A PNWBBA GUIDE TO

Habitat Management for Bumble Bees in the Pacific Northwest

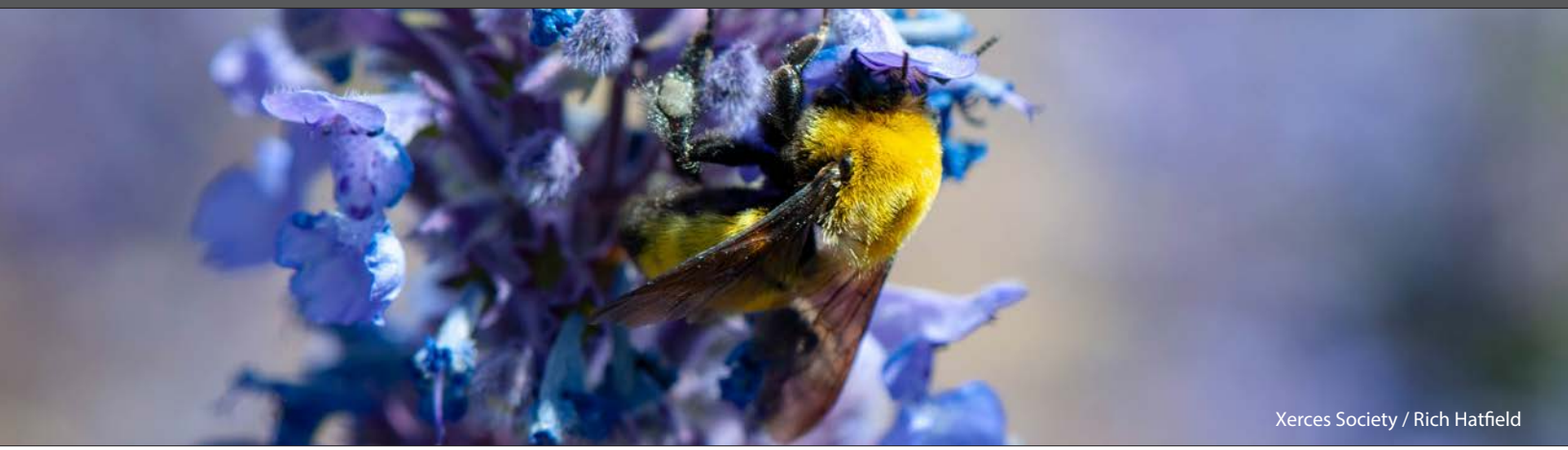

Figure 1: Several rare bumble bees in the PNW have been identified in State Wildlife Actions Plans for their conservation need, including Morrison Bumble Bee (*Bombus morrisoni*), a Species of Greatest Conservation Need in Washington and Idaho and a Data Gap species in Oregon.

Introduction

Bumble bees (*Bombus* spp., Apidae) occur throughout much of the world, particularly in the Northern Hemisphere, and are key pollinators throughout their range. They are essential to the health of wildlands and natural areas as pollinators of many plant families, and their long tongues and unique ability to fly in inclement weather make them significant contributors to the global agricultural industry. Unfortunately, there have been alarming reports of bumble bee population declines from multiple continents.

The causes of these declines are not fully understood, but the likely contributing factors are loss and fragmentation of habitat, pesticide use, climate change, improper livestock grazing, competition with honey bees, low genetic diversity, and pathogens—the latter most significantly through amplification and distribution by managed bee species, including honey bees and commercial bumble bees. While each of these factors is a significant threat alone, it is likely the combination of two or more of these factors working in synergy has led to the significant declines observed in North America.

Highlighting the need for conservation, several *Bombus* species have recently been identified in State Wildlife Action Plans (SWAPs) as Species of Greatest Conservation Need (SGCN). Washington and Idaho's SWAPs include the Western (*B. occidentalis*), Morrison (*B. morrisoni*), and Suckley Cuckoo (*B. suckleyi*) bumble bees (IDFG 2015; WDFW 2015). The Yellow (*B. fervidus*) and Hunt (*B. huntii*) bumble bees are also included as SGCN in Idaho.

Regardless of the ultimate cause of bumble bee declines, surviving populations require high quality habitat to persist. Protecting, restoring, enhancing, and creating new bumble bee habitat is the best way to conserve populations of these indispensable animals and reverse current population trends.

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. Contained in this document are 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.

PACIFIC NORTHWEST
BUMBLE BEE ATLAS

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pnwBumbleBeeAtlas.org

Bumble Bee Habitat Basics

Bumble bee habitat has three principle components: 1) high-quality pollen and nectar sources from early spring through fall; 2) suitable nesting habitat; and 3) suitable overwintering habitat. While these three components do not necessarily need to be in the same location, having foraging resources close to nesting habitat improves foraging efficiency, ultimately boosting nesting success. Unfortunately, there is still little known about nesting and overwintering habitat for most bumble bee species.

Box 1: Keys to Success When Considering a Habitat Project

- Match ambition with resources. Make sure that funds, timeline, and size of area tackled are aligned with the realities of habitat restoration work. Don't bite off more than you can chew.
- Site preparation is critical: attempting to transform a site in a highly degraded condition is a long-term project and likely ill-advised for creating pollinator habitat on a short timeline (< 3 years).
- Consider use of forb plugs instead or in addition to forb seeds. While in the short-term plugs may be more expensive, they may result in better habitat and increased overall project success.
- The availability of local native plant seed or plug resources is often limited and may require multiple years to develop. Plan well in advance, and when possible work directly with plant materials providers to support development and availability of desired plants (see Table 1) at the scale you plan to use them.

Creating and Maintaining High Quality Habitat

Foraging Habitat

In order to successfully reproduce, bumble bee colonies need access to high-quality flowering resources (insecticide-free plants that provide both pollen and nectar) throughout the entire time their colony is active. The period from when queen bumble bees first emerge from hibernation in spring until gynes (newly produced queens that will continue the life cycle the following year) enter hibernation may be 12–25 weeks, or even longer in temperate climates. This time-period differs by species, but also by habitat type, elevation, and latitude.

