Enhancing Pollinator Habitat in Remnant Oak Plant Communities

Oak savanna at Memaloose Overlook (photo: Matthew Shepherd).

The preservation and restoration of oak plant communities in Wasco and eastern Hood River counties can be important for many reasons. These habitats are dominated by the Oregon white oak (*Quercus garryana*) and ponderosa pine (*Pinus ponderosa*). Because of the historical clearing of vast areas for grazing and agriculture, only a small percentage of these oak savannas and woodlands in Oregon remain. Research conducted by Oregon State University (OSU) as a part of an USDA Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (CIG) and data collected by participants in the Oregon Bee Project has found that native plant habitat in remnant oak stands in Wasco County provide the most important habitat for sustaining the bee diversity in the region. These oak plant communities also serve as important habitat for other beneficial (predator and parasitoid) insects that attack crop pests.

In addition to pollinators and other beneficial insects, these plant communities also play a critical role in supporting wildlife diversity, surpassing that of some conifer forests. They provide essential refuge for the imperiled western gray squirrel and many bird species, such as dark-eyed juncos, goldfinches, nuthatches, wild turkeys, and acorn and pileated woodpeckers. Beyond their ecological significance, these habitats offer many benefits for farms and ranches, such as providing shade for livestock or acting as natural buffers that protect streams from sediment or manure runoff.

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Table 1 (page 7) includes the plant species that occur in association with white oak that are most attractive to native bees in oak habitats. These plants also attract a wide variety of beneficial insects including parasitoid wasps in the family Ichneumonidae, predaceous wasps in the family Vespidae (paper wasps and yellowjackets), and predaceous lacewing (*Chrysopa* spp. and *Chrysoperla* spp.). Oak habitats were found to be especially important for lacewings in April and May and then again in August. Similarly, April, May, and August were the primary months when wasps and native bees utilized oak habitats.

Purpose

The purpose of this document is to provide information on the best techniques to assess, manage, enhance, or establish habitat for pollinators and beneficial insects in remnant oak plant communities in Wasco and Hood River counties. This document can be used by landowners, NRCS conservation planners, and other conservation professionals to implement conservation practices. Depending upon existing weed pressure and the composition of native plants in remnant oak habitat near farms, these plant communities can be managed to remove non-native weeds competing with important pollinator plants or diversified with native plant species that provide important habitat for native pollinators.

Increasing the diversity of native flowering plants near orchards and other agricultural areas provides nectar and pollen resources for pollinators and beneficial insects, and also serves as a refuge from pesticide applications. Additionally, the presence of native bees and various predaceous and parasitic insects within white oak plant communities can provide benefits to farmers, contributing to enhanced pollination and pest control in adjacent orchards. The management or enhancement of white oak habitat can be important for ecological conservation and provide ecosystem services for agriculture in Hood River and Wasco counties.

Site Characteristics

Prior to planning pollinator habitat conservation practices, evaluation of site characteristics and existing plant community is the first critical step in the habitat planning process. Assessing and documenting factors such as soil composition, topography, water drainage patterns, and microclimates can help determine potential plant community composition. At the same time, planners or interested landowners should assess which, if any, native plant species that are valuable to pollinators are present (see Table 1 on page 7). Inventories of introduced and invasive species will help determine if the best course of action is to manage the site to reduce weed pressure to release the native plant community, to interplant additional native plants, or to conduct significant weed eradication and site preparation to replant or restore diverse native pollinator habitat.

Understanding the following site characteristics will help determine the course of action for pollinator habitat conservation in Wasco County oak habitat:

- **Native plant species:** Evaluate what species are present. Refer to Table 1 and the plant identificiation resources listed on page 11 to assist in identifying important forbs for native bees and other beneficial insects.

- **Weed/invasive species pressure:** Take note of the weed species present. Dominant weeds in this region include cheatgrass, bulbous bluegrass, medusahead, and diffuse knapweed. Other grasses that require additional considerations for site preparation include introduced bunchgrasses such as crested wheatgrass, tall wheatgrass, and sheep fescue, and rhizomatous grasses such as intermediate wheatgrass, and smooth brome.

