



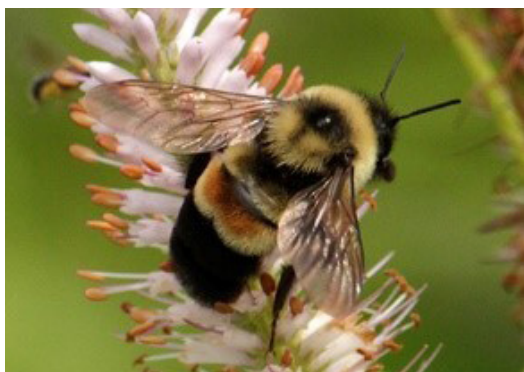
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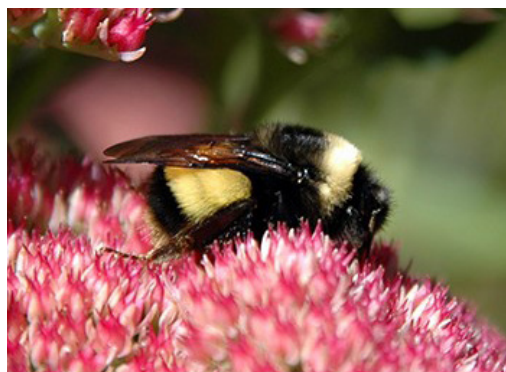


Rusty Patched Bumble Bee (*Bombus affinis*) & Yellow Banded Bumble Bee (*Bombus terricola*)

Field Guide



Rusty Patched Bumble Bee
Photo Courtesy of Susan Day



Yellow Banded Bumble Bee
Photo Courtesy of Sandy Gillian

The Rusty Patched Bumble Bee (*Bombus affinis*; RPBB) and Yellow Banded Bumble Bee (*Bombus terricola*; YBBB) belong to the same subgenus (Williams et al. 2008). All RPBB have entirely black heads, but only workers and males have a rusty reddish patch centrally located on the abdomen (Colla et al. 2011). Adult YBBB have black heads and all yellow hairs on the front of the thorax, and second and third abdominal segments (Colla et al. 2011).

Most bumble bees have large geographic ranges. At one time RPBB was found surrounding the Great Lakes and along the east coast from Maine to South Carolina (USFWS 2016). Since the late 1990s, RPBB distribution and abundance have declined dramatically with only five percent of the historical locations currently occupied (USFWS 2016). The historic range of YBBB included all of the southern Canadian provinces, south along higher elevations in the Appalachian Mountains, and west through North Dakota with the densest concentrations in the northeastern and Appalachian states (Koch and Strange 2009). However, in recent decades, the YBBB range has receded markedly in the southern and far western portions of its historical range and the species appears to have been extirpated from much of the British Columbia, Southern Appalachians, and southeast plains (USFWS 2018a).

Habitat alteration, introduction of non-native pathogens from managed bumble bee and honeybee colonies, and widespread use of pesticides over the past 30 years have likely all contributed to reduced range and abundance for both bumble bees (USFWS 2016, 2018a). On January 11, 2017, the U.S. Fish and Wildlife Service (USFWS) published the final rule to list the rusty patched bumble bee (*Bombus affinis*) as an endangered species under the Endangered Species Act (ESA) (USFWS 2017). The listing became effective on March 21, 2017. On August 15, 2019, the USFWS found that listing was not currently warranted for the yellow banded bumble bee (*Bombus terricola*) (USFWS 2019a). However, they did find that its range has been significantly reduced and occupancy and abundance are likely to continue to decline. Given that habitat loss is affecting both species and their habitat requirements are similar, this report provides habitat restoration recommendations for both RPBB and YBBB.

LIFE HISTORY

RPBB and YBBB are highly social and form annual colonies consisting of a single queen, female workers, and males. Colony sizes of RPBB are considered large compared to other bumble bees, and healthy colonies may consist of up to 1,000 individual workers in a season (Macfarlane et al. 1994). Yellow banded bumble bee colonies are medium-sized, producing an average of 150-430 workers (Macfarlane et al. 1994).

Both species have annual cycles similar to those of other bumble bees that begin in early spring with colony initiation by solitary queens and progresses with the production of workers throughout the summer and end with the production of males and new queens, in mid to late summer and early autumn (Macfarlane et al. 1994, Colla and Dumesht 2010). New queens emerge from their underground overwintering site in early spring. The queen must immediately forage to rebuild her body reserves. Once she finds a suitable nest site, she collects nectar and pollen from flowers to support the production of her eggs, which are fertilized by sperm she has stored since mating the previous autumn. The queen lays up to twelve eggs on top of a mass of pollen mixed with nectar and, if necessary, maintains the temperature by shivering her flight muscles. As the workers hatch and the colony grows, workers assume the responsibility of food collection, colony defense, and care of the young, while the queen remains within the nest and continues to lay eggs for workers, males and new queens. From July to September, new queens and males emerge from the nest to mate, during which males will disperse up to 10 km (Lepais et al. 2010, Kraus et al. 2009). At the end of the season, these fertile queens feed heavily to build up reserves and find overwintering sites, while the old queen, workers, and males die.



Yellow Banded Bumble Bee Photo Courtesy of Leif Richardson

HABITAT

These two bumble bee species need three things: nectar and pollen from diverse and abundant flowers from spring through autumn, undisturbed nesting sites in proximity to floral resources, and overwintering sites for hibernating queens in proximity to spring floral resources.