Maintaining a diversity of flowering plants through the blooming season, considering color, shape, size, and plant structure will do the best job of maintaining diverse bumble bee communities, which is the ultimate goal. As a group, bumble bees are considered generalists, foraging on a wide array of flowering plants. However, individual species do have floral preferences. Paying attention to these subtle differences between species will help to ensure that we are supporting all species of bumble bees, and not just those with the most flexible diet, or that are most common in a particular area. Table 1 lists the plants on which the five Idaho and Washington bumble bee SGCN were recorded

Figure 2: Bumble bees need a diversity of high-quality floral resources throughout the entire time the colony is active. Photo: Xerces Society / Rich Hatfield.

Figure 3: Quality bumble bee habitat[1] provides 1) a diversity of native floral resources throughout the growing season[2]; 2) suitable habitat for nesting (e.g., bunch grasses, rock piles)[3]; and 3) suitable habitat for overwintering (e.g., shaded/wooded areas, on slopes)[4]. Photos: Xerces Society / Rich Hatfield[1,2,4], Kent McFarland / flickr[3].

Table 1: Plant genera that provide key flowering resources for SGCN bumble bees in the Pacific Northwest.

This list of plant genera is presented in order from most-visited to least-visited by our SGCN bumble bees in the Pacific Northwest Bumble Bee Atlas project. The list only includes plant genera that we considered to be appropriate to use in a restoration project (i.e., we did not include plant genera that do not have native species that are known to be attractive to bumble bees). We present these suggestions at the level of plant genus, so as to allow regional selections of appropriate plant species. Listed approximate bloom times are included to help practitioners create plant lists that provide pollen and nectar resources throughout the bloom period. These bloom times will vary by species, and by habitat.

PLANT GENUS	COMMON NAME	APPROXIMATE BLOOM TIME		
		Early	Mid	Late
Cirsium	Native Thistles		■	■
Lupinus	Lupine	■	■	
Trifolium	Native Clovers	■	■	
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	Fleabanes/Asters		■	■
Aquilegia	Columbine	■		
Pedicularis	Lousewort	■	■	
multi-species appeal [🐝]				

Figure 4: *Left to right*—While bumble bees are considered generalist foragers, some plants out perform others. Certain flowering plants may provide appeal to multiple species and/or are important bee food plants, including the following : Yellow Bumble Bee (*Bombus fervidus*) on native Elk Thistle (*Cirsium scariosum*), Yellow-head Bumble Bee (*B. flavifrons*) on Silverleaf phacelia (*Phacelia hastata*), and Red-belted Bumble Bee (*B. rufocinctus*) on Rydberg's penstemon (*Penstemon rydbergii*). Photos: Xerces Society / Rich Hatfield.



Phenology of SGCN Bumble Bees in the PNW

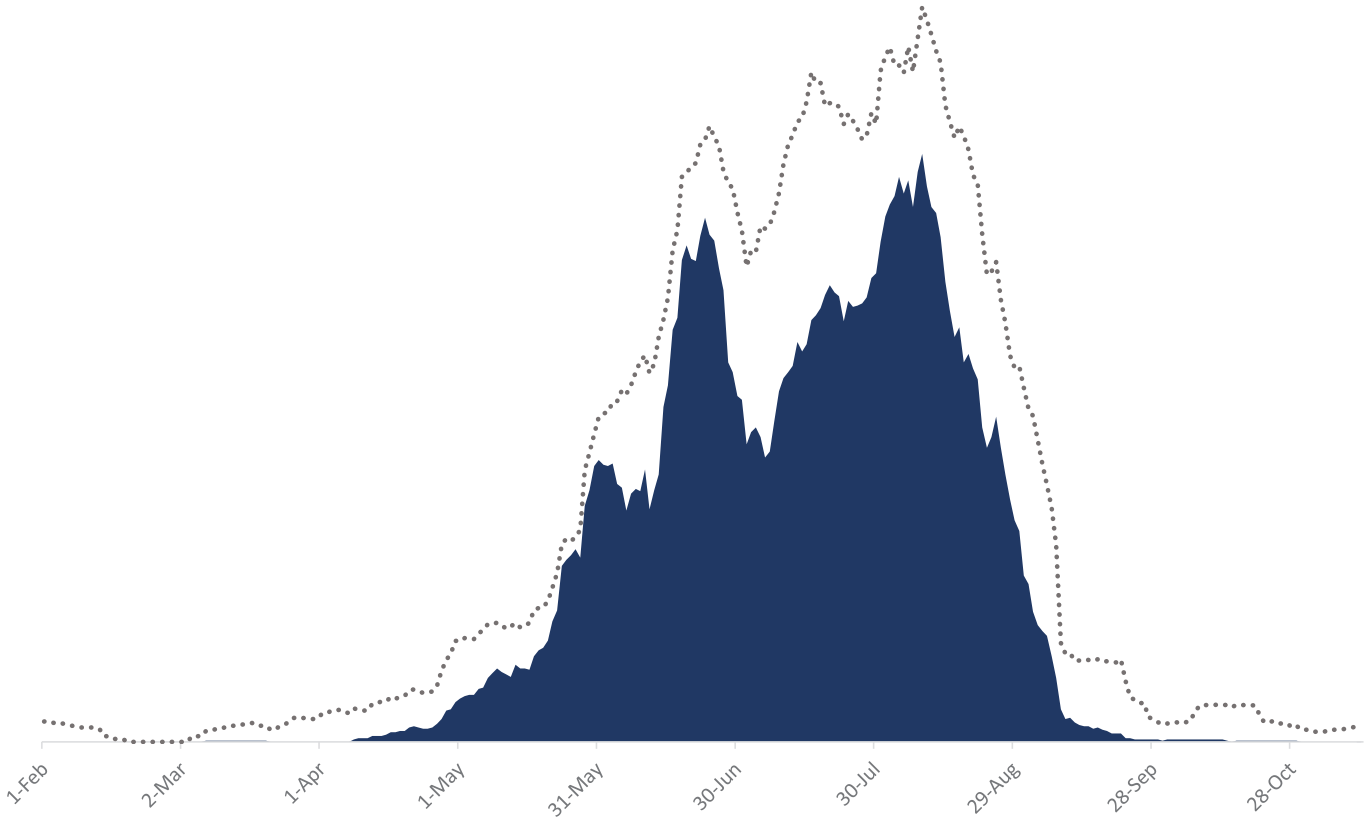


Figure 5: This figure shows the phenology of all SGCN bumble bees in the PNW (blue) and represents the time in which these species depend on the availability of floral resources in the region. Dotted lines represent the phenology of all bumble bee species detected in the PNWBBA.

