill in any important missing elements.

These factors have also been quantified and condensed into a Habitat Assessment (**see Habitat Assesment Form**) to help you plan for improvements and track changes to your site over time. Even if your assessment reveals serious challenges, there is likely *something* you can do to improve habitat for pollinators. Be clever with your resources, be imaginative in your design, and think like a pollinator! Of note- while a site with open exposure to the sun does heat up cold-blooded pollinators, and a view of the sky does help them to navigate, full sun is not necessary for creating valuable habitat. Shady and partially-shady sites can still provide rich structure and forage for many pollinating insects and birds, or can be a food source for larval stages of pollinators, such as butterflies.

1) Logistics Checklist

- ☐ **Permission:** Do you have permission from the landowner? Do you need any specific permits or have constraints to consider? If relevant, check on zoning regulations, critical areas ordinances, building codes, and underground or overhead utilities.
- ☐ **Boundaries:** What are the exact boundaries of your site? Flag or map the perimeter clearly, paying attention to property lines. Note that parcel lines (viewed through King County iMap or Parcel Viewer) cannot be solely depended upon for accuracy. Additional surveying may be required if your project is near a property border.
- ☐ **Access:** Where are the access points to the site for crews, volunteers, and/or deliveries of materials?
- ☐ **Size:** What is the square footage or acreage of your site?
- ☐ **Site Prep:** How much site preparation (invasive weed control, trash removal, de-paving, etc.) is necessary? Is it high intensity and requires professional crews, or low intensity and can incorporate volunteers?
- ☐ **Volunteer Friendly?** This means that the site is not on steep slopes and is relatively safe from falling overhead branches, broken glass, and other hazards. Volunteer events are a great way to accomplish a lot of work and get the community invested in your project.
- ☐ **View Constraints:** Are there height limitations on plants due to public rights of way, residential views, or sightlines?

2) Determine Pollinator Habitat Type

'Habitat Type' is a broad categorization of your site according to factors including geography, geology, land use, soil, moisture, light, and plant communities. Your site will likely fit, or be on a restoration trajectory towards, one or more of the following general categories for the Puget Sound lowlands. See full recommendations here: **5.2 Management Recommendations by Habitat Type.**

Upland Forests: conifer, deciduous, mixed

Riparian Areas: river, stream, lake, wetland, wet meadow, freshwater riparian forest, marine riparian forest, dune, bluff, backshore

Prairies, Savannas, Oak Woodlands

Green Stormwater Infrastructure: rain garden, bioswale, stormwater detention pond

Agricultural Areas: farm, orchard, garden, hedgerow

Contained Spaces and Lots: traffic circle, parking lot, green roof, schoolyard, home landscaping

Corridors and Roadsides: rights of way, roadside, trailside, power line corridor, airport runway

3) Assess Topography and Features

Aspect: Which cardinal direction does the site or main slope face? Although any aspect can provide habitat, many invertebrates show preferences for sunny and well-drained south facing slopes.

Topography: Any mounds or depressions? For example, your site may be mostly dry and sunny, but a north-facing depression tucked within your site could provide a refugium for cold and moisture loving plants. Slopes? If you plan to work directly on an erosion-prone and/or steep (>40%) slope, you will need a slope stabilization plan before disturbing it. If the slopes are very steep, a geotechnical engineer may be necessary to evaluate for erosion or landslide potential.

Habitat Features: Estimate a density per acre of standing dead trees and downed logs. Are rocks or boulders a major feature? Any flowing or still water?

4) Assess Soils

Soil moisture and composition are clues that help determine habitat type, erosion potential, plant selection, and plant establishment options like watering. Observe these two factors at several different locations within the site:

Soil Drainage: Do the soils appear to drain fast, average or slow? Are the soils generally dry, moist or wet? Be sure to check for low lying areas where water might pool, as well as proximity to water sources like seeps or streams. A plant assessment will also provide soil moisture clues based on what type of plants are growing.

Soil Composition: Are the soils mostly sand, clay, or loam? Perform a simple 'ribbon test'.

You may choose to send a soil sample to a lab for testing of nutrient levels, mineral composition or if toxic levels of pollutants are a concern (e.g. if the site is near a lead-painted barn). If toxicity is not a concern, then soil testing is not usually prioritized due to budget constraints (although King Conservation District tests for free, and other local Conservation Districts or Cooperative Extensions may test inexpensively). You can also explore soil information (including soil composition, depth to hardpan, drainage information) through the online USDA resource – the Web Soil Survey.

Figure 3. Satyr comma (Polygonia satyrus) on bark. Photo: David Droppers

Soil amendments are often expensive and time consuming. Tilling them in can damage soil structure and destroy ground-nesting bee and bird habitats. Avoid major soil amendments or inputs if the soil composition includes a loamy component. However, if the soil is pure clay or sand, amending the top 4-6 inches of your topsoil with compost or a topsoil product may be necessary. If you have poor soil, and a soil amendment is not feasible, consider planting a more limited palate of plant species that will tolerate the existing soil conditions.

5) Assess Plants

Plants observed on site (or on reference sites or adjacent property) will not only inform your plant selection (**see Part 6: Plant Lists**), but provide clues to the habitat type and soil moisture questions as well. Make detailed observations of existing plant species and abundance. Which plants are thriving and which plants are distressed? Also, make notes about soil moisture and light exposure.

6) Observe Reference Sites and Adjacent Property

A reference ecosystem is "a community of organisms and abiotic components able to act as a model or benchmark for restoration. A reference ecosystem usually represents a non-degraded version of the ecosystem complete with its flora, fauna, abiotic elements, functions, processes and successional states that would have existed on the restoration site had degradation, damage or destruction not occurred – but should be adjusted to accommodate changed or predicted environmental conditions." (McDonald et al. 2016)

A true reference site may not exist. You may need to observe multiple sites, historical records, and anecdotes from locals familiar with the area, to piece together information about what plants, wildlife, soil and hydrological conditions are or were present. Reference sites can be tricky to learn from, due to the nuances of each site's specific history, conditions, management goals, and external stressors.

"The formulation of a reference ecosystem involves analysis of the composition (species), structure (complexity and configuration of species) and functionality (underlying abiotic and biophysical processes and community dynamics of organisms) of the ecosystem to be restored on the site. The reference ecosystem should also include descriptions of successional or developmental states that may be characteristic of the ecosystem's decline or recovery and descriptions of ecological stressors and disturbance regimes that need to be reinstated." (McDonald et al. 2016)

Lastly, check out adjacent properties for any red flags such as insecticide use or invasive plants.

Now that you have gathered information on these six key factors, you should have a broad snapshot of your site. Your site assessment will also directly inform future choices about plant selection, habitat feature installation, and expected maintenance. Don't forget that even if you find out that your soils are all clay, or the site is covered in invasive weeds, there is still reason for hope! Just make a smaller goal.

Figure 4. Yellow-faced bumble bee (Bombus vosnesenskii) nectaring on Douglas spiraea (Spiraea douglasii). Photo: Nelson Salisbury

PART 3: SITE DESIGN

Once you have completed Part 2: Site Assessment, consider all you have learned about your site. Absorb the theoretical framework of 3.1 Attributes of Pollinator Habitat Integrity and integrate specific considerations from 3.2 Pollinator Resource Requirements and 3.3 Site-level Design with your unique site in mind. Keep in mind that not all of the suggestions may apply to your site. If your site is an intact and functional ecological community with little to no external pressures, it may benefit from a few small enhancements or a more passive approach. If your site contains little native habitat, is fragmented, severely altered, and/or suffers from high pressures, then consider a more intensive restoration.

3.1 Attributes of Pollinator Habitat Integrity

These attributes of ecological integrity may not apply to every site, but they set a general context for specific pollinator habitat restoration BMPs. They should inform development of long term goals and short-term objectives.

Size. The larger the geographic extent of the habitat, the more opportunity for ecological community establishment, wildlife mobility, and natural processes. Although any sized habitat area provides benefits, at least 2,000 square feet (0.05 acre) is optimal, and a size of at least two acres has been shown to provide even greater benefits (Morandin & Winston, 2006; Kremen et al. 2004).

Connectivity. "Reinstatement of linkages and connectivity for migration and gene flow; and for flows including hydrology, fire, or other landscape scale processes" (McDonald et al. 2016). Sustainable pollinator populations will ultimately be achieved at the landscape scale. "Landscape connectivity is the degree to which the landscape facilitates or impedes movement among resource patches" (Taylor et al. 1993). At the land planner/manager level, this requires that we design for and physically connect individual sites to create networks of habitat. At the site level, create your design to maximize connectivity and flow throughout your site, and possibly with neighboring sites as well. To link two or more areas, consider a connective corridor or stepping-stone patches of flowering plants less than 500 feet apart for small bees and up to a couple miles for bumble bees.

Physical Conditions. Hydrological and substrate conditions (McDonald et al. 2016), and habitat features including shelter and water sources, will set the table for biodiversity.

Biodiversity.

Richness. The variety of species, and genetic variation within species, to represent a rich, multiplicity of living forms.

Evenness. The relative abundance of each species within a certain area.

Structural Complexity. A robustness or a layering of the physical structures (e.g. vertical strata of plant heights) and trophic webs of the system.

Ecosystem Functionality. "Appropriate levels of growth and productivity, reinstatement of nutrient cycling, decomposition, habitat elements, plant-animal interactions, normal stressors, on-going reproduction and regeneration of the ecosystem's species" (McDonald et al. 2016).

Resistance and Resilience. Resistance is the capacity of a system to tolerate a stressor without loss. Resilience is the capacity to recover or reorganize after it has been disturbed, degraded, or invaded. (Lake, 2013) Size, connectivity, structural complexity, biodiversity, and ecosystem functionality (mentioned previously), and the following aspects, can increase resistance and/or resilience:

Redundancy. Repeated clumps of plant species, multiple habitat features, or numerous spots of bare ground, spread throughout the site, creates spatial redundancy. Providing multiple species of flowers in bloom throughout the year, especially during the potentially more vulnerable late season (Fantinato et al. 2018) creates temporal redundancy.

Buffered from Excessive Stressors (Faber-Langendoen et al. 2012). Examples include invasive weeds, human or pet activities, mowing, stormwater pollution, pesticide application or drift, drought, or flooding. Some of these examples are manageable and others are not. Depending on the stressor, consider how to use natural buffers (e.g. adjacent natural areas, hedgerows) or impose practices (e.g. minimize social trails, limit pesticide use, establish a pollinator-friendly mowing regime, etc.) to minimize stressors.

3.2 Pollinator Resource Requirements

Many pollinators are known as generalists- they can feed on a wide variety of plants. The following principles will encourage a foundation for generalist pollinators. Once the basic conditions are established, consider creating resources for specialists-pollinator species who will only feed on specific plants.

Figure 5. Fuzzy-horned bumble bee (Bombus mixtus) on Nootka rose (Rosa nutkana). Photo: Nelson Salisbury

Figure 6. Harsh Indian paintbrush (Castilleja hispida), broadleaf lupine (Lupinus latifolius), and thimbleberry (Rubus parviflorous) growing together. Photo: Nelson Salisbury

FOOD: Pollinators can be drawn to a plant's flower based on perfume, color, size, shape and the timing of its bloom. Consider the following:

- **Native plants** are naturally adapted to the climate, soils, and pollinators of the region. To establish, they require no fertilizers and little to no watering. They do not negatively encroach, degrade or invade our local eco-systems like many non-native plants do. Although some non-native plants may provide sources of pollen and nectar, larval life stages of native pollinators often depend on native plants. In some instances, such as a backyard, community garden, or farm cover crop, non-native plants may be used if deemed by the land manager as not invasive. If you choose to stray from strictly native plants, consider choosing plants which are "native neighbors", such as plants native to Southern Oregon, Northern California, or Eastern Washington.
- **Species Diversity.** In Phase II (see **Part 4** to learn about the phase approach), start with at least 10 species of flowering plants that fit your moisture,

light and soil conditions. At first, choose hardy species and get them to establish. In Phase III, monitor which species died, thrived, or just survived. Supplement according to what you find- try out several more species to maximize diversity as your site approaches Phase IV.

