CHARACTERIZATION OF WESTERN BUMBLE BEE (*BOMBUS OCCIDENTALIS*) NESTING HABITAT AND MANAGEMENT RECOMMENDATIONS TO CONSERVE BUMBLE BEE NESTS

A western bumble bee entering its nest. Look closely in the bottom left quadrant of the photo to see the bee. Photo by the Xerces Society.

Developed by the Xerces Society in partnership with Washington Department of Fish and Wildlife, Idaho Department of Fish and Game, and Oregon Department of Fish and Wildlife

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THE WESTERN BUMBLE BEE (*Bombus occidentalis*)

The western bumble bee (*Bombus occidentalis*), a once common bumble bee in the Pacific Northwest, has become increasingly rare (Williams et al. 2014, Rhoades et al. 2016). Unfortunately, populations of many species of bumble bees around the world are decreasing in range and abundance (Kerr et al. 2015, Cameron and Sadd 2020, Hatfield et al. 2021a, Graves et al. 2020, Janousek et al. 2023). Likely factors leading to these declines include climate change, land cover change, disease, and exposure to pesticides (Janousek et al. 2023).

The western bumble bee is a species of conservation concern and is undergoing a status review for potential listing under the Endangered Species Act. The species is assessed as Vulnerable by the IUCN (Hatfield et al. 2015), and as a species of concern in other status assessments (NatureServe 2023, Cameron et al. 2011). The western bumble bee is a Candidate Species in Washington State. While efforts to protect and conserve this species are ongoing, gathering additional information about the species will inform effective evidence-based conservation.

Figure 1. A western bumble bee worker. Photo by the Xerces Society.

Protecting and expanding high-quality habitat will help support this species throughout its range. In addition to flowering plants on which to forage, bumble bees require nesting and overwintering habitat. While a substantial amount is known about what constitutes high quality foraging habitat, much less is known about where the western bumble bee overwinters and nests. This lack of understanding of the habitat required to support the entire life cycle of the western bumble bee could be one of the primary barriers to conserving the species.

To help close this gap in our understanding, the Xerces Society, in partnership with the Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, and Idaho Department of Fish and Game, as part of the Pacific Northwest Bumble Bee Atlas, undertook a focused effort to locate western bumble bee nests. Field biologists used a variety of methods to find nests, including intense manual searches in areas with a high density of western bumble bees (in 2022 & 2023) and radio telemetry (limited trial in 2023). Once a nest was found, biologists carefully evaluated the habitat around the nest, documenting plant structure and species composition, as well as characteristics of the ground surface around the nest entrance. To date, the effort has resulted in the discovery and documentation of two western bumble bee nests (located near Santiam Pass, OR). The nests were located in 2023 by Xerces Society Technicians, Pauline Peterson and Ashley Martens, and University of Utah graduate student, Jessie Roughgarden. Four additional western bumble bee nests have been located by others. One nest was located in 2022 by Lincoln Best, Faculty Research Assistant, Oregon State University, also near Santiam Pass, OR. Pacific Northwest Bumble Bee Atlas volunteer, Ingrid Carmean, documented two additional nests near Sequim, WA, one in 2022, and one in 2023. Additionally, USGS Research Ecologist,

Tabatha Graves, and members of her research team documented a western bumble bee nest near the southeastern corner of Glacier National Park, MT in 2023.

After the nesting season, attempts were made to excavate five of these nests to learn more about the nest architecture and to evaluate the productivity of each nest. The nest structure was successfully recovered from three of these nests. The data from these excavations are still being evaluated, but will provide important insights into the success of different nests in the habitats in which they were found. Oregon State University created a 3D model of the core of one of the nests found.

All of this new data vastly expands our understanding of western bumble bee nest characteristics; however, it should be interpreted with caution due to the restricted range of habitat types surveyed and the relatively small number of nests found. Nevertheless, this information represents the best available science. The following summary of our current knowledge of western bumble bee nesting ecology, integrating our findings with what was previously known from the literature, provided the foundation on which we developed management guidance. We hope that land managers in areas with known or suspected western bumble bee populations will include considerations for nesting and overwintering habitat in their management activities.