during the PNWBBA project and will be appropriate for restoration projects that seek to provide floral habitat for Pacific Northwest species. The plants are listed by genus only to allow selection of species appropriate for each region. Choosing native plants, and not horticultural varieties, will provide the best results. Additionally, when creating bumble bee foraging habitat in arid landscapes, choose plants that can tolerate the extremes of the climate. During times of drought, many plants reduce the number of flowers they make, as well as volume of nectar they secrete. To get the best outcomes for bees, choose plants that are native to your region and able to tolerate some degree of drought stress. This list does not reflect or indicate commercial availability. By creating a list of key Pacific Northwest floral resources, we hope to increase demand and interest in developing these species for habitat restoration projects.

Figure 6: In arid landscapes choose plants native to your region and that can tolerate the extremes of the climate. Photo: Xerces Society / Rich Hatfield.

Nesting and Overwintering Habitat

Unfortunately, not enough is known about the specifics of bumble bee nesting and overwintering habitat to provide discrete management recommendations by bumble bee species or habitat type. However, enough general information is known that land management decisions can make a difference.

Nesting

Most bumble bee nests are below ground, often in abandoned rodent burrows, although some species also nest under logs, in rock piles, tree cavities, and bird nests, or even on the surface of the ground. As such, managing land to preserve undisturbed ground, particularly around areas where rodent activity is observed, is a best practice to promote bumble bee nesting habitat. Likewise, preserving downed wood, rock piles, and tall grasses is also likely to provide nesting habitat. In managed grasslands (including hay and alfalfa fields, as well as roadsides), bumble bee nests on the ground surface may be destroyed by mowing. Thus, in each growing season, portions of these habitats should be protected from mowing until fall (see Best Management Practices below).

Nesting and foraging habitats are not necessarily found in the same location. Bumble bee nests are observed in open areas, as well as in woodland areas, and likely do not require flowering resources in the immediate vicinity (e.g., < 30 m / 33 yd) of the nest. Some research shows that even if flowers are present, bumble bees do not forage close to their nest entrance, though access to flowering resources within 100 m (110 yd) from their nest will improve foraging efficiency, and is likely important. Because of the disparate locations of nesting and foraging habitat, land management for bumble bees needs to extend at least 100 m (110 yd) into habitats (e.g., woodlands and forests) beyond what might traditionally be considered high quality habitat for pollinators (i.e., abundant flowering resources).

Overwintering

Bumble bee queens overwinter in different locations from their natal nest. Overwintering queens have been found under the surface of the ground at depths between 2 and 15 cm (0.79 and 5.9 in). Though queens of some species have been observed to overwinter in close proximity to each other near their natal nest, others overwinter at some distance from their natal nest. No matter the proximity of the hibernaculum to the nest, most sites have been found in or near moss, leaf litter (both broad leaves and evergreen