- **Structural Diversity.** A variety of plant forms (e.g. branching trees, thicket-forming shrubs, creeping groundcovers, etc.) will support a variety of insect and animal species. Strive to establish multiple vertical layers (strata) of plant heights. Where appropriate, include both annual and perennial species, as well as both woody and herbaceous plants. Even non-flowering plants, like sword fern, are helpful in a pollinator restoration because they are hardy evergreens that create structure. Flowers with a variety of different shapes (e.g. flat radials, cups, rounded domes, tubular trumpets, etc.) will appeal to different species of pollinators. Evergreens can be used on the site borders to help block noise, air pollution, pesticide drift, etc. from other properties.

- **Overlapping bloom times** throughout the season provide a continuous sequence of nectar and pollen resources from spring to autumn. **Part 6: Plant Lists** are divided into three groups: early-bloom season, mid-bloom season, and late-bloom season species. Aim for at least three species blooming in each season.

Figure 7. Woody debris installation and plants staged in 'species clumps' on the Burke Gilman trail, Seattle, WA. Photo: Matthew B Schwartz

- **Transplants or seed?** Transplants (plugs, bare roots, potted plants, live stakes) are more expensive than seed, but establish quickly and bloom the first year. Seeds are inexpensive but can be difficult to establish or even germinate. Depending on the site size and budget, using a majority of transplants with some experimental seeding in between plant clumps, is a cost-effective way to start. Observe successes and failures and supplement throughout Phase III accordingly.

- **Plant species in clumps,** preferably in a rounded shape. A clump of flowers, rather than separate individuals, helps pollinators locate them. This formation also improves plant establishment and makes maintenance between clumps easier. A round shape to the clump minimizes the edge-to-area ratio making it less vulnerable to weed invasion.

- **Contained sites,** such as garden beds, traffic circles, or rain gardens may benefit from a selection of slower growing species, since aggressive species can quickly dominate and limit diversity.

Figure 8. Halictus at nest entrance Photo: Will Peterman

Figure 9. California bumble bee (Bombus fervidus, ssp. californicus) on rock. "Vulnerable" on the IUCN Red List of Threatened Species. (Hatfield et al. 2015) Photo: Nelson Salisbury

Figure 10. Osmia in snag. Photo: Will Peterman

Figure 11. Ceratina in pithy stem. Photo: Will Peterman

SHELTER: Pollinators need safe places for nesting, egg laying and overwintering, ideally located within 300 ft of a food source. Consider the following:

- **Undisturbed and untidy** sites provide the best shelter. In agricultural areas, no-till practices can dramatically limit soil disturbance. In landscaping areas, it is beneficial to leave some designated areas in an un-manicured state by leaving branches and leaves on the ground, and minimizing mowing.
- **Dead wood** includes standing dead trees, downed logs, stumps, root wads, log rounds, untreated lumber, and chunks of bark. "Significant proportions of

wasp, bee, and ant (Hymenoptera) species live in decaying wood" (Stokeland et al. 2012). Consider placing large wood in the shade. As fungus rots it out, holes, peeling bark, or bits of wood can be utilized as lodging or for housing materials by butterflies, beetles, and bees.

- **Hugelkultur** is the creation of raised beds embedded with layers of logs and dead plant material. They retain moisture, provide long and short-term carbon and nutrients, and support various root structures of various plant species. The beds can be built at any height and plants are installed on the top and sides. This is an excellent way to diversify the topography of a site, especially if it has readily available downed branches and leaves.

- **Compost or brush piles** are great nest sites for bumble bees. If you need to flip a compost pile to remove invasive weeds from underneath it, first examine the pile for signs of bee nesting. If so, flip the pile during summer, not during winter nesting season. Do not apply herbicide to piles at any time.

- **Rocks** provide safe and dark spaces for all kinds of invertebrates. Piles of rocks can provide overwinter refuge and cover for butterflies and bumble bees. If rocks are already on your site, it is more valuable to leave them and not disturb the critters already using them. If importing rocks to a site, consider making a few piles and placing near plantings, as they keep moisture in the ground during summer.

- **Spots of bare, undisturbed ground** allow ground-nesting bees to make a home. They need a few spots that are un-vegetated and un-mulched, even better if they are sunny and gently sloped. Well-draining soils that are sandy or loamy are preferred.

Figure 12. Educational sign along a clearly marked path promotes "guided inclusion" into a site. Kincaid Ravine Natural Area, UW. Seattle, WA. Photo: Matthew B Schwartz

- **Pithy or hollow stems** are used by cavity nesters who burrow into the stems (e.g. elderberry, salmonberry). Select plant species which support this nesting structure.

- **Larval host plants** are critical for moths and butterflies. Adults generally choose to lay their eggs on or near the specific plants that larvae need to eat once they hatch. Some butterfly species require very specific plants to complete their lifecycles, such as Milbert's tortoiseshell (*Aglais milberti*) that only lays their eggs on stinging nettle (*Urtica dioica*). **Part 6: Plant Lists** highlights some common native species used as host plants in our region.

- **Grass and sedge species** can act as larval host plants for some butterflies and provide overwintering or nest sites for bumble bees and other beneficial insects. Grasses and sedges can provide forage resources for beneficial insects (including larval growth stages of native butterflies), potential nesting sites for colonies of bumble bees, and possible overwintering sites for beneficial insects (Kearns & Thompson, 2001; Purtauf et al. 2005; Collins et al. 2003). The combination of grasses and herbaceous plants can also be an effective way to limit weed colonization (Vance et al. 2006). Grasses also produce conditions suitable for burning if this practice is to be considered. Where appropriate, try to include at least one native bunchgrass in your plant palette.

WATER: Clean water provides a bathing and drinking source for pollinators. A shallow water source with gentle banks is best, but do not modify any natural water features that are already hydrologically functional. Running, ponding, or containerized water can be complemented by well-placed riparian and wetland plants of varied heights. Wet, muddy areas provide mud for nest building or mineral feeding. Hydrology improvements can be complicated and require permitting, but any appropriate actions to improve the function of seeps, ponding areas, creeks, wetlands, or rain gardens, will likely benefit pollinators as well.

3.3 Site-level Design

Now with the theoretical and practical considerations from the last two sections in mind, work through the following design checklist. Create a realistic and interesting design, but allow for flexibility as challenges arise throughout the process. The design must reflect the resources you have available (time, money and people power). Keep the design realistic- it is better to commit to high quality work on a smaller area than to spread your resources too thin and risk implementing a large but low-quality project.

- **Management Units:** If the site has areas with different management objectives, or distinct Habitat Types, divide the site into more than one Management Unit (MU).
- **Square Footage:** Calculate square footage or acreage of the entire site and each MU.
- **Site Prep:** Create a site preparation plan for each MU (see **4.1 Phase I: Site Prep**).
- **Habitat Features:** Create a design for placement of habitat features, as necessary. If your site has some diverse topography, wood, and rocks, you may leave it as is and skip right to planting. If installing features would add needed complexity to your site, then consider installing woody debris, water features, hugelkultur, rocks, etc. If possible, embellish any existing features right where you found them to minimize unnecessary heavy lifting and soil disturbance.

- **Planting Plan:** Refer to your site assessment of soil moisture, light exposure, and existing plant species. Work with the conditions that you have and only choose plants that are appropriate for your site. Include plants that are important to all life-cycle-stages of pollinators. When ordering plants, confirm with the nursery that that the plants you purchase are insecticide-free, weed-free, and of local genetic stock. (see **Part 6: Plant Lists**)

- **Timeline and Season: Part 4: Restoration: A Four Phase Approach** provides guidance on the four phases of restoration. Plan out a timeline and consider the appropriate seasons for each activity. If there are insects or birds who already use your site, then conduct restoration activities according to the season that will do the least harm. For example, nesting songbirds may use blackberry thickets. The thickets can be removed during non-nesting season, and in phases to create a more gradual transition for the birds.

Figure 13. Red admiral (Vanessa atalanta) on vine maple (Acer circinatum) at the Wetherill Nature Preserve, Hunts Point, WA. Photo: Nelson Salisbury

3.4 Specific Pollinator Requirements

Fun facts that shed light on a handful of specific requirements for common PNW pollinators:

- **Bees:** All 20,000 bee species are obligate florivores, as opposed to any other type of non-bee pollinator. Also, bees feed on flowers at both the larvae and adult stage, rather than other non-bee pollinators who only feed on flowers as adults. (Michener, 2007)

- Most native bees are **solitary**- they nest individually or in small groups. Most solitary bees are **ground nesters**, e.g. digger bees, mining bees. Look for pencil sized holes surrounded by tiny mounds of dirt, typically found in areas of compressed soils.

- **Bumble bees** are generalist, social bees who like to nest in old rodent holes, compost piles, or rock piles.

- **Leaf cutter bees** need medium-thickness leaves that are smooth on one side to construct their nests, e.g. snowberry or rose species. They are cavity nesters and prefer small diameter (size of a nickel or smaller) pre-formed holes in rotten wood to overwinter and lay their eggs in.

- **Mason bees** are solitary cavity nesters who need wet mud (high in clay content) to seal their eggs into chambered nests. They look for cracks and crannies aboveground to lay their eggs, such as bored holes in logs. There are approximately 300 mason bee species in the Northern Hemisphere, with an estimated 75 species found in the PNW.
- **Sweat bees** are relatively small, they pollinate by climbing deep into flowers and spend a lot of time drinking nectar and collecting pollen.
- **Mining bees** are ground nesters with one female creating a few nests during her adult lifetime, which often lasts just four to eight weeks.
- **Cuckoo bees** are parasitic, and lay eggs in the nests of other bees.
- **Travel** abilities vary greatly. Some bumble bees can travel more than a mile, but smaller species may travel no more than a few hundred feet.
- **Moths** are nighttime pollinators and they need night-blooming plants. Artificial light at night disturbs their life cycle.
- **Hummingbirds** have no sense of smell. They pollinate tubular flowers with their long bill, and are mostly drawn to reds and hot pinks.
- **"Mud-puddling"** butterflies congregate in areas of wet or moist soil in search of salt and other minerals.
- **Red, orange blooms** more often draw hummingbirds and butterflies. Bumble bees can't see red.
- **Blue, purple blooms** are a big draw for bees.
- **Syrphid flies:** (the native) "syrphid fly larvae may quickly suppress aphid infestations, as each is capable of destroying hundreds of aphids during its development" (WSU, 2017).

Figure 14. A blackberry monoculture removal and sheet mulching. Mulching will be phased out as invasive plant control is achieved to allow bare spots for ground nesters. Burke Gilman trail, Seattle, WA. Photo: Matthew B Schwartz

PART 4: RESTORATION: A FOUR PHASE APPROACH

This timeline is an improvised version of the Green Seattle Partnership's four-phase restoration approach. The goal of ecological restoration is to facilitate recovery of ecological functions and the structure of a self-sustaining system. That said, our highly altered landscape requires active stewardship to assure persistence of critical ecosystems services, such as pollination. The entire process values adaptive management - a real time decision tool to adapt and flex as unexpected challenges or opportunities arise.