INFORMATION TO INFORM LAND MANAGEMENT

Bumble Bee Life Cycle:

Most species of bumble bees are eusocial, meaning they primarily reside in colonies of related individuals that cooperate to support the colony by foraging for food, rearing offspring, and defending the nest. This cooperative lifestyle, with many individuals centered around a single nest, influences the habitat that they require for foraging, nesting, and overwintering.

For the most part, bumble bees have an annual lifecycle, which means most individuals in the colony live about one year or less (Williams et al. 2014)—reproductive females are the only caste that overwinters. Generally, a mated queen starts a new colony in early spring (exact timing will depend on the bumble bee species, as well as the elevation, latitude, and habitat conditions) by selecting a nest site, laying her first generation of eggs, and collecting resources (pollen and nectar) to support her future offspring. The queen cares for her offspring until the first brood of female workers emerge as adults. Once these first offspring have emerged, they take over the responsibility of foraging, tending to offspring, feeding and cleaning the queen, and defending the nest. In most circumstances, the queen never leaves the nest again and continues to lay eggs and oversee the growth of the nest. Only at the end of the summer does the colony produce reproductive females and males. These reproductive individuals leave the nest to mate. Following mating, the males die, and the newly mated queens continue to forage and build up fat reserves for the winter, while returning to the nest. Eventually, they search out a hibernacula, usually a shallow hole in the ground that they excavate, where they undergo diapause through the winter (Williams et al. 2014). The timing of the active season for bumble bees varies based on a variety of factors including elevation, weather, and climate. Western bumble bee sightings in the Pacific Northwest (Washington, Oregon, and Idaho) mainly occur between early April and late August, peaking between mid-June and late July (Hatfield et al. 2021a). Detections of the western bumble bee throughout their U.S. range peak around mid-July (Graves et al. 2020).

Overwintering Habitat:

Similar to nesting habitat, overwintering habitat is not well understood given the challenges of locating overwintering queens. Past findings suggest that overwintering habitat is likely different from foraging and nesting habitat, both spatially and in terms of habitat characteristics (Darvill et al. 2004, Waters et al. 2011, O'Connor et al. 2017, Williams et al. 2019). Overwintering sites have generally been found underground, most often in shaded areas near trees as well as in banks without dense vegetation and in areas with tree litter, moss, or in bare patches within short grass (Sladen 1912, Plath 1927, Bols 1937, Hobbs 1965a, 1965b, 1967, Alford 1969). The buff-tailed bumble bee (*B. terrestris*), a close relative of the western bumble bee, reportedly overwinters beneath trees (Sladen 1912).

Overwintering queens have most often been found on north-facing slopes, likely to prevent early emergence on warm, sunny winter days; queens may also overwinter on slopes with other aspects or on flat ground (Sladen 1912, Plath 1927, Bols 1937, Hobbs 1967, Alford 1969). Overwintering sites most often occur in sandy, well-drained, or loose soil (Bols 1937, Plath 1927, Hobbs 1967, Alford 1969), though recent research has shown that hibernating queens can survive at least 7 days completely submerged underwater (Rondeau and Raine 2023). Queens overwinter at varying depths within the soil, likely to regulate their temperature and emerge at the optimal time (Hobbs 1966a, 1965b, 1966b, 1967, Alford 1969, Szabo and Pengelly 1973).

Nesting Habitat:

Bumble bees can nest in a variety of landscapes and ecosystems, including agricultural and urban landscapes as well as in alpine, dune, forested, forest edge, and grassland ecosystems. A review of bumble bee nesting habitat identified grasslands, agricultural lands, and forests as the most common habitats for bumble bee nesting (Liczner and Colla 2019).

Out of the six western bumble bee nests discovered in 2022 and 2023, two were situated within a relatively young lodgepole pine forest with smaller components of mountain hemlock and sub-alpine fir, recently thinned to reduce overstocking and fire risk; one was positioned at the border of the forest type described above and an open meadow; two were found in open areas with tall grasses and shrubs; and one was in a meadow between a forested area and a lake. Four of the sites were in montane environments, while two of them were in a managed natural area near Sequim, WA. We did not detect any pattern regarding the direction of canopy cover at nest sites in or near forest. Management activities in the surrounding habitats (within 100 m of nest sites) included logging, grazing, and mowing; these varied between sites.