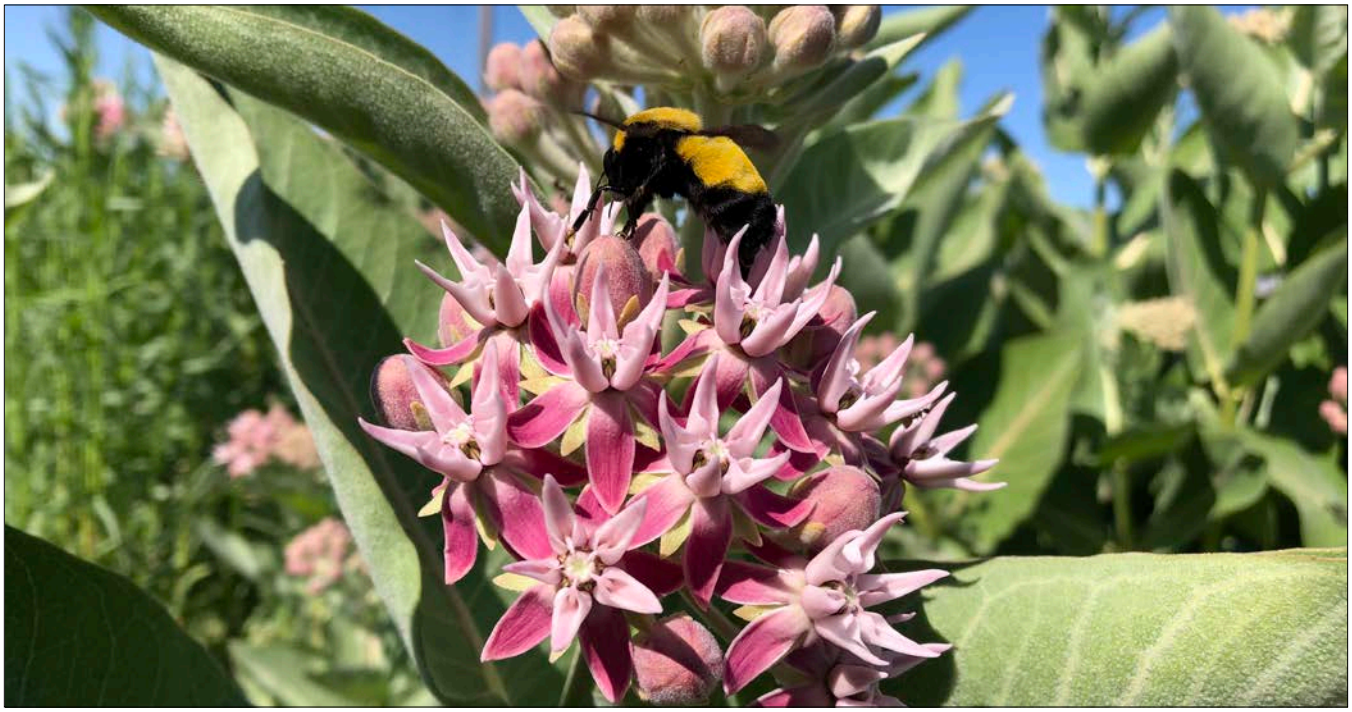


Figure 7: Species-level information on nesting and overwintering preferences of bumble bees is often lacking, including for the rare Morrison Bumble Bee (*Bombus morrisoni*) featured above on Showy Milkweed (*Asclepias speciosa*); however, general information is available and provided in these Habitat Guidelines to help inform habitat management projects to promote nesting and overwintering life stages. Photo: Xerces Society / Leif Richardson.

Box 2: Key Nesting and Overwintering Habitat Features

Nesting and overwintering sites are not necessarily in close proximity to foraging habitat, so land management to protect bumble bees needs to extend at least 100 m (110 yd) into habitats beyond what is normally considered high-quality habitat (open areas with an abundance of flowering resources). Nearby woodlands, forests, and shrublands likely provide both nesting and overwintering opportunities.

While more research is needed to clarify the needs of individual species, acting now to protect (and create) the following habitat features are likely to promote bumble bee nesting and protect overwintering queens:

Nests:

- Occur in forested, open, and edge habitats [likely within ~100 m (110 yd) of flowering resources].
- Most nests are underground in existing cavities (rodent burrows/nests, under logs, and under rocks).

Overwintering Sites:

- Occur in shaded areas (including forests) and on slopes without dense vegetation.
- Most sites have been found in or near moss, leaf litter, and loose organic material at a depth of 2 to 15 cm (1 to 6 in).

Figure 8: Bumble bee nest sites occur in a variety of habitat types, including open, edge, and forested habitats, and are usually within about 100 m (110 yd) of high-quality habitat with abundant floral resources similar to the picture above. Photo: Xerces Society / Michele Blackburn.

Figure 9: Overwintering sites are found within loose organic material in shaded areas and on slopes without dense vegetation. Photo: Xerces Society / Rich Hatfield.

needles), and loose organic material. These are important microhabitat features. Shaded areas close to trees, and slopes without dense vegetation have had the most observations of overwintering queens (though this might reflect the difficulty of conducting searches in dense vegetation as much as habitat preference).

Overwintering sites are not necessarily in close proximity to nesting and foraging sites. Importantly, overwintering represents at least half of the duration of a bumble bee life cycle, and is an essential component of survival. As such, land management to conserve bumble bees needs to happen at a landscape scale, considering both open and forested habitats.

Case Study 1: Forb Habitat Installation in Washington, by Kurt Merg, WDFW

The Washington Department of Fish and Wildlife (WDFW) has utilized seed of native plant species to improve wildlife habitat since that seed has been commercially available. During that time, although we have developed techniques that are remarkably successful at establishing stands of native grass from seed, we have struggled to find successful strategies for native forbs.

Native forb seeds appear to fail in projects either because they don't germinate, or because the fragile seedlings do not survive after germination. To assess an alternative approach that bypasses these life stages, we conducted plug-based plantings to enhance foraging habitat for pollinators, especially bumble bees, on the northeastern Washington, Sinlahekin, and Sherman Creek Wildlife Areas (WLAs) in November 2018 and 2019, respectively, and monitored the plantings in subsequent years.

We planted 3, 4, and 10 in^3 (164 cm^3) tubling plugs (200, 2,168, and 2,768 plugs, respectively) of 14 native forb species in sites first cleared of vegetation by prescribed burning within the 6 weeks preceding our planting days. Planting was accomplished with powered 2 in (5.1 cm) auger bits driven approximately 10 in (25.4 cm) into the soil to create a hole for planting. Plugs were placed in holes, surrounded with loose soil from the spoil piles left by the auger, and tamped into place by hand. We used crews of 8–10 people to accomplish all planting at a site in a single day. A subset of forb plugs was marked with surveyor's flags to be monitored for survival.

Even in our most successful forb seedings, we conservatively estimate that less than 2% of forb seed typically becomes established. Further, establishment from seed is always dominated by a subset of species, the "proven performers," included in every seed mix. Many of these species are included in seed mixes more for how readily they survive than for their value to wildlife. In contrast, for our project we selected plants with for their potential to support bumble bees, without regard to how we expected them to survive.

Forb plugs planted at the Sinlahekin WLA survived at remarkably high rates. Survival of plugs at the Sinlahekin project was 97% in May of 2019 and had declined to 80% by August of 2019, the end of that project's first growing season. While COVID hampered plug monitoring in 2020, survival at the end of the second growing season (August 2020) was conservatively estimated to exceed 50% and may have been significantly higher. The first growing season survival at the Sherman Creek project appeared to be similarly high, but again, COVID constrained monitoring in 2020. Nevertheless, we estimated survival conservatively at approximately 75%, roughly on par with that at the Sinlahekin site.

Figure 10: Restoration sites were first cleared of vegetation by prescribed burning (above) prior to planting (below). Photos: WDFW / Kurt Merg.

As an additional, and unforeseen benefit, several species of forbs flowered in their first year from plugs in these projects, something that almost never happens

when forbs are planted from seed. These included Canada goldenrod (*Solidago canadensis*) at both sites, and two beardtongue (*Penstemon*) species at the Sinlahekin site. At the Sinlahekin site, several insect species were observed visiting these flowers. Thus, not only did plugs have better establishment, but they provided more immediate habitat for the wildlife for which they were intended.