4.1 Phase I: Site Prep and Initial Invasive Plant Control

Thorough site preparation is essential for success. This includes control of weeds, any soil amending, and cessation of any insecticide use within a minimum of 100 ft of the site. Educational signage can go a long way in engaging the community and identifying future supporters and volunteers.

- **Invasive plant control.** Methods should follow an Integrated Pest Management (IPM) plan and are listed in **Table 1**. In areas with high invasive weed coverage, expect more than one year to achieve control. Methods and timing of weed control depend on the life cycle of the particular species. Control heavily-seeding plants, such as *Impatiens spp.,* before they go to seed. Manual removal of heavily rooted species, such as English ivy, is easier in late spring or early fall when rain has softened the soil. Herbicide treatments should be conducted by a licensed operator, considering proper timing, chemical, and concentration.

Inquire with the land manager for more information or to request herbicide applications for your site.

- **Soil amendments.** Soil enrichment can be expensive and time consuming, so avoid it if you have decent soil composition. However, if your budget allows and your soil is pure clay or sand, mix in 4-6 inches of compost to the top layer. (see 'Assess Soils' in **Part 2**)

- **Mulch.** A great restoration tool, mulch provides weed suppression, retains moisture, and adds organic content to the soil. However, it also obstructs ground-nesting pollinators and can smother herbaceous plants and bryophytes. Either plan to phase out mulching after your plant stock becomes fully established, only mulch in certain areas (e.g. mulch rings around your installed plants), or do without. If you do without, more vigilant weeding will be necessary.

- **Take care with soils.** Excessive social trails, tillage, compaction, and digging more than necessary, disrupt the soil community including pollinator nest sites. It can take hundreds or thousands of years for soils to develop their structure and living community of bacteria, fungi and insects, so tread lightly.

Figure 15. Echo azure (Celastrina echo) on a log near the Puyallup River in Orting, WA. Photo Nelson Salisbury

- **Leave it messy!** Logs, branches, leaf debris, rocks, dead plants, and compost piles are all structural and nutrient resources for a rich and diverse insect paradise.

- **Avoid geotextile fabrics**. Wide swaths of fabric (used for weed suppression) can block ground nesting pollinators so if sheet mulching is necessary, utilize biodegradable burlap or cardboard.

Table 1.Summary of Initial Weed Control Methods by the Institute for Applied Ecology. (Prairie Landowner Guide for Western WA, 2011)

Control Method	Advantages	Limitations	Type of Site Where Method is Most Applicable
Hand pulling	Inexpensive and requires only basic tools and expertise. If done properly, removes entire root system of weeds. Targets only invasive species.	Time consuming and usually requires repeated pulling over time to remove all weeds.	Small sites or patches of weeds interspersed with desirable native vegetation.
Sheet mulching or smothering	Inexpensive. Doesn't require experienced landscapers or heavy equipment. Suppresses and kills all vegetation.	Labor intensive. Kills native plants. Does not eliminate the weed seed bank.	Degraded sites dominated by invasive species. Small areas or large areas with scattered patches of weeds.
Solarization	Effective at killing existing vegetation and weed seed bank.	Covering material may be expensive and must stay installed properly, requiring maintenance following wind or other damage. Some seeds are extremely long-lived and would need repeated years of solarization to exhaust the seed bank.	Small areas or patches within larger areas. Relatively flat places without obstacles. Heavy infestations with little to no native component.
Cultivation	If large tilling equipment is available, can be done quickly and efficiently. Can be performed at any time of year.	Labor intensive and may require special equipment or experienced landscapers. Does not affect the weed seed bank. Leaves behind or spreads segments of weeds that can resprout. Should not be performed in protected Mima Mound areas.	Small or large areas but not in Mima Mound habitat.
Prescribed Burning	Effective method that mimics historic fire processes. Can remove moss and thatch layer.	Requires expert oversight to avoid damage to structures or neighboring properties from fire. May require follow up herbicide treatment (see resources appendix).	Large parcels.
Herbicides	Specific herbicides can be used that target non-native grasses (and avoid natives). Cost effective for larger areas. Spraying can be done over large areas or spot treated at precise locations.	Requires careful use of toxic chemicals.	Most sites if herbicide is applied correctly per label instructions.
Mowing	Low cost if a mower is readily available. Does not require special expertise. Reduces future weed seed bank if timed prior to seed set.	May weaken but does not remove the weed root system. Affects desirable native herbs as well as weeds.	Relatively flat sites dominated by weeds, where the other control methods are not feasible.

4.2 Phase II: Native Plant and Habitat Feature Installation

- **Habitat Feature Installation** (e.g. woody debris placement) or **Earth Moving** (e.g. hugelkultur, water diversion). This should happen in the dry season and before plant installation. Try to use materials found on site and aim for minimal disturbance.

- **Plant Sourcing.** Buy from local nurseries. Genetics matter; plants whose seed source is local have the best chance of establishing at your site and being a good match for native pollinators. Ask about provenance- what seed transfer zone or geographic area is the plant sourced from? Consider genetic stock from your own seed zone or (considering regional warming trends) a slightly warmer, drier seed zone. Demand weed-free plants and seeds. If collecting your own seeds, search out best management practices for the correct identification, ethical collection, and proper storage and cleaning, such as "Native Seed Collection Guide For Ecosystem Restoration" by Lucinda S. Huber (August 1993) or "Collecting and Using Your Own Wildflower Seed" by James Eckberg et al. (2016).

- **Start with 10 Hardy Plant Species.** At least three flowering species per bloom season.
- **Timing**. Plant installation in mid-Oct through early March takes advantage of the rains. If planting a wetland, or supplemental watering is feasible, then timeline flexibility increases.
- **Staging.** Place shrubs and groundcovers in same-species clumps of at least 3 ft by 3 ft blocks. Pollinators can locate a clump more easily than an individual plant. Repeat these clumps throughout condition-appropriate areas of your site. Even larger single-species clumps (more than 25 sq ft) can be exponentially more beneficial at large sites.
- **Spacing.** Plan for maturity when you design a planting plan. Place shrub clumps 4-8 ft from other plants. Space groundcover clumps out 1-2 ft from each other, and put them at least 4 ft from shrubs and 10 ft from trees to avoid them getting crowded out. Space small trees individually 10-15 ft from other plants.
- **Invasive Plant Control.** Vigilant weeding is required at this stage to protect newly installed plants. Controlling invasive species is a continuous task and one of the most critical factors to project success.
- **Bee Hotels.** Structures can be created from wood, bamboo, or other materials, to attract solitary nesting bees and wasps. It is important to research BMPs for constructing and maintaining these structures if they are to be successful. Of note- artificially aggregating large populations of bees can be a vector for disease or parasites. If you choose to install these structures, bee boxes should be cleaned annually with great care and monitored throughout the season for signs of pest infestation.

4.3 Phase III: Native Plant Establishment

- **Invasive Plant Maintenance.** Vigilant weeding at this stage protects newly installed plants.
- **Mulching.** Replenish mulch rings as needed to suppress weeds and retain moisture for installed plants. In order to leave bare areas for ground nesters, and to allow for volunteer plant sprouting, phase mulching out over time.
- **Watering.** Over the first few years, installed plants may benefit from watering. If deemed necessary, plan for summer watering for at least two years from June-Sept.
- **Soil Rebuilding.** Strike a balance between vigilant weeding and leaving soils free to rebuild structure without unnecessary compaction or disturbance. Knowledge of proper weeding techniques can aid with conserving soil structure.

- **Multi-Year Consistency**. Several years are essential for proper Phase III plant establishment. Regular maintenance is essential and will be necessary for several growing seasons until the plants become firmly established.

4.4 Phase IV: Long Term Stewardship

This is an extended period of infinitely maintaining a restoration site. Monitoring and control of invasive weeds is paramount. As invasive weeds decline, introduce supplementary waves of planting as appropriate to the site. These supplementary plantings focus on reinforcing both species diversity and structural diversity on the site. This may include promoting a more complex shrub layer, delicate wildflowers, groundcovers, or bunchgrasses.

Figure 16. Syrphid fly (Helophilus trivittatus) on Douglas aster (Symphyotrichum subspicatum), Snohomish estuary, WA. Photo: Nelson Salisbury

Sites that require intensive management, such as burning or mowing, should be monitored to gauge whether these actions are working or need to be adapted. Otherwise, if properly maintained, the site should enter a trajectory of increasing self-sustainability. Although there will always be stressors, the natural processes of soil building, water capture and retention, micro-climate stabilization, plant rooting, seed dispersal, and pollination will begin to re-regulate the system without you! However, even in the later stages of site establishment, site managers should continue to monitor restoration sites for signs of new invasive weed infestation or other issues which require attention.

Figure 17. Temporary educational signage for the public during Phases I and II. Burke Gilman trail, Seattle, WA. Photo: Matthew B Schwartz

PART 5: A POLLINATOR'S PATH FORWARD FOR THE PUGET SOUND LOWLANDS

At the time of writing, the Puget Sound lowlands are experiencing a hyper-intensive period of development and sprawl. Fortunately, our development toolkit now sports sustainability concepts such as low impact development, green stormwater infrastructure, and renewable energy. The concept of *living landscapes*, **within and adjacent to the built environment, must also be mainstreamed into the modern sustainability equation. To achieve a sustainable region, there must be an aggressive multi-faceted shift in policy, economic valuation, design, and planning, in order to conserve and restore the necessary structures, resources and connectivity for native pollinators.**

On the whole, a single isolated pollinator restoration project achieves little. In fact, it may act only as a sink to attract existing pollinators, rather than a source that actually increases abundance and diversity. A mentality shift from the site level to the landscape level for land managers and municipalities is key to achieving functional biodiversity. This can accompany innovative opportunities related to development, agriculture, local economy, tourism, and education.

Finally, pollination is an ecosystem service under threat from climate change. Pollinator habitat conservation and restoration deserves inclusion in climate change adaptation plans.

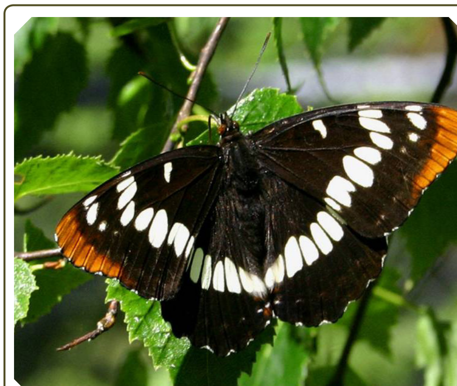

Figure 18. Lorquin's admiral (Limenitis lorquini). Photo: David Droppers

5.1 General Recommendations for Municipalities and Land Managers

Design and Planning: Integrate native pollinator restoration into urban design and municipal Open Space Plans. Promote certifications for Low Impact Development, such as LEED (which features a relevant Restore Open Habitat credit).

Valuation: Explore valuation of pollination as an ecosystem service (FAO, 2016). This is not a substitute for the multi-faceted tenets of biodiversity conservation, but a complement to it (Senapathi et al. 2015). Consider incentive programs for pollinator restoration, pollinator-friendly agricultural practices, and new or retrofitted development. Consider pollinator restoration as a mitigation tool for development.

Conservation, Restoration and Enhancement:

- Conserve sites that provide resource and nesting habitat for pollinators.
- Restore sites of potentially high pollinator value (especially large or connected tracts, or prairie and savannah habitat types), if this does not interfere with an existing target habitat type.
- Restore sites of currently low ecological value (including grass medians, power line corridors, parking lot medians, roofs, traffic circles, roadsides, airport runways, de-paved parking lots), if this does not interfere with an existing target habitat type.
- Enhance all habitat types (see 5.2) with attributes of pollinator habitat integrity (See 3.1)

Integrated Pest Management: Limit use of pesticides (insecticides, herbicides, and fungicides) and fertilizers that cause direct or indirect harm to pollinators.