- **Soil:** Soil type may affect both the types of plants that could occur on site, as well as the type of tools that may be used to install habitat. Soils of remnant oak plant communities in Wasco County are often deep well-drained loam, silt loam, or cobbly/gravelly loam. However, many sites with remnant oaks close to orchards may have thin, rocky soil that affects the ability to cultivate the site or to utilize no-till or range drills. It is also important to consider that some plant species are more well-suited to rocky or gravelly soil. Species that can tolerate these conditions and typically occur in rocky soils include bigseed lomatium, arrowleaf buckwheat, andtall buckwheat.

- **Risk of Pesticide Drift into Plantings:** Habitat must be protected from pesticides. Only sites with low risk for pesticide drift should be established as new habitat. The need for protection is greatest from insecticides and bee-toxic fungicides, but also broad-leaf herbicides that could damage native wildflowers and shrubs. This includes some pesticides approved for use on organic farms. Pesticide use in orchards is of particular concern in this region. Application of insecticides and fungicides with air blast sprayers has a high potential for drift. Buffers of 60 ft from pesticide application by air blast sprayer to pollinator habitat is recommended.

- **Risk of Introducing Unwanted Plants and Disturbing Current Native Species:** Take precautions by cleaning equipment and boots prior to working in the area to prevent the movement of invasive species into the site. Ideally, survey the site for native species in the spring, summer, and fall prior to planning the habitat to avoid disturbing any remnant plant species. Disturbing an oak site may have unwanted consequences of introducing invasive plant species and affecting native species present on site.

- **Risks to Non-Target Wildlife Species:** The planner should be mindful of potential impacts on other wildlife. An example is the disturbance or destruction of a habitat element such as large downed logs in various states of decay which can provide protection to terrestrial amphibians, reptiles, birds, and small mammals. In addition, downed wood provides these animals with food such as insects, fungi, and seeds.

- **Irrigation Availability:** Many areas may not have irrigation available. If this is the case, seeding habitats may be best. Establishing plants from plugs, pots, or bare roots may require irrigation.

- **Site Accessibility:** New habitat should be accessible to equipment for planting and maintenance operations if needed. Areas with a slope greater than 30% may not be accessible by tractors. Areas that are not accessible to seeding equipment can be planted with plugs or be seeded with broadcast seeder (e.g., ground driven cone spreader, belly grinders) or hand broadcast.

- **Sunlight:** Many of the plants included in this specification thrive in full sun, but some species tolerate partial or full shade. Refer to Table 1 for more details on sunlight requirements for different plant species.

Pollinator Habitat Enhancement Decision-Making

The characteristics listed above will help guide conservation planning to enhance habitat for pollinators and beneficial insects. Depending on the starting condition of the site, determine which strategy for enhancing pollinator habitat is the best. Refer to the flow chart in Figure 1 (page 4) to help determine which course of action to take. Establishing new habitat is not always the most effective course of action. NRCS conservation practices such as Weed Treatment (315), Brush Management (314), or Wildlife Habitat Planting (420) can be used to implement the strategies below. Three general approaches to enhancing habitat are outlined here:

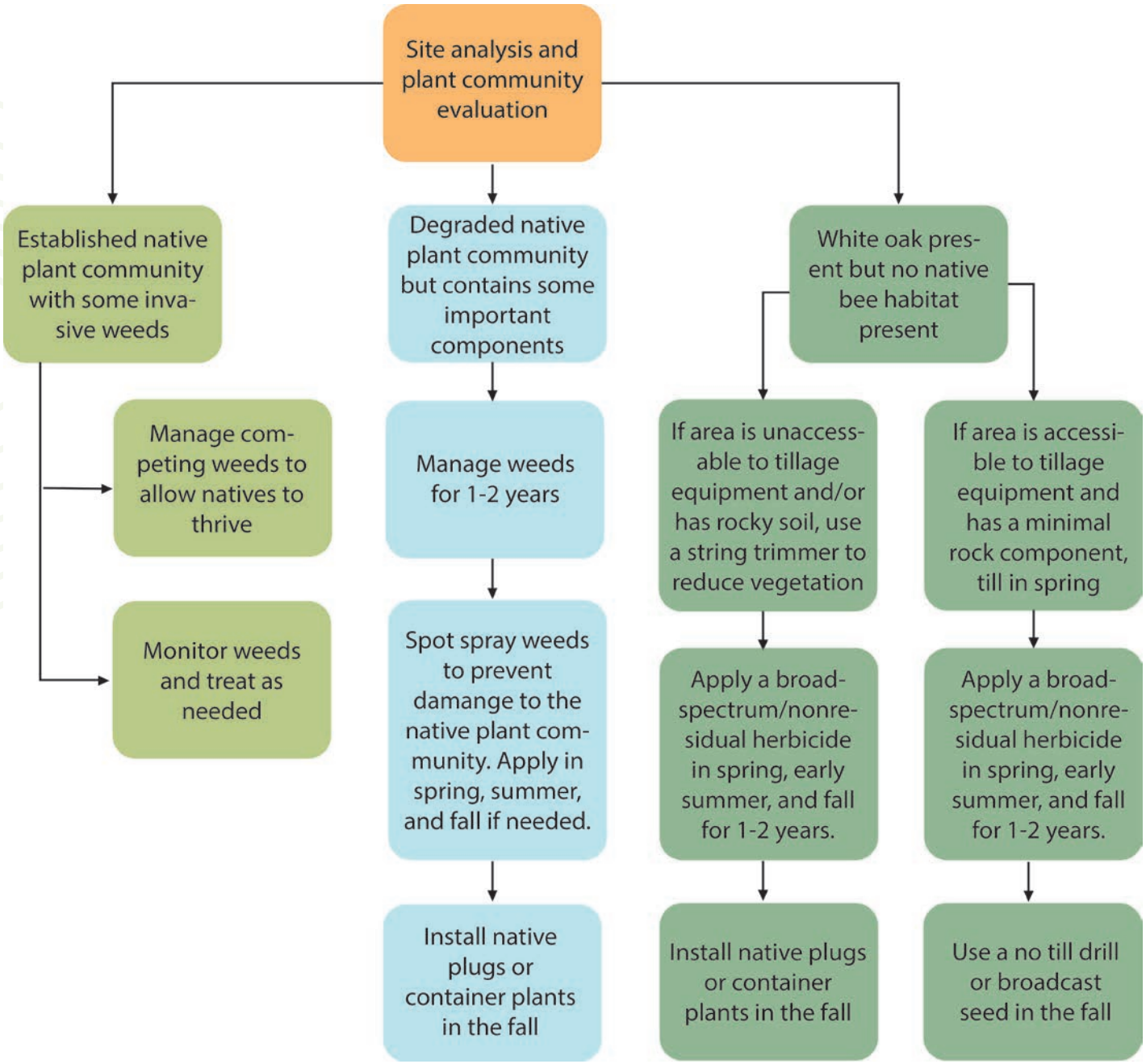
1. **Manage weeds to release natives.** If the site has a remnant community of native plants that provide good pollinator habitat it may be best to suppress weeds by implementing NRCS practices such as Weed Treatment (315) or Brush Management (314) to allow the native plant community to thrive. Careful spot spraying of herbicides with hooded sprayer wands or wick applicators can minimize impacts on adjacent plants. It is common for some sites to be dominated by invasive grasses with a remnant population of native forbs. Consider the use of grass-selective herbicides in this scenario to help release the native forbs from grass competition. Alternative methods to manage weeds include mechanical control such as the use of string trimmers, mowers, or hoes for scalping. After implementing these practices evaluate whether this approach is sufficient or whether interplanting with natives (approach #2 below) is needed to fill the spaces and prevent weed encroachment.

2. **Manage weeds and interplant native pollinator plants.** If the site has a degraded native plant community that is lacking in some key pollinator plants this may be the best approach. Implement NRCS practices Weed Treatment (315) or Brush Management (314) followed by Wildlife Habitat Planting (420). If the weed pressure is low, several spot

applications of herbicides in areas without natives will remove non-natives. If using a broad leaf non-residual herbicide, plant forb or grass transplants 72 hours after the last herbicide application in the fall to occupy the space as soon as possible. Select and plant forb or shrub species that are not represented in the site to provide a broad range of pollen and nectar resources in spring, summer, and fall. Small transplants or plugs may need supplemental water the first year during dry periods.