Figure 2. A variety of habitats in which western bumble bee nests were found. Photos by the Xerces Society (top left, top right, and bottom right) and Tabatha Graves (bottom left).

Most western bumble bee nests have been found in cavities, including in abandoned rodent burrows on open west-southwest facing slopes, bordered by trees, although a few nests have been reported in above-ground locations including in logs among railroad ties (Plath 1922, Hobbs 1968, Thorp et al. 1983, Macfarlane et al. 1994). Given the importance of abandoned rodent burrows for bumble bee nest sites, availability of nest sites for the western bumble bee may depend on rodent abundance in some areas (Free and Butler 1959, Kells and Goulson 2003, Evans et al. 2008). Entrances to bumble bee nests located in underground burrows are sometimes covered with either living or dried vegetation (Hoffmann et al. 2004, De Meulemeester et al. 2011, de Oliveira et al. 2015).

All six of the nests observed in 2022 and 2023 were underground, in putative rodent burrows. Generally, the nest entrance holes were obscured by plants, leaf litter, and/or woody debris. Nest entrances were

generally small with a diameter ranging from approximately 2 to 4 cm (see figure 3). Interestingly, four of the six nests had more than one entrance hole.

Figure 3. The entrance to a western bumble bee nest with a notebook for scale (cm). Photo by the Xerces Society.

All nests had pine needle duff or leaf litter within 1 m of the entrance and downed woody debris within 10 m. Other ground cover characteristics varied between sites. Multiple nests were located near stumps or trees, which could potentially provide underground structure to tunnels and nests.