- Update and revise Integrated Pest Management (IPM) plans. Achieve the most effective, least-toxic herbicide treatments by following current best management practices for herbicide chemicals, concentrations, timing, and application methods.
- Ensure accountability of applicators and operators to strictly adhere to WSDA laws and best practices for application.
- Identify and label pesticides and fertilizers that cause direct or indirect harm to pollinators.
- Develop limits for overall quantity of pesticides and fertilizers applied and explore non-chemical alternatives to controlling pests and enhancing soils.

Although acreage limits of pesticide applied are provided on pesticide labels, municipalities can even further reduce pesticide use by setting annual municipal-wide limits.

- Time chemical weed control when pollinators are less active and avoid spraying blooms.
    - Seasonally: control weeds before flowering or after flowering but before seed set.
    - Daily: most pollinators are more active in the sunlight, so control weeds closer to dawn, dusk or on non-sunny days.
- Achieve non-native plant control of large monocultures in stages, rather than complete removal in one single instance. Since there will be lag time between non-native plant removal and native plant revegetation, a staged-approach eases the transition for wildlife that utilize the non-native targeted plant, as sub-optimal substitutes.
- Follow weed control with native re-vegetation to both prevent non-native regrowth and provide pollinator habitat. Ensure thorough weed control before planting.

Equitable Community Participation: Provide opportunities for leaders and community members from tribal, rural, urban and suburban areas to lead and/or participate in policy, land use, and land management decisions related to pollinators, as well as on-the-ground restoration and long-term stewardship of pollinator habitat.

5.2 Management Recommendations by Habitat Type

'Habitat Type' is a broad categorization of sites according to factors including geography, geology, moisture, light, soil, and plant community. To refine your Habitat Type, set a more detailed target ecosystem by referencing: Rocchio, J., Crawford R. (2015). Ecological Systems of Washington State: A Guide to Identification.

The following objectives are not comprehensive best practices, but are important considerations for pollinator restoration according to your general Habitat Type.

5.2.1 Upland Forests

Coniferous, deciduous and mixed forests, from dry to mesic, can provide opportunities for pollinator habitat.

Objective #1: Promote pollinator abundance and diversity by restoring the diversity of structure and composition in forests. Allow for forest disturbance dynamics, and promote a mature canopy with canopy gaps, early seral habitat, and a complex flowering understory (aligned with the site's specific Target Forest Type).

Implementation #1:

- A mature canopy includes trees that create umbrella structure in both the canopy and the rhizosphere. Install site-adapted long-lived tree species. Promote flowering deciduous trees to represent at least 15% of the overstory. Encourage tree growth by reducing competition from invasive non-native plants.
- Forest disturbance dynamics create a mosaic of canopy gaps over time in which understory plants thrive and trees regenerate. Consider creating canopy gaps in continuous canopies to allow for enough sunlight to reach the shrub and herb understory to increase flowering. (Wender et al. 2004) Early seral vegetation is the most species rich phase of forest development in the Puget Sound lowlands.
- In the case of removing hazard trees or creating canopy gaps, consider leaving standing snags instead of removing the whole tree. Standing snags create nesting habitat for solitary bees.
- Understories are often degraded and invaded, so a restoration trajectory should aim for a well-developed and complex native understory. Install shade-tolerant shrubs of different heights to maximize vertical diversity. Complement this multi-tiered tall and short shrub layer with a carpeted patchwork of diverse flowering groundcovers in any shrub gaps.
- Develop long-term invasive non-native plant control strategies through an Integrated Pest Management plan, coupled with an Early Detection, Rapid

Response tactic for noxious weeds. Be especially strategic about limiting herbicide use in establishing forests.

5.2.2 Riparian Areas

Wet areas often maintain a high diversity of flowering plants for extended periods of the year, even when nearby areas do not.

Figure 19. Rock penstemon (Penstemon rupicola) above the Cle Elem River in Eastern WA. Photo: Nelson Salisbury

Objective #1: Promote hydrological function and water quality as the basis for riparian pollinator plants.

Implementation #1:

- Restore geomorphic and hydrologic aspects of waterbody as appropriate.
- Limit point source pollution. Agricultural: Adopt sustainable practices for water body livestock access and crossings, feed operations, and manure management. Oil Spills: Ensure nearby facilities have a Spill Prevention, Control, and Countermeasure (SPCC) plan in place.
- Limit non-point source pollution. Reduce stormwater inputs by incorporating green stormwater infrastructure into upstream basins. Manage animal waste, pesticides, fertilizers, septic tanks, soil erosion, and oil leaks. If lacking, encourage government officials to develop construction erosion and sediment control ordinances.
- Promote overhanging vegetation to cool adjacent water body and add terrestrial food-sources to the aquatic system.
- Promote bank vegetation with varying root forms to maximize erosion control.

Objective #2: Encourage plant species of varied plant heights, flower forms and branching forms, to create a diversity of both food and structure for pollinators, as appropriate to the water body.

Implementation #2:

- Promote long-term invasive weed control strategies through an Integrated Pest Management plan, coupled with an Early Detection, Rapid Response tactic for noxious weeds. Manage aggressive riverine weeds (e.g. knotweeds, *impatiens spp*., etc.) through a multi-year "survey and treat upstream-to-downstream" (STUD) approach. For wet meadows, limit conifer encroachment by thinning, mowing, herbicide, or burning, as appropriate.

- Utilize a variety of plant forms to create structure and food overhanging the water for riparian insects.
- Value litter production from overhanging vegetation. This process transfers nutrients and enriches the food web in three locations- onshore, directly instream and downstream.
- Value woody debris. Dead wood inputs create topographical diversity and thermal refugia within and around a waterbody. (Roni et al. 2015)

Objective #3: Strengthen the connectivity of water bodies to create wildlife corridors.

Implementation #3:

- Expand and connect floodplains, stream buffers, and riparian forests to strategically link landscapes and water bodies.
- Remove or retrofit barriers to passage for sediment, nutrients, woody debris, insects, and other wildlife. This includes dams, diversions, and undersized or failing culverts.
- Promote native plant species contiguity throughout a water course.

Objective #4: Dunes, bluffs, and backshores provide unique pollinator habitat opportunities at the crossroads of land and seascapes. Promote living green shorelines- achieve multi-benefit shoreline objectives by coupling green solutions to sea level rise and coastal erosion, with healthy native habitats.

Implementation #4:

- Promote native coastal flowering plants on public and private shorelines. Depending on how rocky, shallow-soiled, windy, sand-abrasive, salty and/or steep the site is, install an appropriate plant palate of coastal flowering shrubs, forbs and bunchgrass species, interspersed with trees.
- Coastal dunes, in particular, need to remain dynamic and vegetated in a patchwork of sparse and dense populations. Control non-native plant species, since they often stabilize dunes, which disrupts a dunes natural movement and function.

5.2.3 Prairies, Savannas, Oak Woodlands

These low elevation areas are highly valuable to pollinators, and they are rapidly disappearing. They are often highly biodiverse and may feature bunchgrasses, wildflowers, and Oregon white oak (*Quercus garryana*). Many prairies were historically maintained with high frequency and low intensity fire by Native American tribes, in the South Sound and in the rain shadow of the Olympic Mountains. Crawford and Hall (1997) found that historically the Puget Sound lowlands claimed 233 prairies, averaging 618 acres in size, which included 18 large prairies (>1000 acres). By 1997 there were only 29 prairies, averaging 433 acres in size, and only 2 large prairies.

Objective #1: Maintain pollinator extent- conserve existing prairies, savannas, and oak woodlands from encroaching forests, invasive weeds and residential development.

Implementation #1:

- Reduce fire suppression strategies, where appropriate. Consider a controlled burning regime to maintain an open and regenerative landscape. Minimize direct harm to existing pollinator populations with strategic consideration of appropriate burn acreage, intensity, timing, frequency and monitoring. Fires vary greatly in how they burn, and subsequently how they impact existing pollinator populations, according to the season, type and quantity of fuel, and moisture conditions (Hamman et al. 2011).
- Promote long-term invasive weed control strategies through an Integrated Pest Management (IPM) plan, coupled with an Early Detection, Rapid Response tactic for noxious weeds. If mowing is already occurring, combine with herbicide applications and/or controlled burns to reduce invasive species. Non-native grasses should be completely or mostly eradicated before installing native plants.
- Limit conifer encroachment by thinning, mowing, herbicide, or burning, as appropriate.

Objective #2: Increase pollinator extent- convert new areas of open, sunny land (such as farmland) into restored prairies to link existing prairies and expand habitat.

Implementation #2:

- Identify strategic areas that promote connectivity for acquisition or easement.
- Initiate an IPM strategy to control invasive plant species. Non-native grasses may need a combined approach of mowing, herbicide, controlled burning and/or thatch removal.
- Restrict, minimize, or rotate grazing patterns to maintain sufficient floral forage, larval host plants for butterflies, and ground nests for bees throughout the year.
- Seed a diverse mix of native grasses and forbs, including annuals and perennials. Collect or purchase seeds as locally as possible. Sow seeds according to microtopography including hummocks, hollows, and subtle changes in aspect and moisture.

5.2.4 Green Stormwater Infrastructure

Rain gardens, bioswales, and stormwater detention ponds are underestimated potential stepping stones for foraging pollinators.

Objective #1: Integrate native flowering plants and habitat structure into green stormwater infrastructure.

Implementation #1:

- Plant the uppermost Zone 3 of rain gardens with perennial flowering plants to complement the hydrological benefits of the rain garden with insect habitat.
- Use species of varied plant heights, flower forms and branching forms to create a diversity of both food and structure for visiting pollinators.
- Although rain garden systems often need leaf debris removed from Zone 1, it can be raked and deposited into Zone 3, contributing to topsoil formation, and leaving important cover for insects.
- Consider an aesthetic design of habitat structures adjacent to the rain garden, including logs, wood rounds or stumps.

5.2.5 Agricultural Areas

Farms, orchards, and gardens require pollination in order for flowers to form fruit. Native pollinators can increase crop yields, as well as prey on crop pests. Enhancing native habitat for pollinators has been shown to increase crop yields through increased pollination, especially soft-bodied fruits (Xerces, 2015). For example, the native "syrphid fly larvae may quickly suppress aphid infestations, as each is capable of destroying hundreds of aphids during its development" (WSU, 2017).

Objective #1: Minimize damage to existing insect populations.

Implementation #1:

- Reduce soil tillage and disturbance to soil-dwelling invertebrates.
- Utilize cover crops to suppress weeds, protect bare soils and enrich soil nutrients.
- Establish a mowing or haying frequency that minimizes damage to actively flowering plants and host plants for pollinator larvae.
- Establish a mowing routine timed during non-bloom periods.
- "Allow pollinators to escape mower blades by using a flushing bar on the mower and by mowing at reduced speeds (less than 8 miles per hour). Cut high (a minimum of 12-16 inches) and/or mow in patches to ensure that some pollinator

habitat is left intact." (USDA, 2015, p.29)

- Limit insecticide and herbicide damage through regularly updated Integrated Pest Management (IPM) plans. "Minimize the use of seed treated with insecticides. Use all insecticides, including seed treated with insecticide, as a component of an integrated pest management program, and only when necessary." (USDA, 2015, p.31)

Objective #2: Integrate pollinator habitat into the existing structure of the agricultural area.