3. **Restore native pollinator habitat.** If very few or no native plants are present it may be best to remove the current vegetation and seed or transplant native pollinator plants and native grasses. Implement NRCS practices Herbaceous Weed Treatment (315) or Brush Management (314) if needed. Depending on the weed pressure of the site, preparation may take 1–2 years to reduce the weed seed bank. After proper site preparation implement the Wildlife Habitat Planting (420) practice.

Figure 1. Decision tree for enhancing pollinator habitat in white oak plant communities.



Site Preparation

Site preparation for NRCS conservation practice Wildlife Habitat Planting (420) for pollinators and beneficial insects may take up to two years depending on the weeds present on the site. Sites with perennial weeds typically take two years of weed management before planting. Familiarity with the life cycle of on-site weeds will facilitate appropriate timing of management activities (e.g., see above for common examples in this area). There are 3 steps to site preparation.

1. **Remove existing vegetation**. Before controlling invasive weeds, remove any accumulated grass and weed thatch. Thick grass thatch will prevent future seed planting from having adequate seed-to-soil contact and thatch will prevent container plantings from establishing well.

   - Controlled burns can be an effective method to reduce grass thatch, however without experienced controlled burn technicians this is not recommended.

   - If the site is accessible and on level ground, the area can be mowed and hayed to remove accumulated thatch.

   - If the site is accessible by tractor, tillage can be an effective way to remove the current vegetation. Mowing followed by a harrow can be used to reduce a moderate amount of vegetation. Thickly built-up thatch may necessitate heavy disks or even a moldboard plow to bury the plant residue.

   - Covering small areas with silage tarps, weed mats, or other heavy tarps for 6–9 months can be an effective method to reduce existing vegetation and reduce surface weed seed. Lay out silage tarps (or other black tarps) and hold down the edges with sandbags, cinder blocks, rocks, or other heavy items. Several months in place (in spring) will help remove the vegetation from the area. Keep in place for at least 6–9 months to use this method for weed seed bank reduction.

   - Particularly problematic perennial weeds should be treated early on in the process with targeted herbicide applications to remove them from the planting area. Some herbicides that are effective on composite family (Asteraceae) weeds may have residual activity for 1–3 years.

2. **Create a seeding surface (if seeding habitat)**

   - No-till drills can seed into the ground with minimal or no tillage and generally will require a surface with minimal thatch that has been mowed as low as possible to break down the plant residue that remains. Excessive thatch can prevent a no-till drill from placing the seed on the soil and potentially clog the colters.

   - Broadcast seeding methods such as hand seeding, cone broadcast spreading, and drop seeding will necessitate a fine firm seedbed free of plant residue. A pass with a harrow or very shallow disk followed by a culti-packer would produce a fine seedbed for broadcast planting.

3. **Reduce the weed seed bank.** After creating a seed bed in the spring of the planting year, reduce the weed seed bank in one of the following ways. It is important to minimize tillage after this stage as it will bring dormant weed seed to the surface setting back any reduction in the surface seed bank.

   - *Chemical fallow*. Apply a broad-spectrum, non-residual herbicide to prevent weed growth in the spring, early summer, and fall. The fall application can occur as late as 72 hours prior to planting. Apply herbicide as often as needed to prevent weed growth and accumulation of plant residue. If needed, repeat this process for a second year if the site has high weed pressure.

- *Flaming*. For small sites with low risk of fire spread, flaming is a technique using a propane flamer to kill small germinating weeds before they grow tall. Flame the seed bed repeatedly spring through fall as seeds germinate (as often as every 4 weeks). Repeat this process for a subsequent year if weed pressure remains high.