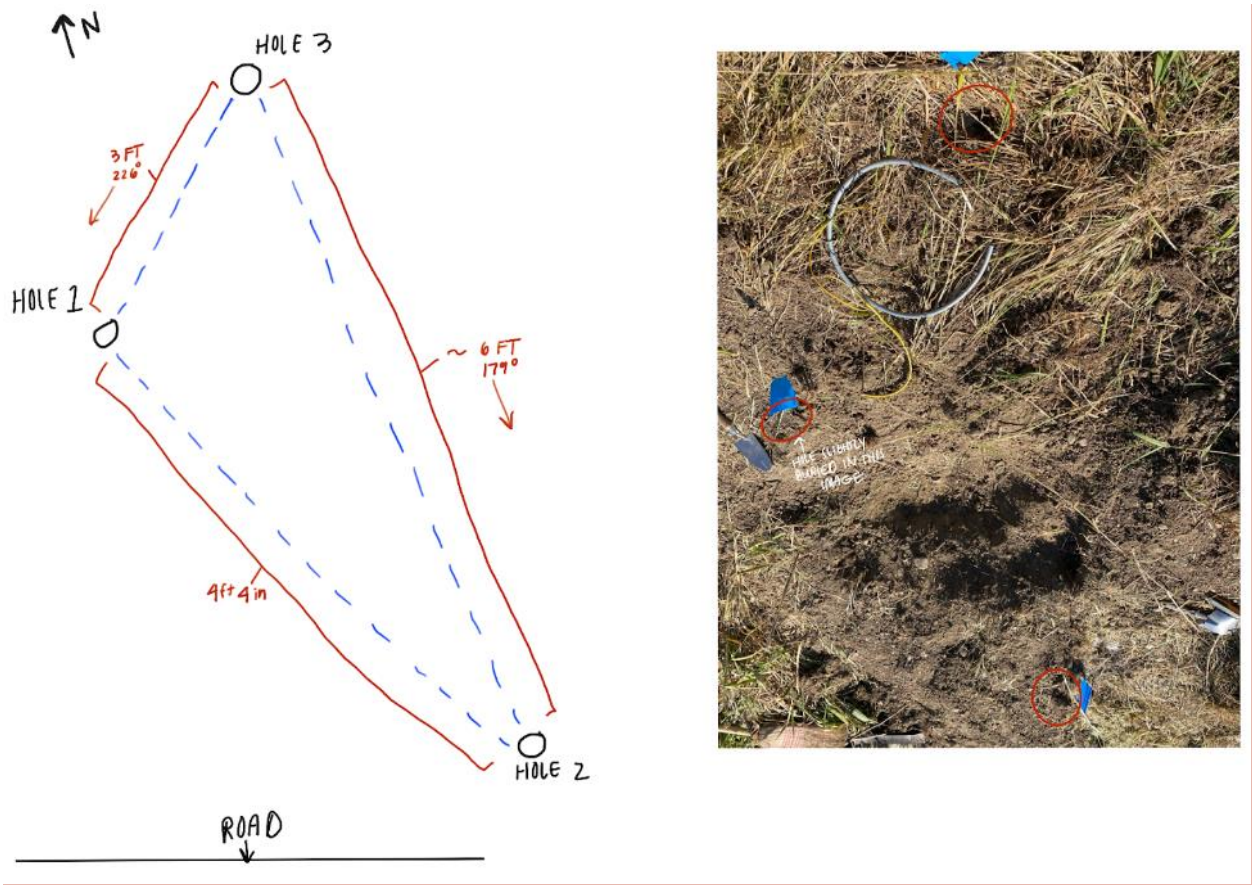

Figure 4. The relative locations of three entrance holes leading to a single bumble bee nest. Photo and diagram by the Xerces Society.

All of the nests we detected were on generally flat, or nearly flat, ground. The slope angle at all sites was below 10° and the aspect varied between sites. Western bumble bee nest tunnels have been reported to be up to 2.1 m long, and nests may be lined with dried grass, hair, small leaves, moss, or bird feathers (Macfarlane et al. 1994, Michener 2007, Goulson 2010). Of the nests excavated in 2022 and 2023, the tunnels connecting nest entrances to nest chambers ranged in length from ~63 cm to ~1.8 m. The depth of the top of the nest below the ground surface ranged from ~6 cm to ~15 cm. All nests contained presumed rodent nesting materials either within the tunnel or within the nest chamber.

Floral resource availability within a landscape generally corresponds to the density of bumble bee nests, and therefore nesting success (Osborne et al. 2008, Knight et al. 2009, Goulson 2010. This is likely due to increasing foraging efficiency as workers do not have to travel as far from the nest to find nectar and pollen and face less risk of predation or accidental death during shorter foraging excursions. Nest sites may co-occur for multiple colonies in habitat suitable for foraging, but nesting habitat may also be in a different location than foraging habitat (Lonsdorf et al. 2009). Bumble bees likely do not require flowering resources in the immediate vicinity of their nests, often foraging 100 m or more from the entrance of the nest (Dramstad 1996, Dramstad et al. 2003, Osborne et al. 1999). However, access to flowering resources within 100 m of a nest may improve foraging efficiency, especially during nest establishment in the spring (O'Connor et al. 2017, Liczner and Colla 2019). The nests discovered in 2022 and 2023 all had at least two species of flowering plants within 10 m of the nest entrance, including both early (around the time of

assumed nest initiation) and mid-blooming (while the colony was in its growth/worker production phase) species.

Figure 5. Rydberg's penstemon (*Penstemon rydbergii)* blooming in the area where a western bumble bee nest was found in 2022. Photo by the Xerces Society.

RECOMMENDATIONS FOR PROTECTING WESTERN BUMBLE BEE NESTING HABITAT

While the efforts to document western bumble bee nests over the past two years have contributed substantially to the understanding of the species' nesting ecology, given the relatively small number of nests and limited search area, these findings have not substantially altered existing guidance for protecting nesting habitat. Incorporating general bumble bee nesting guidance into active management will help support this increasingly rare and sensitive species.

The following guidance has been adapted from the Guide to Habitat Management for Bumble Bees in the Pacific Northwest (Hatfield et al. 2021b), developed as part of the Pacific Northwest Bumble Bee Atlas and applies to a range of bumble bee species, with specific recommendations added to protect the western bumble bee, when possible. In addition to the guidance below, we recommend that land managers work to enhance floral resource availability with a host of blooming plants throughout the flight

season. See Table 1 for a list of plants that will benefit the western bumble bee as well as other sensitive bumble bee species. The plant genera in Table 1 can likely be applied to the majority of the range of the western bumble bee. See the Xerces Society Pollinator Resource Center for other regional specific plant lists (not western bumble bee specific). Additional resources are also available at the end of this document.