Implementation #2:

- Initiate an IPM strategy to control invasive plant species. Non-native grasses may need a combined approach of mowing, herbicide, controlled burning and/or thatch removal.
- Restrict, minimize, or rotate grazing patterns to maintain sufficient floral forage, larval host plants for butterflies, and ground nests for bees.
- Pollinator hedgerows are structures that act as natural fencing, as well as a pollinator attractor to nearby crops. These can be placed as a farm border, livestock exclusion buffer, stream buffer, or wind break. Depending on the purpose, specific native plants should be selected to maximize its utility (e.g. thorny roses for fencing). Conifer dominant hedgerows can be used as a pesticide screen to intercept drift before it enters the site.
- Provide a diversity of native plants within 500 ft of crop field edges. Seed a diverse mix of native grasses and forbs, including annuals and perennials.

5.2.6 Contained Spaces and Lots

Fragmented areas, such as traffic circles, parking lots, green roofs, and schoolyards can still provide valuable habitat and resources, especially if they are strategically located as corridors or stepping stones that link to more contiguous locations. Oftentimes, viewsheds and sightlines are important to maintain, so utilize low-growing or 'creeping' varieties of flowering shrubs.

Objective #1: Manage the multiple stressors created by the edge effect (high perimeter to area ratio).

Implementation #1:

- Establish an extra-vigilant routine of maintenance and monitoring to prevent invasive weeds, trash, and pollution from dominating the site.
- Consider exclusion (e.g. fencing) or guided inclusion (e.g. clearly marked pathways) to keep humans and pets from trampling your site.

- Utilize mulch for weed suppression, moisture retention, and to add organic content to poor soils. However, mulch also obstructs ground-nesting pollinators and can smother herbaceous plants and bryophytes, so either plan to phase out mulching, only mulch in certain areas (e.g. mulch rings around your installed plants), or do without. If you do without, more vigilant weeding will be necessary.

Objective #2: Maximize the educational and aesthetic benefit of pollinator habitat in high visibility areas.

Implementation #2:

- Create immersion-learning opportunities including educational signage, benches, trails and art that draw passersby into the wondersome world of pollinators.
- Host volunteer events to engage the community, accomplish large single-day restoration feats, and publicize your pollinator project.
- Provide long term volunteer opportunities to maintain a consistent stewardship presence, including monitoring and maintenance, of the site over multiple years.
- Design your planting plan to create a varied and visually stimulating flow of bloom color throughout the year in publicly visible areas.

5.2.7 Corridors and Roadsides

Roadsides, trailsides, rights of way, power line or pipeline corridors, and airport runways are valuable potential pollinator highways if managed for floral resources and nesting structures.

Objective #1: Minimize, alter or consolidate disturbance (e.g. mowing, herbicide, light pollution) to optimize in situ habitat and/or usage of connective corridors.

Implementation #1:

- Establish a mowing frequency that minimizes damage to actively flowering plants and host plants for pollinator larvae. Ideally, "no single area should be burned or mowed more frequently than every two years, to protect dormant insects such as butterfly pupae or stem nesting bee larvae. Leaving patches untreated will ensure a population of insects to recolonize treated areas of the site." (Xerces, 2013, p.10)
- Establish a mowing routine timed during non-bloom seasons.
- "Allow pollinators to escape mower blades by using a flushing bar on the mower and by mowing at reduced speeds (less than 8 miles per hour). Cut high (a minimum of 12-16 inches) and/or mow in patches to ensure that some pollinator habitat is left intact." (USDA, 2015, p.29)

- Limit insecticide and herbicide damage through regularly updated Integrated Pest Management (IPM) plans.
- Minimize artificial light, especially at night, as it disrupts moths and other pollinators.

Objective #2: Establish native plant communities and control invasive plants to strengthen the connectivity of wildlife corridors.

Implementation #2:

- Promote long-term invasive weed control strategies through an IPM plan, coupled with an Early Detection, Rapid Response tactic for noxious weeds. If mowing is already occurring, combine with herbicide applications to reduce invasive species. Non-native grasses should be completely or mostly eradicated before sewing or installing native plants.
- Prepare soil and sew or install a combination of native annual and perennial herbaceous species, and/or shrubs according to viewshed restrictions.
- Remove or retrofit barriers to passage for flying or crawling wildlife, such as passage over highways.
- Promote native plant species contiguity throughout a corridor.

Figure 20. Woodland skipper (Ochlodes sylvanoides). Photo: David Droppers

Figure 21. Placing woody debris and planting flowering herbaceous plants at a rain garden installation in Woodinville, WA.
Photo: Matthew B Schwartz

PART 6: PLANT LISTS

The following lists are general suggestions for plants native to the Puget lowlands of Western Washington that are known to support adult pollinators or their larvae. While the lists are not meant to be comprehensive, they offer suggestions for species that will thrive in a variety of conditions (Sunny and Dry, Sunny and Moist, Shady and Dry, Shady and Moist) within our region. For each list, species are ordered by bloom season (Early, Mid, Late) and known larval host plants for Lepidoptera species are identified.

Table 6.1: Sunny and Dry Habitats: These plants generally grow in areas with full to partial sun with ordinarily dry soils.

	Scientific Name	Common Name	Form	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Bloom Color	Mature Height (ft)	Host Plant
Early-Season Bloom	*Amelanchier alnifola*	serviceberry	shrub			■	■						white	15	X
	Arbutus menziesii	Pacific madrone	tree			■							white, pink	100	X
	Arctostaphylos uva-ursi	kinnikinnick	shrub		■	■							pink	0.7	X
	Armeria maritima	sea thrift	forb			■							pink	1.5	
	Eriophyllum lanatum	Oregon sunshine	forb			■	■	■					yellow	2	
	Fragaria chiloensis	beach strawberry	forb			■	■	■					white	0.5	X
	Iris tenax	tough-leafed iris	forb			■	■	■					pink, purple	1.3	
	Mahonia aquifolium	tall Oregon grape	shrub			■	■						yellow	10	X
	Ribes sanguineum	red-flowering currant	shrub	■	■	■							pink, red	10	
	Salix scouleriana	Scouler's willow	shrub		■	■							yellow	35	X
	Sidalcea sp.	checkermallow	forb			■	■	■					pink	6	X
Mid-Season Bloom	*Achillea millefolium*	common yarrow	forb			■	■	■	■	■	■	■	white	2.5	
	Allium cernuum	nodding onion	forb				■	■					pink	1.7	X
	Balsamorhiza deltoidea	deltoid balsamroot	forb				■	■	■				yellow	3.3	
	Castilleja hispida	harsh paintbrush	forb			■	■	■	■	■			red, yellow	2.5	X
	Ceonothus sanguineus	redstem ceanothus	shrub				■	■	■				white	10	X
	Ceanothus velutinus	snowbrush	shrub				■	■	■				white	10	
	Clarkia amoena	farewell-to-spring	forb				■	■	■				pink	2.5	
	Gaultheria shallon	salal	shrub				■	■					white, pink	4	X
	Gilia capitata	globe gilia	forb					■	■				blue	3	
	Holodiscus discolor	oceanspray	shrub				■	■					white	3	X
	Iris douglasiana	Douglas iris	forb				■	■	■				purple, blue	2.5	
	Lonicera hispidula	hairy honeysuckle	vine				■	■	■				pink	10	
	Lupinus bicolor	two-color lupine	forb			■	■	■	■				blue, white	1	
	Lupinus rivularis	river bank lupine	forb			■	■	■	■	■			blue, purple	1.7	X
	Philadelphus lewisii	mock orange	shrub				■	■	■				white	vine	
	Rhododendron macrophyllum	Pacific rhododendron	shrub				■	■	■				pink, purple	1	X
	Rosa gymnocarpa	baldhip rose	shrub				■	■					pink	3	X
	Rosa nutkana	nootka rose	shrub				■	■	■				pink	8	
	Rubus leucodermis	blackcap raspberry	shrub				■	■	■				white	16	
	Rubus parviflorus	thimbleberry	shrub				■	■	■				white	4	
	Sambucus nigra ssp. caerulea	blue elderberry	shrub				■	■	■				white	6	X
	Symphoricarpos albus	snowberry	shrub				■	■	■	■			pink	9	X
	Vaccinium ovatum	evergreen huckleberry	shrub			■	■	■	■				pink	6	X
	Viola adunca	early blue violet	forb			■	■	■	■				purple	1.0	
Late	*Anaphalis margaritacea*	pearly everlasting	forb					■	■	■	■		white, yellow	4.0	X
	Campanula rotundifolia	harebell	forb						■	■			blue, purple	10.0	
	Erigeron speciosus	aspen fleabane	forb					■	■	■			blue	0.3	
	Lupinus latifolius	broadleaf lupine	forb					■	■	■			blue, purple	3.5	X
	Penstemon davidsonii	Davidson's penstemon	forb					■	■	■			purple	2.5	
	Penstemon serrulatus	Cascade penstemon	forb					■	■	■			blue, purple	2.5	
	Sedum oreganum	Oregon Stonecrop	forb					■	■	■			yellow	4	
	Solidago lepida	Canada goldenrod	forb					■	■	■	■		yellow	0.3	
	Bromus sitchensis	Alaska brome	grass					Structure/Host Plant					N/A	2	X
	Danthonia californica	California oatgrass	grass					Structure/Host Plant					N/A	0.5	X
	Elymus glaucus	blue wild rye	grass					Structure/Host Plant					N/A	5	X
	Festuca romeri	Roemer's fescue	grass					Structure/Host Plant					N/A	5	X
	Festuca rubra	red fescue	grass					Structure/Host Plant					N/A	2	X
	Koeleria macrantha	junegrass	grass					Structure/Host Plant					N/A	3	
	Morella californica	Pacific wax myrtle	shrub					Structure/Host Plant					N/A	2	X
	Polystichum munitum	sword fern	shrub					Structure/Host Plant					N/A	2	
	Populus tremuloides	quaking aspen	tree					Structure/Host Plant					N/A	2	X
	Quercus garryana	Garry oak	tree					Structure/Host Plant					N/A	15	X

Table 6.2: Sunny and Moist Habitats: These plants generally grow in areas with full to mostly sunny areas with ordinarily moist to wet soils.