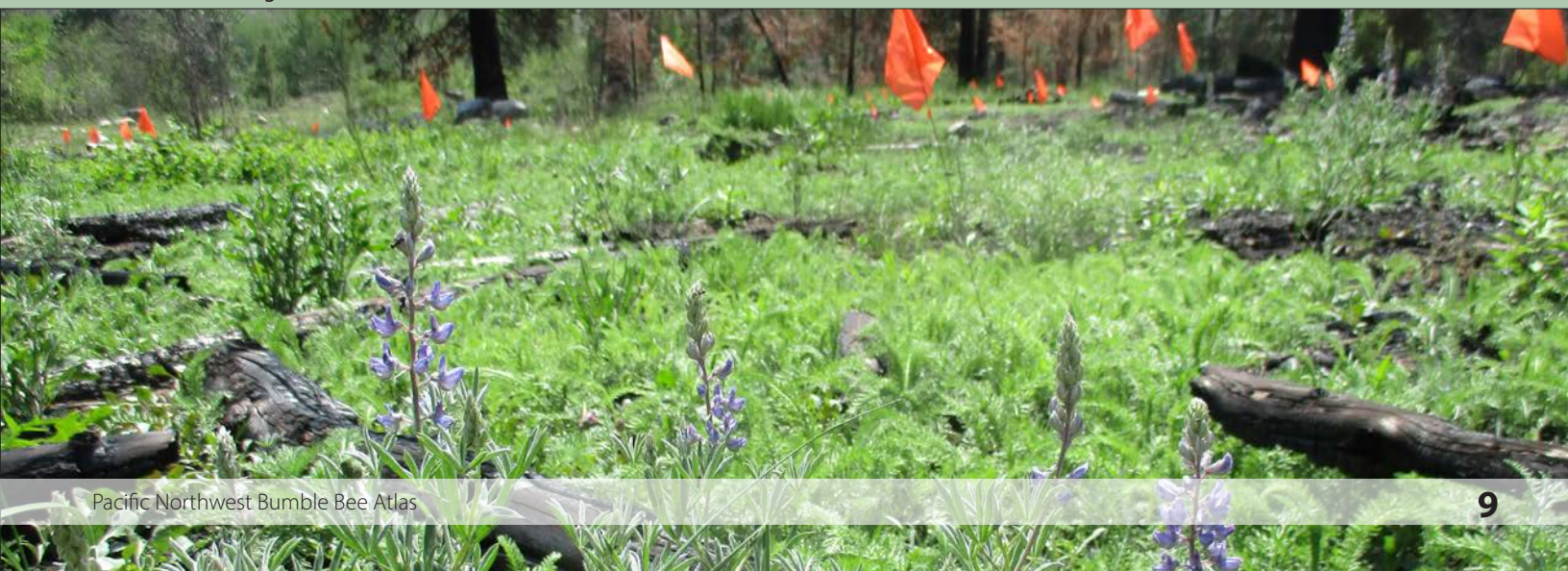
The forb portion of the best seed mix available for a typical WDFW project costs approximately $200–$400 per acre. A typical forb seeding density would be approximately 1.5 million seeds per acre (0.4 ha), and in the best-case scenario would produce approximately 1,500 forb seedlings per acre after two years. That is one forb seedling per 30.1 ft^2 (2.8 m^2), or a survival rate of 0.1%. Each seedling would have cost $0.13–$0.26 (plus planting labor) and it would most likely be Western Yarrow (*Achillea millefolium*, the most reliable proven performer), or one or more of a small group of 3–5 forb species that establish readily from seed in that climate zone or soil type—and not necessarily provide great benefit, or temporal coverage of bloom time for pollinators. Still, we very rarely achieve this best-case scenario.

In contrast, the forb plugs that we planted at these two sites cost an average of $1.83 each. Given the worst-case survival after two years was estimated to be no lower than 50%, the average cost of an established plug was at least $3.66 (plus planting labor, which is more significant than in the seed scenario). There were 2,236 plugs planted across a one-acre plot at the Sinlahekin site, and approximately 1,118 (50%) of them survived two growing seasons. Thus, the survival of plugs (1,118) per acre (0.4 ha) is nearly as good as the best-case survival scenario for forb seedlings per acre (0.4 ha) from seed (1,500), but an established plug costs approximately 28-times more than a seedling established from a seed.

Nevertheless, for bumble bee habitat enhancement forb plugs may return a better overall value than forb seed, for at least three reasons. First, when planting from seed, we rarely succeed as well as the best-case scenario described above (1,500 forb seedlings per acre [0.4 ha] after two years). Very often, forb recruitment from seed is paltry, or—if we don't count the ubiquitous yarrow, which PNWBBA data shows to be rarely used by bumble bees—forb recruitment from seed may be nonexistent. Second, using forb plugs allowed us to focus on plant species that provide the highest value to bumble bees rather than selecting forbs to use solely because they establish reliably from seed. We selected species for these projects primarily for their value to bumble bees, focusing on species that have a balanced blooming chronology and a variety of flower shapes. Adding in the limitation of using only species with proven establishment from seed would have significantly limited options. Third, in some cases, plugs flowered in the first growing season, providing an immediate resource to pollinators. Forbs planted as seeds typically require 2 or 3 growing seasons before becoming a resource available to pollinators.

The remarkable survival of forb plugs in these two projects has been precedent setting for WDFW, particularly in the relatively arid habitats east of the Cascade Crest. Seeking similar survival success, several other project managers have now planted forb plugs, or contracted for them to be grown for future planting. This means that we are overcoming our reluctance to pay the much higher cost of forb plugs, and to devoting the considerable hand labor required for planting them. This is primarily because their survival has been so much greater than that of forb seed, but it is also because many of the species that have survived on these projects have never established from seed in significant numbers.