Table 1. Plant genera associated with bumble bee species of conservation concern along with approximate bloom times. Based on Hatfield et al. 2021a. Every genus listed includes native species. We recommend planting native species within these genera when completing restoration projects.

Plant Genus	Common Name	Approximate Bloom Time		
		Early	Mid	Late
Cirsium	Native Thistle			
Lupinus	Lupine			
Trifolium	Native Clover			
Penstemon	Penstemon			
Agastache	Horsemint			
Ericameria	Rabbitbrush			
Rubus	Thimbleberry			
Helianthus	Sunflower			
Spiraea	Spiraea			
Solidago	Goldenrod			
Chamaenerion	Fireweed			
Phacelia	Scorpionweed			
Rosa	Rose			
Monardella	Coyote Mint			
Symphoricarpos	Snowberry			
Potentilla	Cinquefoil			
Erigeron/Symphyotrichum	Fleabane/Aster			
Aquilegia	Columbine			
Pedicularis	Lousewort			
Mahonia	Barberry			
Ribes	Currants/Gooseberries			
Arctostaphylos	Manzanita			
Salix	Willow			

General (Implement into all management activities)

- Use adaptive management strategies.
- Maintain a mosaic of habitat types.
- When implementing a treatment of any type, treat no more than one third of an overall site at a time.
- Do not treat an entire site in a single year.

Nesting and Overwintering

Extend the below recommended land management practices for bumble bees at least 100 m into terrestrial habitats (e.g., woodlands, forests, shrublands) beyond what might traditionally be considered high quality habitat for pollinators (i.e., grasslands and other areas with abundant flowering resources).

Ground Disturbance:

- Preserve undisturbed ground, particularly around areas where rodent activity is observed. Since many bumble bee species depend on ground nesting mammals for nesting habitat, any negative impact to ground nesting mammals will likely also impact bumble bees.
- Preserve, maintain, and enhance structural complexity including downed wood, rock piles, moss, leaf litter (both broad leaves and evergreen needles), and native bunch grasses (including bear grass).
- Increase the availability of early and mid-blooming plants (including trees and shrubs).
- Generally, bumble bees nest in abandoned rodent burrows, often within forest or forest edge habitat. Based on current knowledge, leaf litter and woody debris are important habitat features for nesting. Given this, land managers should carefully consider the timing of ground disturbance activities, especially in grassland and forest/grassland edge habitats.
    - In areas with high quality nesting habitat, avoid ground disturbance activities during summer months.
    - If ground disturbance is unavoidable, survey for nesting sites prior to summer ground disturbance to avoid significant impacts. These surveys should be conducted by a biologist with experience searching for and observing bumble bee nests.

MOWING

- If mowing is needed, mow at the highest practical height and leave portions of fields unmown to avoid impacting bumble bees nesting on the surface of the ground and key structural elements around the entrance to underground nests. We recommend mowing no more than 1/3rd of the habitat at one time. Ideally, portions of the habitat would remain unmowed for the entirety of the flight period.

PESTICIDES

- Avoid applying insecticides and fungicides to potential bumble bee nesting habitat and limit the use of herbicides in these areas. If herbicide use is deemed necessary for management of noxious or invasive weeds, apply herbicides outside of the period of adult activity and take steps to limit drift and impacts on non-target plants. Likewise, develop and implement a plan to replace the quantity of floral resources being removed by the eradication program. While bumble bees may not prefer non-native plants, they will use their nectar and pollen to provision their nests.

    - Prevention is the best cure—use native plants in landscaping when practical, and avoid moving soil, hay, or other sources of seed long distances.
    - Consider a variety of control methods (mechanical, biological, cultural, and chemical) and use a targeted approach.
    - When using herbicides:
        - When available, use selective herbicides targeted toward the invasive plant(s).
        - Avoid broadcast applications whenever possible.
        - Train staff and/or contractors in plant ID. Avoid treating native plants (especially native thistles!)
        - Do not spray when targeted plants are flowering.
        - If applying to the base of vegetation, avoid spraying directly into existing holes in the ground.