	Scientific Name	Common Name	Form	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Bloom Color	Mature Height (ft)	Host Plant
Early-Season Bloom	*Amelanchier alnifola*	serviceberry	shrub			■	■						white	15	X
Early-Season Bloom	*Armeria maritima*	sea thrift	forb			■							pink	1.5	
Early-Season Bloom	*Camassia leichtlinii*	great camas	forb			■	■						blue	2	
Early-Season Bloom	*Camassia quamash*	common camas	forb			■	■						blue	1.5	
Early-Season Bloom	*Cornus nuttallii*	Pacific dogwood	tree			■	■						white	65	X
Early-Season Bloom	*Cornus sericea*	red osier dogwood	shrub			■	■	■					white	15	X
Early-Season Bloom	*Crataegus douglasii*	black hawthorn	tree			■	■						white	20	
Early-Season Bloom	*Fragaria chiloensis*	beach strawberry	forb			■	■	■					white	0.5	X
Early-Season Bloom	*Fragaria vesca*	woodland strawberry	forb			■	■	■					white	0.5	X
Early-Season Bloom	*Iris tenax*	tough-leafed iris	forb			■	■						pink, purple	1.3	
Early-Season Bloom	*Lysichiton americanus*	Skunk cabbage	forb		■	■	■						yellow	4	
Early-Season Bloom	*Mahonia aquifolium*	tall Oregon grape	shrub			■	■						yellow	10	X
Early-Season Bloom	*Malus fusca*	Pacific crabapple	tree			■	■						white, pink	15	X
Early-Season Bloom	*Myrica gale*	sweet gale	shrub			■	■	■					yellow, green	10	
Early-Season Bloom	*Plectritis congesta*	seablush	forb			■	■	■					pink	2	
Early-Season Bloom	*Potentilla gracillis*	slender cinquefoil	forb				■	■					yellow	2.5	X
Early-Season Bloom	*Prunus emarginata*	bitter cherry	tree			■	■	■					white	50	X
Early-Season Bloom	*Ranunculus occidentalis*	western buttercup	forb			■	■	■					yellow	1.5	
Early-Season Bloom	*Rubus spectabilis*	salmonberry	shrub		■	■	■	■					red, pink	10	X
Early-Season Bloom	*Salix hookeriana*	Hooker's willow	tree		■	■							green	25	X
Early-Season Bloom	*Salix lasiandra var. lasiandra*	Pacific willow	tree			■	■						yellow	40	X
Early-Season Bloom	*Salix scouleriana*	Scouler's willow	shrub		■	■							yellow	35	X
Early-Season Bloom	*Salix sitchensis*	sitka willow	shrub		■	■							green	25	X
Early-Season Bloom	*Sidalcea sp.*	checkermallow	forb			■	■	■					pink	6	X
Early-Season Bloom	*Sisyrinchium idahoense*	Western blue-eyed grass	forb		■	■	■	■					blue	1.5	
Mid-Season Bloom	*Achillea millefolium*	common yarrow	forb			■	■	■	■	■	■	■	white	2.5	
Mid-Season Bloom	*Aquilegia formosa*	red columbine	forb				■	■	■	■			red, yellow	2	
Mid-Season Bloom	*Ceanothus velutinus*	snowbrush	shrub				■	■	■				white	10	X
Mid-Season Bloom	*Ceonothus sanguineus*	redstem ceanothus	shrub				■	■	■				white	10	X
Mid-Season Bloom	*Gaultheria shallon*	salal	shrub				■	■					white, pink	4	X
Mid-Season Bloom	*Geum macrophyllum*	largeleaf avens	forb				■	■					yellow	2	X
Mid-Season Bloom	*Gilia capitata*	globe gilia	forb					■	■				blue	3	
Mid-Season Bloom	*Grindelia integrifolia*	Puget Sound gumweed	forb				■	■	■				yellow	2.5	
Mid-Season Bloom	*Holodiscus discolor*	oceanspray	shrub				■	■					white	10	X
Mid-Season Bloom	*Iris douglasiana*	Douglas iris	forb				■	■	■				purple, blue	1.7	
Mid-Season Bloom	*Lonicera ciliosa*	orange honeysuckle	vine				■	■	■				orange	vine	
Mid-Season Bloom	*Lonicera hispidula*	hairy honeysuckle	vine				■	■	■				pink	vine	
Mid-Season Bloom	*Lonicera involucrata*	black twinberry	shrub			■	■	■	■				yellow	12	
Mid-Season Bloom	*Lupinus rivularis*	river bank lupine	forb			■	■	■	■	■			blue, purple	3	X
Mid-Season Bloom	*Philadelphus lewisii*	mock orange	shrub				■	■	■				white	8	
Mid-Season Bloom	*Physocarpus capitatus*	Pacific ninebark	shrub				■	■					white	15	
Mid-Season Bloom	*Prunella vulgaris ssp. lanceolata*	self heal	forb				■	■	■				purple	1.5	
Mid-Season Bloom	*Rhododendron macrophyllum*	Pacific rhododendron	shrub				■	■	■				pink, purple	16	X
Mid-Season Bloom	*Ribes lacustre*	black gooseberry	shrub			■	■	■	■				pink, pale	5	
Mid-Season Bloom	*Rosa nutkana*	nootka rose	shrub				■	■	■				pink	6	
Mid-Season Bloom	*Rubus leucodermis*	blackcap raspberry	shrub				■	■	■				white	9	
Mid-Season Bloom	*Rubus ursinus*	trailing blackberry	shrub			■	■	■	■	■			white	1	
Mid-Season Bloom	*Sambucus nigra ssp. caerulea*	blue elderberry	shrub				■	■	■				white	1	X
Mid-Season Bloom	*Sambucus racemosa*	red elderberry	shrub				■	■	■				white	20	X
Mid-Season Bloom	*Spiraea douglasii*	hardhack	shrub				■	■	■				pink	6	X
Mid-Season Bloom	*Symphoricarpos albus*	snowberry	shrub				■	■	■	■			pink	4	X
Mid-Season Bloom	*Trifolium wormskioldii*	springbank clover	forb				■	■	■	■	■		pink	2.5	X
Mid-Season Bloom	*Vaccinium ovatum*	evergreen huckleberry	shrub			■	■	■	■				pink	10	X
Mid-Season Bloom	*Viola adunca*	early blue violet	forb			■	■	■	■				purple	0.3	

Table 6.2 (Continued): Sunny and Moist Habitats: **These plants generally grow in areas with full to mostly sunny areas with ordinarily moist to wet soils.**

	Scientific Name	Common Name	Form	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Bloom Color	Mature Height (ft)	Host Plant
Late	*Chamerion angustifolia*	fireweed	forb										pink	2.5	
	Erigeron speciosus	aspen fleabane	forb										blue	10	
	Lupinus latifolius	broadleaf lupine	forb										blue, purple	0.3	X
	Lupinus polyphyllus	big-leaf lupine	forb										blue, purple	8	X
	Penstemon davidsonii	Davidson's penstemon	forb										purple	2.5	
	Penstemon serrulatus	Cascade penstemon	forb										blue/purple	4	
	Solidago lepida	Canada goldenrod	forb										yellow	5	
	Symphyotrichum subspicatum	Douglas aster	forb										purple	0.3	
	Betula papyrifera	paperbarck birch	tree	Structure/Host Plant									N/A	2	X
	Bromus sitchensis	Alaska brome	grass	Structure/Host Plant									N/A	5	X
	Deschampsia caespitosa	tufted hairgrass	grass	Structure/Host Plant									N/A	3	X
	Elymus glaucus	blue wild rye	grass	Structure/Host Plant									N/A	60	X
	Festuca romeri	Roemer's fescue	grass	Structure/Host Plant									N/A	5	X
	Festuca rubra	red fescue	grass	Structure/Host Plant									N/A	2	X
	Koeleria macrantha	junegrass	grass	Structure/Host Plant									N/A	3	
	Morella californica	Pacific wax myrtle	shrub	Structure/Host Plant									N/A	2	X
	Polystichum munitum	sword fern	shrub	Structure/Host Plant									N/A	2	
	Populus tremuloides	quaking aspen	tree	Structure/Host Plant									N/A	2	X
	Urtica dioica ssp. gracilis	stinging nettle	forb	Structure/Host Plant									N/A	15	X

Table 6.3: Shady and Dry Habitats: These plants generally grow in partially sunny to shady areas with ordinarily dry soils.

	Latin Name	Common Name	Form	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Bloom Color	Mature Height (ft)	Host Plant
Early-Season Bloom	*Amelanchier alnifola*	serviceberry	shrub			■	■						white	15	X
	Iris tenax	tough-leafed iris	forb			■	■	■					pink, purple	0.5	
	Mahonia aquifolium	tall Oregon grape	shrub			■	■						yellow	1.3	X
	Mahonia nervosa	dwarf Oregon grape	shrub			■	■						yellow	10	X
	Oemleria cerasiformis	Indian plum	shrub	■	■	■							white	2	
	Quercus garryana	Garry oak	tree			■	■	■					green	10	
	Rhamnus purshiana	cascara	tree			■	■						yellow, green	30	X
	Ribes sanguineum	red-flowering currant	shrub	■	■	■							pink, red	10	
	Salix scouleriana	Scouler's willow	shrub		■	■							yellow	35	X
Mid-Season Bloom	*Achillea millefolium*	common yarrow	forb			■	■	■	■	■	■	■	white	2.5	
	Allium cernuum	nodding onion	forb				■	■					pink	1.7	
	Ceonothus sanguineus	redstem ceanothus	shrub				■	■	■				white	10	X
	Ceanothus velutinus	snowbrush	shrub				■	■	■				white	10	X
	Gaultheria shallon	salal	shrub				■	■					white, pink	4	X
	Holodiscus discolor	oceanspray	shrub				■	■					white	10	X
	Iris douglasiana	Douglas iris	forb				■	■	■				purple, blue	1.7	
	Lonicera hispidula	hairy honeysuckle	vine				■	■	■				pink	vine	
	Rhododendron macrophyllum	Pacific rhododendron	shrub				■	■	■				pink, purple	16	X
	Rosa gymnocarpa	baldhip rose	shrub				■	■					pink	4	X
	Rosa nutkana	nootka rose	shrub				■	■	■				pink	6	
	Rubus leucodermis	blackcap raspberry	shrub				■	■	■				white	9	
	Rubus parviflorus	thimbleberry	shrub				■	■	■				white	6	
	Symphoricarpos albus	snowberry	shrub				■	■	■	■			pink	4	X
	Tellima grandiflora	fringecup	forb			■	■	■	■				white, pink	3	
	Vaccinium ovatum	evergreen huckleberry	shrub			■	■	■	■				pink	10	X
Late	*Anaphalis margaritacea*	pearly everlasting	forb					■	■	■	■		white, yellow	3.5	X
	Oxalis oregana	wood sorrel	forb			■	■	■	■	■	■		white	1	
	Penstemon serrulatus	Cascade penstemon	forb					■	■	■			blue/purple	2	
	Solidago lepida	Canada goldenrod	forb					■	■	■	■		yellow	5	
	Bromus sitchensis	Alaska brome	grass	Structure/Host Plant									N/A	5	X
	Elymus glaucus	blue wild rye	grass	Structure/Host Plant									N/A	3	X
	Morella californica	Pacific wax myrtle	shrub	Structure/Host Plant									N/A	15	X
	Polystichum munitum	sword fern	shrub	Structure/Host Plant									N/A	3	
	Populus tremuloides	quaking aspen	tree	Structure/Host Plant									N/A	45	X
	Quercus garryana	Garry oak	tree	Structure/Host Plant									N/A	80	X

Table 6.4: Shady and Moist Habitats: **These plants generally grow in partially sunny to shady areas with ordinarily moist to wet soils.**