Figure 11: One of several planting plots with Lupine established at the Sinlahekin Wildlife Area. Forb plugs like these and others have shown remarkable survival success and provided more immediate habitat for wildlife compared to establishment from seed. Photo: WDFW / Kurt Merg.



Case Study 2: Large-Scale Habitat Restoration in Idaho, by Joel Sauder, IDFG

Habitat improvement projects for bees have traditionally been small, often significantly less than an acre (i.e., pollinator plots), where manual and hand treatments are a restoration option. However, to have population level impacts, larger plots, covering multiple acres, would likely be more effective. Between 2018 and 2020, as part of the PNWBBA project, the Idaho Department of Fish and Game (IDFG) undertook a large-scale habitat restoration effort that attempted to create over 50 acres (20.2 ha) of pollinator habitat spread across three wildlife management areas in southern Idaho in multiple parcels 2.5 to 7 acres (1.0 to 2.8 ha) in size. The sites selected for restoration were retired agricultural lands that had little wildlife value (e.g., Smooth Brome monocultures or Russian Olive stands). Our intent was to replace these with early and late pollinator foraging habitat to boost their value to wildlife, particularly bumble bees. While the areas are still developing, there are early lessons that can be drawn from these efforts.

Figure 12: Sites chosen for habitat improvement projects were retired agricultural lands that offered little habitat value like the one featured above prior to restoration. Photo: Xerces Society / Rich Hatfield.

Figure 13: Xerces and IDFG staff conduct bumble bee surveys prior to habitat restoration work to provide a baseline snapshot of species utilizing the wildlife management areas in southern Idaho. Photo: IDFG.

Site Preparation

- When attempting to convert retired agricultural lands to native habitats, effective multi-year site preparation prior to seeding is critical to success. In our case, a single year of repeated mowing of previously established native grasses did not reduce competition enough to allow forb seed to get a strong foothold. Consider raking, harrowing, or burning to break up thatch and improve soil-to-seed contact.
- Tilling is generally not recommended, as it is likely to trigger a release of the weed seedbank that is hard to control. If tilling is the only option, consider a season of multiple sessions of tilling, possibly with supplemental watering, to sprout and kill weeds, depleting the seedbank.
- Have a plan and allocate funding and staff for follow-up weed control, such as hand spraying/pulling or using a weed wiper. In our case, a flush of Scotch Thistle (*Onopordum acanthium*) and Prickly Lettuce (*Lactuca serriola*) was challenging to control.

Treatment Timing

- During project planning, ensure staff and equipment will be available at critical times to implement needed management actions. There are often narrow windows for effective weed treatment or supplemental watering (if that is an option) that can have dramatic effects on project success. Be sure that project needs are adequately incorporated into larger annual work plans, so that resources are on hand and these windows are anticipated in advance.
- Be realistic in the results you expect to see during the early (1–2) years of a project. Site preparation may require multiple years to appropriately prepare for successful seeding or planting. A wet or dry year may contribute to a stunted/failed planting. Additional weed-control activities might be required to ensure desired results. And after all the prep work and tending, newly seeded plants often require multiple years to really hit their stride. As Jacie Jensen at Thorn Creek Native Seed Farm in Genesee, Idaho, likes to say, "The first year they sleep, the second year they creep, and the third year they leap." As a result, the time between project conception and seeing results on the ground may be at least 3 years.

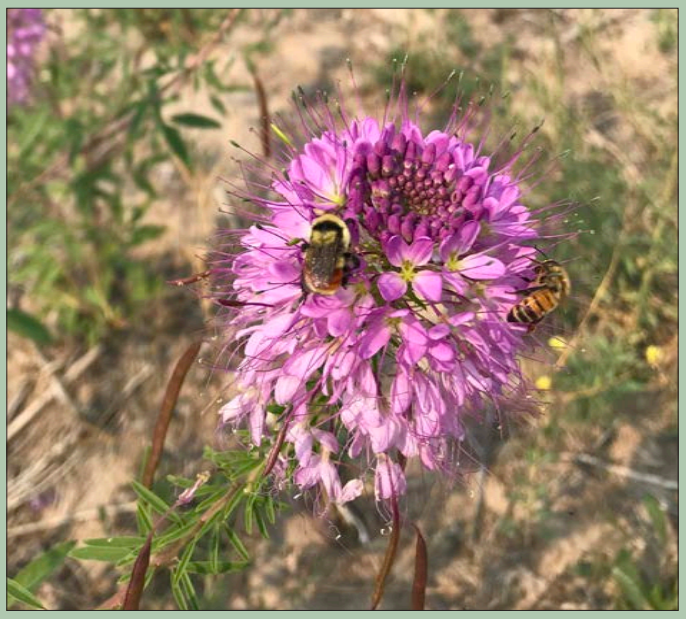


Figure 14: Preparing a restoration site for seeding/planting (above); forbs established from a pollinator seed mix following site preparation (below). Photos: IDFG.

Flexibility and Adaption

- Build flexibility into project planning. While *ideal* pollinator foraging habitat may have 20+ native flowering species with 2–4 species in blooming sequence through the season, identifying appropriate local species and then sourcing seeds or plugs may be difficult or simply not possible. Explore seed and plug availability and coordinate any necessary contract growing of plant materials well in advance of fieldwork in order to avoid being limited to what is readily available on short notice.
- Seed mixes and planting strategies are likely to be very region– and site–specific. Engaging those with previous local experience early in the project planning process can be key.

Box 3: Recommendation for Moving Pollinator Habitat Forward

- Evaluate the success and cost of planting plugs versus seeding in a research setting over an extended period of time (3–7 years). Short-term data from the PNWBBA suggest that plugs may be an important alternative to seeds with some key unique benefits.
- Undertake further research to evaluate fire impacts to bumble bees, including the use of spring burns. In Washington, sites for planting or seeding that had recently burned by either wildfire or prescribed fire and these were successful in producing high-quality pollinator habitat.
- Work with local producers to increase seed and plug availability for species that have been shown to be highly attractive to bumble bees (see Table 1). The availability of local native plant seed or plug resources is often limited and may require multiple years to develop, particularly to support large-scale habitat restoration efforts.