- *Solarization*. Solarization should only be used in full sun areas that have a low risk of erosion and are accessible to mowing, water, and tillage equipment. Begin the solarization process in late May and leave it in place through the summer. Mow and till the soil to create a seed bed. Water the site and place UV-resistant clear plastic (such as greenhouse plastic) over a moist seed bed. Solarization is only effective when starting with a moist soil bed. If irrigation is not available, solarization plastic must be placed down on the area immediately after a rain event in late spring. Bury the edges of the plastic to make sure the heat is sealed in. Leave the plastic in place until the fall. Repair all holes in the plastic as soon as possible with greenhouse plastic repair tape. Remove the plastic and plant immediately. Do not till.

- *Smothering (silage tarping)*. Smothering with light-blocking plastic can be used to reduce the weed seed bank and help decompose surface vegetation. This process may stimulate the germination of some seeds and subsequent death and decomposition of surface plant residue including seeds. Periodically removing the tarp to stimulate seed germination and promptly recovering the area can increase the effectiveness of this method. It is generally less effective on perennial weeds.

Typical Problem Weeds in Oak Plant Communities

Here are some common invasive weeds that require additional consideration in remnant oak habitat. Mowing alone will not control these species. Refer to the PNW Weed Management Handbook for all herbicide recommendations. If these species or other weeds are too dominant on a site, significant effort to remove these plants from the site will be required before a more intensive restoration.

- **Cheatgrass** can typically be controlled with repeated applications of broad-spectrum nonresidual herbicides like glyphosate or grass-specific herbicides. This species typically becomes less important over time as the planted habitat takes over the planting area.

- **Diffuse knapweed and Canada thistle** are difficult to remove from a site without significant forethought and treatment. Avoid sites with knapweed or Canada thistle if at all possible. Effective herbicides for control of knapweeds and Canada thistle can have residual effects on broad-leaved plants in the area for 1–3 years depending on the active ingredient used.

- **Medusahead** can be suppressed with mowing during late spring during the early flowering stage, but this tactic will not reduce populations enough for native species restoration. Prescribed burning in late spring, when the seeds are still on the plant, can kill the seeds and eliminate thatch for subsequent planting. Nonselective and residual herbicide applications, such as glyphosate at tillering in spring or just before seeds are produced, can be effective as well.

- **Bulbous bluegrass** is best controlled with herbicide. However it can also be effectively controlled with early season cultivation or tillage.

- **Himalayan blackberries** can be suppressed by repeated mowing, but this technique will not eliminate them for the purposes of restoration. Plants with established crowns will re-sprout for many years before their root resources are exhausted. Hand digging or mechanical removal of plant crowns with hand tools such as shovels and picks or with chains can be effective if repeated to remove re-sprouting roots. Herbicide treatment is the most effective method to remove blackberries and prevent regrowth.

Plant Selection

Select plant species that provide pollen and nectar resources in the early, mid, and late seasons. Native grasses can also provide habitat for overwintering and nesting bees and other beneficial insects. Grasses are typically included at a rate of 20–25% of the number of seeds planted per square foot.

Table 1. Commercially available pollinator plants that occur in Columbia Gorge white oak plant communities.

COMMON NAME	SPECIES	BLOOM PERIOD			DENSITY*	AVAILABILITY	SUNLIGHT REQUIREMENTS
		EARLY	*MID*	*LATE*			
FORBS							
Common Yarrow	*Achillea millefolium*		X		2 ft spacing or 0.5 PLS lb./acre	Seed or Container	Full sun, Part Shade
Menzies' fiddleneck	*Amsinckia menziesii*	X			9 PLS lb./acre	Seed	Full Sun, Part Shade
Woollypod milkvetch	*Astragalus purshii*	X			9 PLS lb./acre	Seed	Full Sun
Carey's balsamroot	*Balsamorhiza careyana*	X			2 ft spacing or 7–15 PLS lb./acre	Seed or Container	Full Sun, Part Shade
Arrowleaf balsamroot	*Balsamorhiza sagittata*	X			2 ft spacing or 7–15 PLS lb./acre	Seed or Container	Full Sun, Part Shade
Arrowleaf buckwheat	*Eriogonum compositum*	X			1–2 ft spacing	Container	Full Sun
Tall buckwheat	*Eriogonum elatum*	X	X		2–3 ft spacing or 3 PLS lb./acre	Seed or Container	Full Sun
Snow buckwheat	*Eriogonum niveum*		X	X	2 ft spacing or 3 PLS lb./acre	Seed or Container	Full Sun, Part Shade
Oregon sunshine	*Eriophyllum lanatum*		X		1 ft spacing or 4 PLS lb./acre	Seed or Container	Full Sun
Whitestem frasera	*Frasera albicaulis*	X			2 ft spacing	Container	Full Sun
Blanket flower	*Gaillardia aristata*		X	X	2 ft spacing or 6 PLS lb./acre	Seed or Container	Full Sun
Ballhead waterleaf	*Hydrophyllum capitatum*	X			2 ft spacing	Container	Full Sun, Part shade, Full Shade
Columbia desert parsley	*Lomatium columbianum*	X			20 PLS lb./acre	Seed	Full Sun, Part Shade