Prescribed Fire:

- Avoid high intensity fire (since nests and overwintering sites are generally below the surface of the ground, work to minimize peak soil temperatures).
- Burn in cool, humid conditions to the extent possible.
- Leave skips and unburned areas as appropriate to maintain habitat diversity.
- Timing: While there is no perfect time to conduct controlled burns for bumble bees, as burns are likely to affect overwintering, nesting, and foraging habitat, the best time to conduct burns is when bumble bees are dormant (roughly October – February, depending on elevation/latitude, etc.). This will avoid burning at sensitive times of year when queen bumble bees need high quality floral resources to either find a nest or build fat reserves to survive hibernation. No matter the time of year, focus on maintaining a diversity of habitat types and minimizing peak soil temperatures.
    - Post burning is an opportunity to introduce additional floral resources.

Grazing:

- Fall and winter grazing will likely impact bumble bees less than summer grazing given the potential of livestock to compact soil and trample nests. If feasible, adjust grazing time to fall or winter when most flowering plants are dormant and bumble bees are least active.
- For any long duration grazing allotments (>45 days) use low intensity grazing to the extent possible (low AUMs for the site).
- Monitor utilization rates annually.
    - < 40% in xeric landscapes.
    - Reduce or eliminate utilization in riparian areas and mesic meadows and try not to allow stock animals to linger in these habitats longer than necessary.
    - Reduce utilization rates during drought years to allow for adequate rest and recovery of the landscape.
    - Ideally, move animals throughout a grazing allotment to maintain even utilization throughout the entire area.
- Consider a rotational grazing scheme for areas/allotments with season-long grazing practices.

    - Allow large areas within the allotment to remain ungrazed for an entire year and rotate those areas from year to year.
- Sheep grazing should ideally occur only after flowering vegetation has senesced.

NEXT STEPS

Additional information about western bumble bee nests will enable the continued development of specific and actionable management recommendations to protect nesting habitat of western bumble bees as well as other bumble bee species. Anyone can contribute to this effort by keeping an eye out for bumble bee nests and reporting them to Bumble Bee Watch.

In addition to collecting general information about nest characteristics, future research could incorporate the following topics.

- Analyze nest phenology in relation to environmental and climatic variables to better understand the factors contributing to the timing of nest initiation and seasonal activity.
- Record the phenology of flowering plant species around nests to learn more about whether proximity to flowering plants at different times throughout the season impacts nest initiation and success.
- Gain a better understanding of nest distribution in a range of landscapes by systematically searching for nests in a variety of habitat types and documenting both positive and negative detections throughout the active season.
- Assess soil characteristics around nests to better understand the potential impact of soil type on nest location.
- Map rodent holes and burrows throughout areas searched for bumble bee nests to learn more about whether rodent distribution limits the distribution of bumble bee nests.

ADDITIONAL RESOURCES

Xerces Society Pollinator Conservation Resource Center
https://www.xerces.org/pollinator-resource-center
Welcome to the Pollinator Conservation Resource Center! Here we offer region-specific collections of publications, native plant and seed suppliers, and other resources to aid in planning, establishing, restoring, and maintaining pollinator habitat—as well as materials to help you learn about the various invertebrates you might encounter.

Pollinator Plants:

Native Plants for Pollinators and Beneficial Insects: Maritime Northwest Region
https://www.xerces.org/publications/plant-lists/native-plants-for-pollinators-and-beneficial-insects-maritime-northwest

This Xerces Society fact sheet features recommended native plants that are highly attractive to pollinators such as native bees, honey bees, butterflies, moths, and hummingbirds, and are well-suited for small-scale plantings in gardens, on business and school campuses, in urban greenspaces, and in farm field borders.

Native Plants for Pollinators and Beneficial Insects: Inland Northwest Region
https://www.xerces.org/publications/plant-lists/native-plants-for-pollinators-and-beneficial-insects-inland-northwest
This Xerces Society fact sheet features recommended native plants that are highly attractive to pollinators such as native bees, honey bees, butterflies, moths, and hummingbirds, and are well-suited for small-scale plantings in gardens, on business and school campuses, in urban greenspaces, and in farm field borders.