Figure 15: Data from a short-term PNWBBA study suggest plantings initiated with forb plugs are an important alternative to seeds and may provide key benefits to bumble bees, including floral resource availability in the first growing season. Photo: WDFW / Kurt Merg.

Figure 16: Thistles (*Cirsium* spp.) are important bumble bee food plants that have multi-species appeal. Working with producers to increase the availability of plants with high species appeal will improve restoration outcomes for bumble bees. Photo: Xerces Society / Rich Hatfield.

Best Management Practices for Bumble Bee Habitat

The landscape features described above will provide excellent bumble bee habitat. To help retain the value of these habitat for bumble bees, below are best management practices derived from currently available peer-reviewed literature. For further management guidance and background information, please see the recommended resources at the end of the document.

Figure 17: Maintaining a mosaic of habitat types, including high quality foraging habitat, is important to support the bumble bee life cycle. Photo: Xerces Society / Rich Hatfield.

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 or within a habitat feature (nesting, foraging, or overwintering habitat).
- Do not treat an entire site in a single year.

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 to 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, of primary importance is to maintain a diversity of habitat types and to minimize peak soil temperatures.
- The post-burning period is an opportunity to introduce additional floral resources (see Case Study 1).

Figure 18: The time period following a prescribed burn is appropriate for introducing pollinator plants, like this Bitterbrush (*Purshia tridentata*) plug planted at a restoration site in Washington. Photo: WDFW / Kurt Merg.

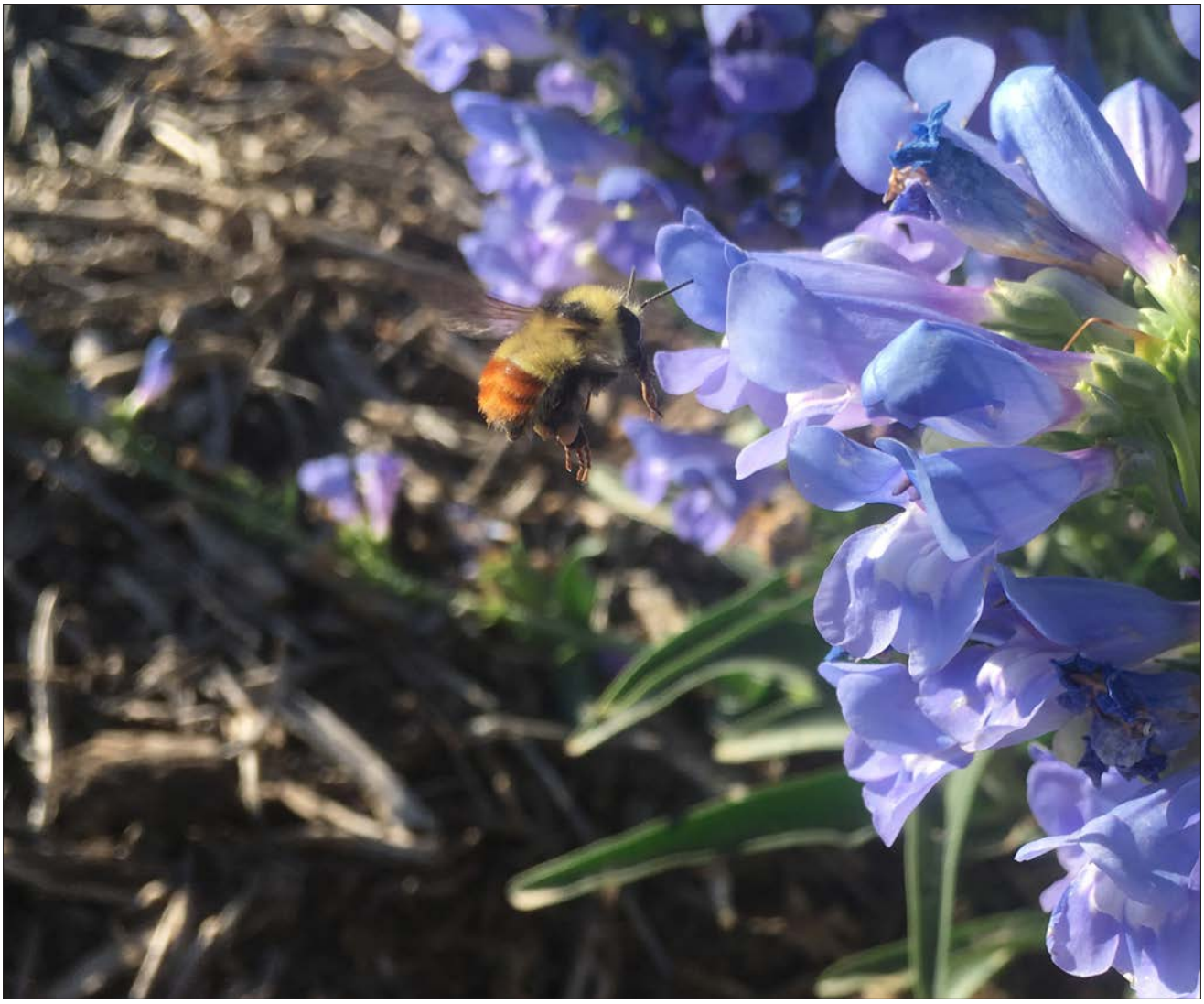


Figure 19: Bumble bees, like the Central Bumble Bee (*Bombus centralis*), are one of a number of pollinator types that utilize rangeland as habitat. Photo: Xerces Society / Kitty Bolte.