COMMON NAME	SPECIES	BLOOM PERIOD			DENSITY*	AVAILABILITY	SUNLIGHT REQUIREMENTS
		EARLY	*MID*	*LATE*			
FORBS							
Fernleaf biscuitroot	*Lomatium dissectum*	X			3 ft spacing or 20 PLS lb./ acre	Seed or Container	Full Sun, Part Shade
Klickitat biscuitroot	*Lomatium klickitatense*	X			2 ft spacing	Container	Full Sun, Part Shade
Bigseed lomatium	*Lomatium macrocarpum*	X			5–10 PLS lb./ acre	Seed	Full Sun, Part Shade
Barestem biscuitroot	*Lomatium nudicaule*	X			2 ft spacing or 20 PLS lb./ acre	Seed or Container	Full Sun, Part Shade
Butterfly-bearing biscuitroot	*Lomatium papilioniferum*	X			23 PLS lb./ acre	Seed	Full Sun, Part Shade
Nineleaf lomatium	*Lomatium triternatum*	X			20 PLS lb./ acre	Seed	Full Sun, Part Shade
Silverleaf phacelia	*Phacelia hastata*	X			7 PLS lb./acre	Seed	Full Sun, Part Shade
SHRUBS							
Tall Oregon grape	*Berberis aquifolium*	X			5 ft spacing	Container	Full Sun, Part Shade
Deerbrush	*Ceanothus integerrimus*		X		8 ft spacing	Container	Full Sun
Rubber rabbitbrush	*Ericameria nauseosa*		X	X	3ft spacing or 0.5 PLS lb./ acre	Seed or Container	Full Sun
GRASSES							
Bluebunch wheatgrass	*Pseudoroegneria spicata*	-	-	-	1 ft spacing or 8 PLS lb./ acre	Seed	Full Sun, Part Shade
Secund bluegrass	*Poa secunda*	-	-	-	1 ft spacing or 6 PLS lb./ acre	Seed	Full Sun, Part Shade
Idaho fescue	*Festuca idahoensis*	-	-	-	1 ft spacing or 8 PLS lb./ acre	Seed	Full Sun, Part Shade
Junegrass	*Koeleria macrantha*	-	-	-	1 ft spacing or 2 PLS lb./ acre	Seed	Full Sun, Part Shade, Full Shade

BASED ON RESEARCH FROM OREGON STATE UNIVERSITY, AND DATA COLLECTED BY VOLUNTEERS OF THE OREGON BEE PROJECT, THESE PLANTS HAVE BEEN DEMONSTRATED TO BE THE MOST IMPORTANT SPECIES FOR NATIVE POLLINATORS IN WASCO COUNTY OAK HABITATS.

*** PLUG DENSITY (SPACING) OR SEEDING RATE (PLS LB./ACRE). DATA IN THIS TABLE IS FOR BROADCAST SEEDING RATES FOR A SINGLE SPECIES. DRILL SEEDING RATES ARE TYPICALLY HALF OF BROADCAST RATES. THESE PLANTS ARE TYPICALLY PLANTED IN A MIX, THEREFORE WHEN DESIGNING A SEED MIX, RATES ARE REDUCED ACCORDING TO THEIR PERCENTAGE IN THE MIX.**

Planting

Determining the best method for planting is dependent on the site conditions, available equipment, and site accessibility. Site conditions such as weed pressure, water availability, and slope may play a role in what planting methods are appropriate.