	Latin Name	Common Name	Form	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Bloom Color	Mature Height (ft)	Host Plant
Early-Season Bloom	*Amelanchier alnifola*	serviceberry	shrub			■	■						white	15	X
Early-Season Bloom	*Cornus nuttallii*	Pacific dogwood	tree			■	■						white	65	X
Early-Season Bloom	*Cornus sericea*	red osier dogwood	shrub			■	■	■					white	15	X
Early-Season Bloom	*Crataegus douglasii*	black hawthorn	tree			■	■						white	20	
Early-Season Bloom	*Dicentra formosa*	Pacific bleeding heart	forb		■	■	■	■					pink, purple	1.5	X
Early-Season Bloom	*Dodecatheon hendersoni*	Henderson's shooting star	forb			■	■						pink	1.5	
Early-Season Bloom	*Fragaria chiloensis*	beach strawberry	forb			■	■	■					white	0.5	X
Early-Season Bloom	*Fragaria vesca*	woodland strawberry	forb			■	■	■					white	0.5	X
Early-Season Bloom	*Iris tenax*	tough-leafed iris	forb			■	■	■					pink, purple	1.3	
Early-Season Bloom	*Lysichiton americanus*	Skunk cabbage	forb		■	■	■						y	4	
Early-Season Bloom	*Mahonia aquifolium*	tall Oregon grape	shrub			■	■						yellow	10	X
Early-Season Bloom	*Mahonia nervosa*	dwarf Oregon grape	shrub			■	■						yellow	2	X
Early-Season Bloom	*Malus fusca*	Pacific crabapple	tree			■	■						white, pink	15	X
Early-Season Bloom	*Oemleria cerasiformis*	Indian plum	shrub	■	■	■							white	10	
Early-Season Bloom	*Petasites frigidus*	coltsfoot	forb		■	■	■	■	■				white	1.7	
Early-Season Bloom	*Rhamnus purshiana*	cascara	tree			■	■						yellow, green	30	X
Early-Season Bloom	*Rubus spectabilis*	salmonberry	shrub		■	■	■	■					red, pink	10	
Early-Season Bloom	*Salix hookeriana*	Hooker's willow	tree		■	■							green	25	X
Early-Season Bloom	*Salix lasiandra var. lasiandra*	Pacific willow	tree			■	■						yellow	40	X
Early-Season Bloom	*Salix scouleriana*	Scouler's willow	shrub		■	■							yellow	35	X
Early-Season Bloom	*Salix sitchensis*	sitka willow	shrub		■	■							green	25	X
Early-Season Bloom	*Sisyrinchium idahoense*	Western blue-eyed grass	forb		■	■	■	■					blue	1.5	
Early-Season Bloom	*Vaccinium parvifolium*	red huckleberry	shrub		■	■	■						pink, green	12	
Mid-Season Bloom	*Acer circinatum*	vine maple	tree				■	■					white	25	
Mid-Season Bloom	*Achillea millefolium*	common yarrow	forb			■	■	■	■	■	■	■	white	2.5	
Mid-Season Bloom	*Aquilegia formosa*	red columbine	forb				■	■	■	■			red, yellow	2	
Mid-Season Bloom	*Aruncus dioicus*	goatsbeard	forb				■	■	■				white	6	
Mid-Season Bloom	*Ceonothus sanguineus*	redstem ceanothus	shrub				■	■	■				white	10	X
Mid-Season Bloom	*Ceanothus velutinus*	snowbrush	shrub				■	■	■				white	10	X
Mid-Season Bloom	*Gaultheria shallon*	salal	shrub				■	■					white, pink	4	X
Mid-Season Bloom	*Geum macrophyllum*	largeleaf avens	forb				■	■					yellow	2	X
Mid-Season Bloom	*Holodiscus discolor*	oceanspray	shrub				■	■					white	10	X
Mid-Season Bloom	*Hydrophyllum tenuipes*	Pacific waterleaf	forb				■	■	■				white, green	2.5	
Mid-Season Bloom	*Iris douglasiana*	Douglas iris	forb				■	■	■				purple, blue	1.7	
Mid-Season Bloom	*Lonicera ciliosa*	orange honeysuckle	vine				■	■	■				orange	vine	
Mid-Season Bloom	*Lonicera hispidula*	hairy honeysuckle	vine				■	■	■				pink	vine	
Mid-Season Bloom	*Lonicera involucrata*	black twinberry	shrub			■	■	■	■				yellow	12	
Mid-Season Bloom	*Physocarpus capitatus*	Pacific ninebark	shrub				■	■					white	15	
Mid-Season Bloom	*Prunella vulgaris ssp. lanceolata*	self heal	forb				■	■	■				purple	1.5	
Mid-Season Bloom	*Rhododendron macrophyllum*	Pacific rhododendron	shrub				■	■	■				pink, purple	16	X
Mid-Season Bloom	*Ribes bracteosum*	stink currant	shrub				■	■					green	9	X
Mid-Season Bloom	*Ribes lacustre*	black gooseberry	shrub			■	■	■	■				pink, pale	5	
Mid-Season Bloom	*Rosa nutkana*	nootka rose	shrub				■	■	■				pink	6	
Mid-Season Bloom	*Rubus leucodermis*	blackcap raspberry	shrub				■	■	■				white	9	
Mid-Season Bloom	*Rubus ursinus*	trailing blackberry	shrub			■	■	■	■	■			white	1	
Mid-Season Bloom	*Sambucus racemosa*	red elderberry	shrub				■	■	■				white	20	
Mid-Season Bloom	*Spiraea douglasii*	hardhack	shrub				■	■	■				pink	6	X
Mid-Season Bloom	*Symphoricarpos albus*	snowberry	shrub				■	■	■	■			pink	4	X
Mid-Season Bloom	*Tellima grandiflora*	fringecup	forb			■	■	■	■				white, pink	3	
Late	*Chamerion angustifolia*	fireweed	forb					■	■	■	■		pink	8	
Late	*Heracleum maximum*	cow parsnip	forb					■	■	■			white	10	X
Late	*Lupinus polyphyllus*	big-leaf lupine	forb					■	■	■			blue, purple	5	X
Late	*Oxalis oregana*	wood sorrel	forb			■	■	■	■	■	■		white	1	
Late	*Penstemon serrulatus*	Cascade penstemon	forb					■	■	■			blue, purple	2	
Late	*Solidago lepida*	Canada goldenrod	forb					■	■	■	■		yellow	5	
Late	*Symphyotrichum subspicatum*	Douglas aster	forb						■	■	■	■	purple	3	
	Betula papyrifera	paperbarck birch	tree					Structure/Host Plant					N/A	60	X
	Bromus sitchensis	Alaska brome	grass					Structure/Host Plant					N/A	5	X
	Elymus glaucus	blue wild rye	grass					Structure/Host Plant					N/A	3	X
	Morella californica	Pacific wax myrtle	shrub					Structure/Host Plant					N/A	15	X
	Polystichum munitum	sword fern	shrub					Structure/Host Plant					N/A	3	
	Populus tremuloides	quaking aspen	tree					Structure/Host Plant					N/A	45	X
	Urtica dioica ssp. gracilis	stinging nettle	forb					Structure/Host Plant					N/A	6	X

Table 6.5: Master Plant List: The following lists represent the complete list of recommendations for plants native to the Puget lowlands of Western Washington that are known to attract pollinators and their larvae. The list is sorted alphabetically by bloom time to help select plants that can provide continuous and overlapping bloom periods.