Plants for Pollinators in the Inland Northwest
https://www.xerces.org/publications/plant-lists/biology-technical-note-no-24-plants-for-pollinators-in-inland-northwest
This NRCS Technical Note provides guidance for the design and implementation of conservation plantings to enhance habitat for pollinators. Plant species included in this document are adapted to the Inland Northwest; encompassing eastern Washington, northeastern Oregon and northern Idaho.

Native Plant Profiles and Lists
https://www.wildflower.org/collections/
The Xerces Society has collaborated with the Lady Bird Johnson Wildflower Center to create plant lists that are attractive to native bees, bumble bees, honey bees, and other beneficial insects, as well as plant lists with value as nesting materials for native bees. These lists can be narrowed down with additional criteria such as state, soil moisture, bloom time, and sunlight requirements.

Ecology and Conservation of Bumble Bees:

Conserving Bumble Bees: Guidelines for Creating and Managing Habitat for America's Declining Pollinators
https://www.xerces.org/publications/guidelines/conserving-bumble-bees
This thorough review of managing land for bumble bees includes sections on the important role these animals play in both agricultural and wild plant pollination, details the threats they face, and provides information on creating, restoring, and managing high-quality habitat. Importantly, these guidelines also describe how land managers can alter current practices to be more in sync with the needs and life cycle of bumble bees. This document also includes regional bumble bee identification guides and lists of important bumble bee plants by region.

A PNWBBA Guide to Habitat Management for Bumble Bees in the Pacific Northwest
https://www.xerces.org/publications/guidelines/pnw-bb-management
Historically, an incomplete picture of the habitat needs and status of bumble bees has been a barrier to effective conservation and land management. To address this need, the Pacific Northwest Bumble Bee Atlas (PNWBBA) was launched in Idaho, Oregon, and Washington in 2018. This large-scale, three-year effort was specifically directed toward understanding bumble bee populations, their habitat needs, and

the efficacy of various habitat management actions, with the goal of significantly improving the effectiveness of bumble bee conservation efforts. This document contains specific lessons learned from the PNWBBA project as well as a synthesis of our understanding of general bumble bee needs and a list of best practices for creating and managing habitat effectively for bumble bees.

Habitat Assessment:

Pacific Northwest Bumble Bee Habitat Assessment Form & Guide
https://www.xerces.org/publications/habitat-assessment-guides/pacific-northwest-bumble-bee-habitat-assessment-form-guide
This Habitat Assessment Guide, a product of the Pacific Northwest Bumble Bee Atlas, is a tool for landowners and managers in the Pacific Northwest to score their existing habitat to highlight areas that could be enhanced, either through improved habitat management, or habitat augmentation. This tool can be used alongside our Habitat Management for Bumble Bees in the Pacific Northwest for a complete toolkit for designing and maintaining high quality bumble bee habitat in Oregon, Washington, and Idaho.

Habitat Assessment Guide for Pollinators: Yards, Gardens, and Parks
https://xerces.org/publications/habitat-assessment-guides/habitat-assessment-guide-for-pollinators-in-yards-gardens
Landscaping for pollinators is one of the easiest ways for urban, suburban, and rural residents to directly benefit local wildlife. Schoolyards, community gardens, back yards, corporate campuses, rain gardens, and neighborhood parks all have the potential to meet the most basic needs of pollinators, including protection from pesticides, and resources for foraging, nesting, and overwintering.

Habitat Assessment Guide for Pollinators: Natural Areas and Rangelands
https://xerces.org/publications/hags/pollinators-farms-and-agricultural-landscapes
This pollinator habitat assessment guide is designed for natural areas and rangelands.

Habitat Assessment Guide for Pollinators: Natural Areas and Rangelands
https://xerces.org/publications/hags/natural-areas-and-rangelands
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Habitat Instillation:

Organic Site Preparation for Wildflower Establishment
https://xerces.org/publications/guidelines/organic-site-preparation-for-wildflower-establishment
Site preparation is one of the most important and often inadequately addressed components for successfully installing pollinator habitat. These guidelines provide step-by-step instructions, helpful suggestions, and regional timelines and checklists for preparing both small and large sites.