Grazing

- High-density, short-duration, low animal unit months (AUM), and/or rest-rotation are considered best grazing practices for maintaining habitat for bumble bees.
- Fall and winter grazing have the least impact on bumble bees; however, soils must be able to withstand late-season or winter grazing, and vegetation must be accessible by livestock. 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.
  - Utilization rates should be lower 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.
- As sheep grazing has been shown to be problematic for bumble bee populations, grazing activity should ideally occur only after flowering vegetation has senesced.

Figure 20: Grazing practices should consider the potential impacts on bumble bees and adopt best grazing practices for maintaining habitat, including foraging habitat featured in this western rangeland. Photo: Stephanie McKnight.

Mowing/Haying

- Strive to limit mowing to a maximum of 2 times per year.
- In hayfields, which provide pollinator habitat (foraging or nesting), to the extent possible delay harvesting until after most plants have bloomed.
- If you must mow during the flight season for bumble bees, try to leave islands of habitat (ideally two–thirds of the site during each mowing event) to create a mosaic pattern with refuge sites; and leave some areas (complete fields, or large field boundaries) entirely unmowed for the entire year, if possible.
- Fall mowing after first frost is best.
- Set the mower at its highest height.
- Use a flushing bar and mow in the middle of the day at slow speeds (< 13 kph / 8 mph) when temperatures are high enough (> 16°C / 60°F) so that bumble bees and pollinators can avoid direct mortality.
- Avoid mowing during early spring and mid-late summer if there are flowering resources present (this will help protect queens at vulnerable life stages).

Figure 21: Leaving managed areas free from mowing or haying if flowering resources are present will help to provide refuge and protect bumble bees. Photo: Xerces Society / Molly Martin.

Invasive Plants

- 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.
- Minimize pesticide exposure to non-target organisms.
- Consider a phased approach to avoid removing an abundance of floral resources.
- Create a revegetation plan. Bumble bees and other pollinators have likely been dependent on the floral resources provided by invasive plants for several years. Those floral resources need to be replaced as soon as possible to avoid a local population decline.
- 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.

Figure 22: Invasive plants, like Himalayan Blackberry (*Rubus armeniacus*), may be common in restoration areas; consider multiple methods to control invasive plants and incorporate a targeted approach to minimize impacts on bumble bees and other wildlife. Photo: Xerces Society / Emma Pelton.

Managed Honey Bees

- Any apiary, no matter the number of hives, should be more than 6.4 km (4 mi) from:
  - Known locations of pollinators that are listed as state or federally threatened or endangered, candidates for listing, or designated as special status, at-risk, or other species of concern (in addition to bees and other pollinators, this includes plants with specific and important native pollinator relationships that could be disrupted by honey bees);
  - Protected natural lands including designated wilderness, national parks and monuments, state preserves, etc.
  - Habitats of special value for biodiversity and/or pollinators (e.g., montane and high-elevation meadows, wet meadows, etc.).
- Each apiary should have no more than 20 hives.
- Apiaries should be separated by at least 6.4 km (4 mi).

Figure 23: Honey bees may compete with native bees for resources. Apiaries should be kept away from known locations of at-risk pollinators, protected natural areas, and special value habitats. Photo: Katie-Hietala-Henschell.

Additional Resources

Honey Bees

Hatfield, R., S. Jepsen, M. Vaughan, S. Black, and E. Lee-Mäder. 2018. *An Overview of the Potential Impacts of Honey Bees to Native Bees, Plant Communities, and Ecosystems in Wild Landscapes: Recommendations for Land Managers*. Portland, OR: The Xerces Society for Invertebrate Conservation.

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.

Ecology & Conservation of Bumble Bees

Hatfield, R., S. Jepsen, E. Mader, S. H. Black, and M. Shepherd. 2012. *Conserving Bumble Bees. Guidelines for Creating and Managing Habitat for America's Declining Pollinators*. Portland, OR: The Xerces Society for Invertebrate Conservation.

Thorough review of managing land for bumble bees. It 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 lifecycle of bumble bees. They also include regional bumble bee identification guides and lists of important bumble bee plants by region.

Liczner, A. R., and S. R. Colla. 2019. A systematic review of the nesting and overwintering habitat of bumble bees globally. *Journal of Insect Conservation* 23:787–801

Peer-reviewed publication that reviews all of the published literature on bumble bee nesting and overwintering. At the time of publication, this is the most comprehensive summary of these two subjects.

Pollinator BMPs on Rangelands

McKnight, S., C. Fallon, E. Pelton, R. G. Hatfield, A. Code, J. Hopwood, S. Jepsen, and S. H. Black. 2019. *Best Management Practices for Pollinators on Western Rangelands*. Portland, OR: The Xerces Society for Invertebrate Conservation (for the US Forest Service).

These best management practices were developed for federally managed rangelands that span the eleven western United States: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. The management practices addressed in the BMPs include grazing, mowing, prescribed fire, and pesticide use, as well as recommendations on how to address pollinators in restoration projects, invasive nonnative invasive plant management, managed pollinators (e.g., permitting honey bee apiaries on public land), recreation, and climate change impacts. The BMPs also provide an introductory overview of major pollinator groups (bees, butterflies and moths, other invertebrates, and vertebrates), their status, and threats as a primer on these animals and their habitat needs. In addition, the BMPs include methods to monitor pollinator populations, a comprehensive literature review, and tables detailing native pollinator phenology, conservation status, ecoregion associations, and habitat requirements.

Pollinator Habitat Maintenance

Sardiñas, H., J. Hopwood, J. K. Cruz, J. Eckberg, K. Gill, R. Powers, S. F. Jordan, M. Vaughan, N. L. Adamson, and E. Lee-Mäder. 2016. *Maintaining Diverse Stands of Wildflowers Planted for Pollinators*. Portland, OR: The Xerces Society for Invertebrate Conservation.

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.

Figure 24: The rare Western Bumble Bee (*Bombus occidentalis*) is one of several bumble bee species that utilize public lands as habitat. Photo: Xerces Society / Rich Hatfield.

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