	Scientific Name	Common Name	Form	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Bloom Color	Light	Moisture	Host Plant	Height (ft)
Early-Season Bloom	*Amelanchier alnifola*	serviceberry	shrub			■	■						white	sun, part shade	dry, moist	X	15
	Arbutus menziesii	Pacific madrone	tree			■							white, pink	sun	dry	X	100
	Arctostaphylos uva-ursi	kinnikinnick	shrub		■	■							pink	sun	dry	X	0.7
	Armeria maritima	sea thrift	forb			■							pink	sun	dry, moist		1.5
	Camassia leichtlinii	great camas	forb			■	■						blue	sun	moist		2
	Camassia quamash	common camas	forb			■	■						blue	sun	moist, wet	X	1.5
	Cornus nuttallii	Pacific dogwood	tree			■	■	■					white	sun, part shade, shade	moist	X	65
	Cornus sericea	red osier dogwood	shrub			■	■						white	sun, part shade	moist, wet		15
	Crataegus douglasii	black hawthorn	tree		■	■	■	■					white	sun, part shade, shade	moist	X	20
	Dicentra formosa	Pacific bleeding heart	forb			■	■						pink, purple	part shade, shade	moist		1.5
	Dodecatheon hendersoni	Henderson's shooting star	forb			■	■	■					pink	part shade, shade	moist		1.5
	Eriophyllum lanatum	Oregon sunshine	forb			■	■	■					yellow	sun	dry	X	2
	Fragaria chiloensis	beach strawberry	forb			■	■	■					white	sun, part shade	dry, moist	X	0.5
	Fragaria vesca	woodland strawberry	forb			■	■	■					white	sun, part shade	moist		0.5
	Iris tenax	tough-leafed iris	forb		■	■	■						pink, purple	sun, part shade	dry, moist, wet		1.3
	Lysichiton americanus	Skunk cabbage	forb			■	■						yellow	sun, part shade	moist, wet	X	4
	Mahonia aquifolium	tall Oregon grape	shrub			■	■						yellow	sun, part shade	dry, moist	X	10
	Mahonia nervosa	dwarf Oregon grape	shrub			■	■						yellow	part shade, shade	dry, moist	X	2
	Malus fusca	Pacific crabapple	tree			■	■	■					white, pink	sun, part shade	moist, wet		15
	Myrica gale	sweet gale	shrub	■	■	■							yellow, green	sun	wet		10
	Oemleria cerasiformis	Indian plum	shrub		■	■	■	■	■				white	part shade	dry, moist		10.0
	Petasites frigidus	coltsfoot	forb			■	■	■					white	shade	moist		1.7
	Plectritis congesta	seablush	forb				■	■					pink	sun	moist, wet	X	2
	Potentilla gracillis	slender cinquefoil	forb			■	■	■					yellow	sun	moist, wet	X	2.5
	Prunus emarginata	bitter cherry	tree			■	■	■					white	sun	moist		50
	Ranunculus occidentalis	western buttercup	forb			■	■						yellow	sun	moist	X	1.5
	Rhamnus purshiana	cascara	tree	■	■	■							yellow, green	part shade	dry, moist, wet		30
	Ribes sanguineum	red-flowering currant	shrub		■	■	■	■					pink, red	sun, part shade	dry	X	10
	Rubus spectabilis	salmonberry	shrub		■	■							red, pink	sun, part shade	moist, wet	X	10
	Salix hookeriana	Hooker's willow	tree			■	■						green	sun, part shade	moist, wet	X	25
	Salix lasiandra var. lasiandra	Pacific willow	tree		■	■							yellow	sun, part shade, shade	moist, wet	X	40
	Salix scouleriana	Scouler's willow	shrub		■	■							yellow	sun, part shade, shade	dry, moist	X	35
	Salix sitchensis	sitka willow	shrub		■	■	■	■					green	sun, part shade	moist, wet	X	25
	Sidalcea sp.	checkermallow	forb		■	■	■	■					pink	sun	dry, moist		6.0
	Sisyrinchium idahoense	Western blue-eyed grass	forb		■	■	■						blue	sun, part shade	moist, wet		1.5
Mid-Season Bloom	*Acer circinatum*	vine maple	tree				■	■					white	partial shade	moist, wet	X	25
	Achillea millefolium	common yarrow	forb			■	■	■	■	■	■	■	white	sun, part shade	dry, moist		2.5
	Allium cernuum	nodding onion	forb				■	■					pink	sun, part shade	dry	X	1.7
	Aquilegia formosa	red columbine	forb				■	■	■	■			red, yellow	sun, part shade	moist		2
	Aruncus dioicus	goatsbeard	forb				■	■	■				white	part shade, shade	moist		6
	Balsamorhiza deltoidea	deltoid balsamroot	forb				■	■	■				yellow	sun	dry		3.3
	Castilleja hispida	harsh paintbrush	forb			■	■	■	■	■			scarlet or yellow	sun	dry		2.5
	Ceanothus velutinus	snowbrush	shrub				■	■	■				white	sun, part shade	dry, moist	X	10
	Ceonothus sanguineus	redstem ceanothus	shrub				■	■	■				white	sun, part shade	dry, moist	X	10
	Clarkia amoena	farewell-to-spring	forb				■	■	■				pink	sun	dry		2.5
	Gaultheria shallon	salal	shrub				■	■					white, pink	sun, part shade, shade	dry, moist	X	4
	Geum macrophyllum	largeleaf avens	forb				■	■					yellow	sun, part shade	moist, wet	X	2
	Gilia capitata	globe gilia	forb				■	■	■				blue	sun	dry, moist		3
	Grindelia integrifolia	Puget Sound gumweed	forb				■	■					yellow	sun	dry, moist	X	2.5
	Holodiscus discolor	oceanspray	shrub				■	■	■				white	sun, part shade	dry, moist		10
	Hydrophyllum tenuipes	Pacific waterleaf	forb				■	■	■				white, green	shade	wet		2.5
	Iris douglasiana	Douglas iris	forb				■	■	■				purple, blue	sun, part shade	dry, moist, wet		1.7
	Lonicera ciliosa	orange honeysuckle	vine				■	■	■				orange	sun, part shade	moist		vine
	Lonicera hispidula	hairy honeysuckle	vine			■	■	■	■				pink	sun, part shade	dry, moist		vine
	Lonicera involucrata	black twinberry	shrub			■	■	■	■	■			yellow	sun, part shade	moist, wet	X	12
	Lupinus bicolor	two-color lupine	forb				■	■	■				blue, white	sun	dry		1
	Lupinus rivularis	river bank lupine	forb				■	■					blue, purple	sun	dry, moist		3
	Philadelphus lewisii	mock orange	shrub				■	■	■				white	sun	dry, moist		8
	Physocarpus capitatus	Pacific ninebark	shrub				■	■	■				white	sun, part shade	moist, wet	X	15
	Prunella vulgaris ssp. lanceolata	self heal	forb				■	■					purple	sun, part shade	moist	X	1.5
	Rhododendron macrophyllum	Pacific rhododendron	shrub			■	■	■	■				pink, purple	sun, part shade	dry, moist		16
	Ribes bracteosum	stink currant	shrub				■	■					green	part shade, shade	moist, wet	X	9
	Ribes lacustre	black gooseberry	shrub				■	■	■				pink, pale	sun, part shade	moist, wet		5
	Rosa gymnocarpa	baldhip rose	shrub				■	■	■				pink	sun, part shade	dry		4
	Rosa nutkana	nootka rose	shrub				■	■	■				pink	sun, part shade	dry, moist	X	6
	Rubus leucodermis	blackcap raspberry	shrub			■	■	■	■	■			white	sun, part shade	dry, moist		9
	Rubus parviflorus	thimbleberry	shrub				■	■	■				white	sun, part shade	dry	X	6
	Rubus ursinus	trailing blackberry	shrub				■	■	■				white	sun, part shade, shade	moist	X	1
	Sambucus nigra ssp. caerulea	blue elderberry	shrub				■	■	■				white	sun	dry, moist	X	1
	Sambucus racemosa	red elderberry	shrub				■	■	■	■			white	sun, part shade	moist, wet	X	20
	Spiraea douglasii	hardhack	shrub			■	■	■	■				pink	sun, part shade	moist, wet		6
	Symphoricarpos albus	snowberry	shrub			■	■	■	■				pink	sun, part shade	dry, moist	X	4
	Tellima grandiflora	fringecup	forb			■	■	■	■				white, pink	part shade, shade	dry, moist		3.0
Late	*Anaphalis margaritacea*	pearly everlasting	forb					■	■	■	■		white, yellow	sun, part shade	dry	X	3.5
	Campanula rotundifolia	harebell	forb						■	■			blue, purple	sun	dry		2.5
	Chamerion angustifolia	fireweed	forb					■	■	■	■		pink	sun, part shade	moist		8
	Erigeron speciosus	aspen fleabane	forb					■	■	■			blue	sun	dry, moist		2.5
	Heracleum maximum	cow parsnip	forb					■	■	■			white	shade	moist	X	10
	Lupinus latifolius	broadleaf lupine	forb					■	■	■			blue, purple	sun	dry, moist	X	4
	Lupinus polyphyllus	big-leaf lupine	forb					■	■	■			blue, purple	sun, part shade	moist, wet	X	5
	Oxalis oregana	wood sorrel	forb			■	■	■	■	■	■		white	part shade, shade	dry, moist		1
	Penstemon davidsonii	Davidson's penstemon	forb					■	■	■			purple	sun	dry, moist		0.3
	Penstemon serrulatus	Cascade penstemon	forb					■	■	■			blue/purple	sun, part shade	dry, moist		2
	Sedum oreganum	Oregon Stonecrop	forb					■	■	■			yellow	sun	dry		0.5
	Solidago lepida	western Canada goldenrod	forb					■	■	■	■		yellow	sun, part shade	moist, dry		5
	Symphyotrichum subspicatum	Douglas aster	forb						■	■	■	■	purple	sun, part shade	moist, wet		3
Structure/Host Plant	*Betula papyrifera*	paperbarck birch	tree					Structure/Host Plant					N/A	sun, part shade, shade	moist, wet	X	60
	Bromus sitchensis	Alaska brome	grass					Structure/Host Plant					N/A	sun, part shade	dry, moist	X	5
	Danthonia californica	California oatgrass	grass					Structure/Host Plant					N/A	sun	dry	X	2
	Deschampsia caespitosa	tufted hairgrass	grass					Structure/Host Plant					N/A	sun	moist, wet	X	2
	Elymus glaucus	blue wild rye	grass					Structure/Host Plant					N/A	sun, part shade	dry, moist	X	3
	Festuca romeri	Roemer's fescue	grass					Structure/Host Plant					N/A	sun	dry, moist	X	2
	Festuca rubra	red fescue	grass					Structure/Host Plant					N/A	sun	dry, moist	X	2
	Koeleria macrantha	junegrass	grass					Structure/Host Plant					N/A	sun	dry, moist		2
	Morella californica	Pacific wax myrtle	shrub					Structure/Host Plant					N/A	sun, part shade	dry, moist	X	15
	Polystichum munitum	sword fern	shrub					Structure/Host Plant					N/A	sun, part shade	dry, moist		3
	Populus tremuloides	quaking aspen	tree					Structure/Host Plant					N/A	sun, part shade	dry, moist, wet	X	45
	Quercus garryana	Garry oak	tree					Structure/Host Plant					N/A	sun, part shade	dry	X	80
	Urtica dioica ssp. gracilis	stinging nettle	forb					Structure/Host Plant					N/A	sun, part shade	moist, wet	X	6

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POLLINATOR HABITAT ASSESSMENT

Landowner/Manager:	Location:
Planned by:	Date:
Habitat Enhancement Objectives:	

Logistics

Permission:

Describe site ownership and any access constraints

Boundaries:

After mapping the site, describe any pertinent boundary features or considerations

Access:

Describe any relevant access points for crews or materials

Size:

Indicate the overall square footage or acreage of the site

Site Prep:

Briefly describe the intended site preparation strategy

Volunteer Access:

Indicate if site is volunteer accessible or any potential concerns

View Constraints:

Indicate possible height limitations resulting from views, power lines, or other constraints

Site Design Notes

LOCAL RESTORATION EARTH CORPS GLOBAL LEADERSHIP

Pollinator Habitat Type

Circle the general habitat type or trajectory for your site

- Upland Forests: conifer, deciduous, mixed
- Riparian Areas: river, stream, creek, wetland, wet meadow, freshwater riparian forest, marine riparian forest, dune, bluff, backshore
- Prairies, Savannas, Oak Woodlands
- Green Stormwater Infrastructure: rain garden, bioswale, stormwater detention pond
- Agricultural Areas: farm, orchard, garden, hedgerow
- Contained Spaces and Lots: traffic circle, parking lot, green roof, schoolyard, backyard
- Corridors and Roadsides: rights of way, roadside, trailside, power line corridor, airport runway

Topography and Features

Aspect: N NE E SE S SW W NW Flat

Indicate general slope direction for the site

Exposure: full sun partial shade full shade

Indicate the general level of sun exposure for your site - if you have more than one environment, consider completing individual site checks for each type

Moisture: dry moist wet

Indicate the general moisture level for your site - if you have more than one environment, consider completing individual site checks for each type

Topography: ______________________________

Describe any topographical irregularities of your site such as mounds or depressions

Slope:	very steep	steep	moderate	gentle	flat
	>40%	*16-40%*	*10-15%*	*4-9%*	*0-3%*

Indicate relative steepness of the site

Soils

Drainage: fast average slow

Briefly indicate the general speed at which the soils on site will drain

Composition: sand silt clay muck gravel

Describe the general characteristics of the soil

Soil Notes: ______________________________

Describe any proposed amendments or results from a soil test etc.

Site Topography/Soil Notes

____

____

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____

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Site Design

Positive Indicators

	1	2	3	4	5	Score
Size:	1	2	3	4	5	
	<0.1 acre	*0.1-0.5 acre*	*0.5-1 acre*	*1-2 acres*	*>2 acres*	______
Determine and rank overall size of pollinator habitat						
Connectivity:	1	2	3	4	5	
	>2 miles	*0.5-2 miles*	*0.1-0.5 miles*	*<500 feet*	*adjacent*	
Indicate and rank based on general proximity to relatively natural or intact habitat						
Native Cover:	1	2	3	4	5	
	<25%	*26-50%*	*51-75%*	*76-90%*	*>90%*	______
Estimate and rank the total cover of native plant species across the site						
Native Richness	1	2	3	4	5	
	<50%	*51-70%*	*71-80%*	*81-90%*	*>90%*	
Determine and rank native species richness on site (# native/total # of species)						
Native Evenness	1	2	3	4	5	
	>60%	*51-60%*	*41-50%*	*31-40%*	*<30%*	______
Determine if any single species dominates the site and rank based on above criteria						
Structural Complexity		1	3	5		
		one	*two-three*	*four or more*		
Identify vertical strata and rank based on vegetative complexity						
Redundancy:	1	2	3	4	5	
	one	*two*	*three*	*four*	*five or more*	______
Rank based on the number of native plants present that will bloom during ***each of the three seasons*** *(early, mid, late) - see plant list for details*						

Total Positive Indicator Score (from 7 to 35): ☐

Habitat Enhancement Indicators

Shelter:	*None*	*Low*	*Med*	*High*	
☐ Areas of undisturbed or un-manicured habitat	0	1	2	3	______
☐ Dead wood	0	1	2	3	______
☐ Compost or brush piles	0	1	2	3	______
☐ Large rocks or rock piles	0	1	2	3	______
☐ Areas of bare soil	0	1	2	3	______
☐ Pithy or hollow stems	0	1	2	3	______
☐ Larval host plants (see plant list)	0	1	2	3	______
☐ Native bunchgrass or sedge species	0	1	2	3	______
☐ Clean water or wet, muddy areas	0	1	2	3	______

Indicate and quantify each feature present on your site and tally points (from 0 to 27): ☐

Site Indicator Notes

______

______

______

______

______

______

Habitat Stressor Indicators

Invasive Cover:	0	-1	-2	-3	-4	-5	
	<1%	*1-5%*	*6-10%*	*11-30%*	*30-50%*	*>50%*	______

Estimate and circle the total cover of invasive plant species across the site

Other Stressors	*None*	*Low*	*Med*	*High*	
☐ Known pesticide use on or adjacent to site	0	-1	-2	-3	______
☐ Mowing (esp. large scale or during bloom periods)	0	-1	-2	-3	______
☐ Excessive human impacts or disturbance	0	-1	-2	-3	______
☐ Presence of artificial light	0	-1	-2	-3	______

Total Stressor Indicator Score (from 0 to -17): [ ]

OVERALL SITE DESIGN SCORE (from 0 to 62): [ ]

Sketch of Site Plan