Establishing Pollinator Meadows from Seed
https://xerces.org/publications/guidelines/establishing-pollinator-meadows-from-seed

Establishing wildflower habitat for pollinators is the single most effective course of action to conserve pollinators that can be taken by anyone at any scale. These guidelines provide step-by-step instructions for establishing pollinator meadows from seed in areas that range in size from a small backyard garden up to areas around an acre.

Habitat Management:

Maintaining Diverse Stands of Wildflowers
https://xerces.org/publications/guidelines/maintaining-diverse-stands-of-wildflowers-planted-pollinators
High quality pollinator meadows sometimes experience a decline in wildflower diversity or abundance as they age. This guide provides recommendations on how to bring declining meadows back into a high-quality condition.

Nesting and Overwintering Habitat for Pollinators and Other Beneficial Insects
https://xerces.org/publications/fact-sheets/nesting-overwintering-habitat
This guide focuses on a variety of natural nesting habitat features that can be readily incorporated into most landscapes. Compared to artificial nesting options such as bee blocks and bee hotels, natural nesting habitat features often better mimic the natural nest site density of insects, and also break down naturally with time, limiting disease and parasite issues.

Best Management Practices for Pollinators on Western Rangelands
https://xerces.org/publications/guidelines/best-management-practices-for-pollinators-on-western-rangelands
The Xerces Society developed these guidelines to help land managers incorporate pollinator-friendly practices into rangeland management. This publication is focused on federally managed rangelands that span the following western states: Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Utah, Oregon, Washington, and Wyoming.

Roadside Best Management Practices that Benefit Pollinators
https://xerces.org/publications/guidelines/roadside-best-management-practices-that-benefit-pollinators
These best management practices provide concrete steps that can be taken by any roadside management agency to improve roadside vegetation for pollinators. The BMPs cover management of existing habitat, including ways to modify the use of mowing and herbicides to enhance roadsides, and methods to incorporate native plants and pollinator habitat into the design of new roadsides.

Pesticide Protection:

Guidance to Protect Habitat from Pesticide Contamination: Creating and Maintaining Healthy Pollinator Habitat
https://xerces.org/publications/fact-sheets/guidance-to-protect-habitat-from-pesticide-contamination

This Xerces Society guidance document was designed to help growers, land managers, and others safeguard pollinator habitat from harmful pesticide contamination. It includes information on selecting habitat sites, as well as ways to maintain clean habitat by limiting and carefully managing pesticide use.

Smarter Pest Management: Protecting Pollinators at Home
https://xerces.org/publications/fact-sheets/smarter-pest-management-protecting-pollinators-at-home
Most of North America's native bee species only forage over a distance of a few hundred yards, so with a little planning, your yard can provide a safe space for bees and other pollinators to thrive. All you need to give them are flowering plants throughout the growing season, undisturbed places to nest, and protection from pesticides. This Xerces Society guide will help you with the last item, managing yard pests in a pollinator-friendly way.

Smarter Pest Management: Pollinator Protection for Cities and Campuses
https://xerces.org/publications/fact-sheets/smarter-pest-management-pollinator-protection-cities-campuses
This Xerces Society fact sheet introduces to city and campus land managers the concept of integrated pest management (IPM), a system that emphasizes prevention first and seeks to eliminate the underlying causes of plant diseases, weeds, and insect problems rather than relying on routine use of pesticides.

How Neonicotinoids Can Kill Bees: The Science Behind the Role These Insecticides Play in Harming Bees 2nd edition
https://xerces.org/publications/scientific-reports/how-neonicotinoids-can-kill-bees
Neonicotinoids are a group of insecticides used widely on farms and in urban landscapes. They are highly toxic to bees and can be taken up into plant pollen and nectar. This report provides an overview of research on neonicotinoid impacts on bees and recommendations to protect pollinators for policy makers, applicators, and the public.

Honey Bees:

An Overview of the Potential Impacts of Honey Bees to Native Bees, Plant Communities, and Ecosystems in Wild Landscapes: Recommendations for Land Managers
https://xerces.org/publications/guidelines/overview-of-potential-impacts-of-honey-bees-to-native-bees-plant
Literature review of the potential impacts of honey bees to native bees (including bumble bees) and their habitats. It covers the potential effects of honey bees through competition with native bees and disease transmission, as well as the potential effects of honey bees on native plant populations and other wildlife.

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