Transplanting

Plug or container planting is one method for establishing plants, especially for woody perennials and shrubs. Plugs can also be used to establish herbaceous forbs but entail higher labor input and plant material costs than seeding. Transplants may be preferred in sites with high weed pressure; transplants will establish better in these sites with adequate mulching and irrigation, if possible. Also, some sites with steep slopes may be easier to establish with transplants. Seed placed on sloped sites can wash away during heavy rains and make seeding with tractor or ATV equipment difficult. Similarly, rocky sites will make site preparation and seeding difficult. Plug planting may be an option in this scenario.

Some sites may already have some components of the native plant community that would be beneficial to be retained. In this condition, planting transplants may be preferred to preserve species already present. Some rarer forb species or species for which seed production is difficult may only be available as transplants. Planting transplants of these species would allow landowners to include these species in their planting. In addition, some species, such as slow-growing balsamroot, are difficult to establish from seed.

Before planting transplants remove the surface vegetation. Scalp each planting location with a hoe or shovel in a 1–2 ft diameter circle. Use a hoe, shovel, or planting bar to open a hole of the appropriate size for each plug, or container size. Mulching the surface around each plant location with wood chips (3 inches deep) will provide some weed control and result in better establishment. Avoid placing mulch on the base of transplants. Leave a 2-inch radius circle of unmulched soil around each transplant to prevent damage to the plants. Planting of woody plants, forbs, and grasses is best done in the fall before the soil freezes.

Seeding

In most situations planting seed is the preferable method for establishing native forbs and grasses. Most forbs that are available by seed are easier and less expensive to establish by direct seeding compared to transplanting. There are several methods to disperse the seed, including broadcast or drill. Plant seed preferably in the fall from October to November, after frost and before the ground freezes. Wait at least 72 hours after the last herbicide treatment before seeding a native forb mix.

Drill seeding

The preferable method for seeding natives is a seed drill. Seed drills use less seed than other methods and often result in better seed-to-soil contact. Seed rates using a no-till drill are usually about half the rate used for broadcast seeding. Many areas in and around remnant oak plant communities may not be accessible by a tractor and seed drill. Drill seed (preferably with a no-till drill or range drill) into the prepared seed bed, ideally just before the fall rains. Add a seed bulking agent to help seeds evenly flow through the seed drill. Seeds can be mixed and bulked up with an inert carrier ingredient such as rice hulls. Use two to three parts of bulking agent for each part seed by volume.

Broadcast seeding

Broadcast seeding methods may offer more flexibility in maneuverability and practicality in and around remnant oak stands. This method may be preferable in areas inaccessible to tractors, with rocky soils, or sites too small to be practical with a seed drill. Seeds can be broadcast with a handheld (belly grinder) or ATV-mounted broadcaster, or spread by hand. Seed mixes should be bulked up with an inert carrier ingredient such as sand, fine-grained vermiculite, clay-based kitty litter, gypsum, or polenta (coarse cornmeal). Use two to three parts of bulking agent for each part seed by volume and mix thoroughly. These inert carriers help improve the seed distribution across a site, while also providing visual feedback on where seed has been thrown. Seed can be hand broadcast (similar to scattering poultry feed). When hand broadcasting, divide the seed into at

least two batches, bulk the seed mix with an inert carrier, and sow each batch separately. Scatter the first batch evenly over the site while walking in parallel passes across the site. Then to ensure the seed is evenly distributed, walk perpendicular to the previous passes to scatter the second batch.

Maintenance

Maintenance is critical to the success of wildlife habitat plantings. Control weeds around the planting to prevent reseeding of weeds for the first two years. Maintenance practices must be adequate to control noxious and invasive species and may involve methods such as string trimming, hand hoeing, or careful spot spraying with herbicides. Seeded habitat typically does not need irrigation to establish successfully. If transplants are used, irrigation may be needed the first year after planting especially in a dry year. Monitor for rodents, deer, or other animal damage and install protection if necessary.

During the establishment period, it is important to provide:

- **Protection** from deer, elk and rodents with tree tubes, or cages. Fencing areas may be necessary to exclude grazing or browsing animals.

- **Weed control** is critical in the first and second years after planting. If the site is well prepared, then less effort will be required for weeding after project installation. Maintenance practices must be adequate to control noxious and invasive species and may involve methods such as mowing, string trimming, hand hoeing, or spot spraying with herbicides. Weeds should be prevented from going to seed in, or adjacent to, the planting during the first two (and possibly three) years after planting to help ensure long-term success. Familiarity with the life cycle of on-site weeds will facilitate appropriate timing of management activities.

Arrowleaf balsamroot (*Balsamorhiza sagittata*) in an oak savanna at Memaloose Overlook (photo: Matthew Shepherd).

Common weed-management strategies include:

- **Spot spraying:** Spot spraying with herbicides can be effective, relatively inexpensive, and require minimal labor, even on larger project areas. Care should be taken that herbicides do not drift or drip onto desirable plant species.
- **Selective herbicides:** Grass-selective herbicides can be used to control weedy grasses. Contact a local crop advisor or Extension specialist for appropriate herbicide selection and timing or refer to the resources in the site preparation and planting resources listed below.
- **Mowing/string trimming:** Mowing or string trimming can be utilized to keep weedy species from going to seed.
- **Hand weeding:** Hand weeding (including hoeing) can be effective in small areas with moderate weed pressure.

Resources

Plant Identification

- *Flora of the Pacific Northwest: An Illustrated Manual.* (2018, 2nd ed.; Leo Hitchcock and Arthur Cronquist.) Seattle: University of Washington Press.
- *Handbook of Northwestern Plants.* (2001; Helen Gilkey, La Rea Dennis, and L. D. Johnston.) Corvallis: Oregon State University Press.
- *Plants of Southern Interior British Columbia and the Inland Northwest.* (1999; Ray Coupe, Dennis Loyd, and Roberta Parish.) Vancouver, BC: Lone Pine Publishing.
- *Wildflowers of the Columbia River Gorge: A Comprehensive Field Guide.* (1988; Russ Jolley.) Portland: Oregon Historical Society Press.
- *Wildflowers of the Pacific Northwest.* (2006; Mark Turner and Phyllis Gustafson.) Portland, OR: Timber Press.
- *A Manual of the Higher Plants of Oregon.* (1961; Morton E. Peck.) Hillsboro, OR: Binfords & Mort Publishers.

Site Preparation and Native Planting

- Xerces Organic Site Preparation Methods: xerces.org/publications/guidelines/organic-site-preparation-for-wildflower-establishment
- *PNW Weed Management Handbook*: pnwhandbooks.org/weed
- *Shrub Steppe and Grassland Restoration Manual for the Columbia River Basin*. (2011; J. E. Benson, R. T. Tveten, M. G. Asher, and P. W. Dunwiddie.) wdfw.wa.gov/publications/01330

Table 2. Regional native seed vendors and plant nurseries

SEED VENDORS		
BFI Native Seeds https://www.bfinativeseeds.com/ 1145 S Jefferson Ave Moses Lake, WA 98837 Matthew Benson ph: (509) 765-6348 fax: (509) 764-9978 mbenson@bfinativeseeds.com	**L&H Seeds Inc.** http://www.lhseeds.com/ 3930 Moon Rd Connell, WA 99326 Damon Winter ph: (509) 234-4433 fax: (509) 234-0202 info@lhseeds.com	**Heritage Seedlings** http://www.heritageseedlings.com 4194 71st Ave SE Salem, OR 97317 Lynda Boyer ph: (503) 585-9835 fax: (503) 371-9688 sales@heritageseedlings.com
PLANT NURSERIES		
Derby Canyon Natives http://www.derbycanyonnatives.com/ 9750 Derby Canyon Rd WA 98847 PO Box 185 Peshastin, WA 98847 Mel Asher ph: (509) 240-9792 mel@derbycanyonnatives.com	**Humble Roots Farm and Nursery LLC.** https://www.humblerootsnursery.com/ Mosier, OR 97040 Kristin Currin and Andrew Merritt ph: (503) 449-3694 humbleroots@gorge.net	

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