Early-spring emerging bumble bees, such as the RPBB and YBBB, are associated with mixed and woodland habitats and wetlands, and likely have co-evolutionary relationships with early spring woodland ephemeral plants (Colla and Dumesht, 2010, Colla 2016, Williams et al. 2014). RPBB has been observed and collected in a variety of habitats, including prairies, woodlands, marshes, agricultural landscapes, and residential parks and gardens (Colla and Packer 2008, Colla and Dumesht 2010, USFWS RPBB unpublished geodatabase). YBBB have been observed close to or within a variety of forest types, including riparian woodlands, mature deciduous forests, and coniferous forests. They also utilize wetlands, undisturbed bogs, blueberry barrens, and prairies (Batra 1993, Heinrich 1976a, Williams et al. 2014, Koch and Strange 2009). Although some minor differences exist, habitat protection that benefits RPBB will likely have comparable benefits for YBBB as well as other native pollinators.

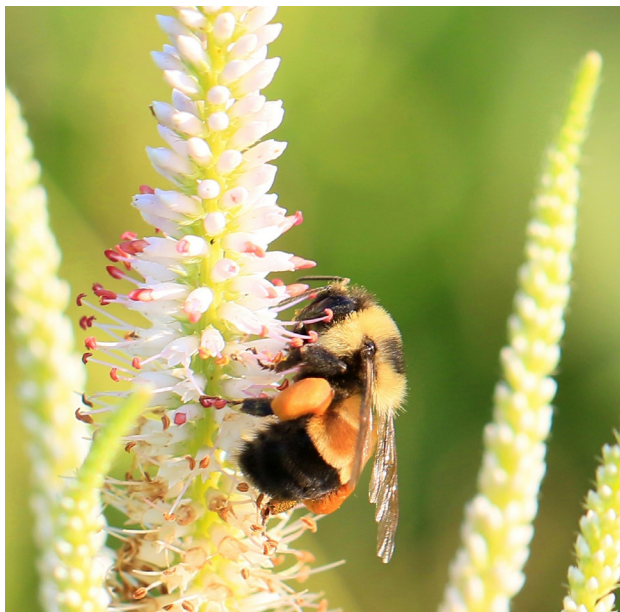
NECTAR AND POLLEN PLANTS

Bumble bees are generalist foragers, meaning they gather pollen and nectar from a wide variety of flowering plants near their nests (Xerces 2013). RPBB and YBBB are short-tongued species (Colla et al. 2011), so they are not able to easily access the nectar in flowers with deep corollas (all of the petals of a flower). Studies of other *Bombus* species have found foraging distances are typically less than 1 km from nesting or

overwintering sites (Knight et al. 2005, Wolf and Moritz 2008, Dramstad 1996, Osborne et al. 1999, Rao and Strange 2012). Unlike honeybees, *Bombus* colonies immediately consume food as there is limited storage space in the nest (Colla and Dumesht 2010, Heinrich 1976a, Williams et al. 2014). When there is constant food availability, the size of individual bees and colonies increases (Colla 2016, Tasei and Aupinel 2008).

These species emerge early in the spring and go into hibernation late, so to meet their nutritional needs, RPBB and YBBB require a constant and diverse supply of flowers that bloom throughout the colony's long life cycle, from April through September (MacFarlane et al. 1994).

RPBB and YBBB are likely dependent on woodland spring ephemeral flowers and early blooming trees and shrubs because of the queens' early emergence in the spring (Colla and Dumesht 2010). Proximity of the nest to food sources is critical while the queen alone is establishing a new colony and caring for the brood. The egg-laying rate of queens in well provisioned colonies is higher than in colonies with limited pollen resources (Burns 2004). Access to abundant and diverse floral resources in the late summer and autumn is important because it influences the number, size, and fitness of fertile males and new queens needed to ensure the founding of new colonies in the following spring (Burns 2004, Hatfield and LeBuhn 2007). For new queens to survive overwintering, the habitat needs to include large quantities of pollen and nectar in the autumn because substantial body fat reserves are needed for hibernation (Goulson 2010, Sutcliffe and Plowright 1990).



Rusty Patched Bumble Bee Photo Courtesy of Larry Reis

NESTING HABITAT

Nesting habitat may be a limiting factor for bumble bees due to long search times required to locate suitable sites, low levels of natural sites, niche overlap with other bee species, and high frequency of nest usurpation by other bees (Hines and Hendrix 2005, Richards 1978). The transition zone between forest and grassland can be particularly valuable bumble bee nesting habitat, as well as field boundaries, meadow margins, and forest edges (Hines and Hendrix 2005). Both species make nests 1-4 feet underground in downward sloping tunnels and typically in a pre-existing burrow such as an abandoned rodent nest (Hobbs, 1968, Williams et al. 2014). Successful bumble bee nests are typically found within 1 km of high diversity nectar areas (FWS 2018b) in habitat that is undisturbed, until late summer when the reproductive bees leave the

nest.

OVERWINTERING HABITAT NEEDS

Overwintering sites close to early spring floral resources are critical for newly emergent queens to restore body fat reserves rapidly and for adequate energy to locate a suitable nest site and establish a new colony (Alford 1969, Goulson 2010, Williams et al. 2014). The site needs to remain undisturbed from late autumn through the spring while the queen is in hibernation. Little is known about the overwintering sites of RPBB queens, but the YBBB's overwintering habitat is an underground burrow that the new queen digs on barren soil to an adequate depth. The amount of time it takes and depth to which she digs depends on the soil type. If the site is not suitable, and a rock or root is encountered, she will abandon that burrow and begin digging another until she has a suitable small oval cavity (Alford 1969, Goulson 2010).

HABITAT RESTORATION RECOMMENDATIONS

Priority areas in Pennsylvania –

A. RPBB

- Delaware County with expansion into Montgomery, Bucks, and Berks Counties
- Mercer County with expansion into Crawford and Erie Counties

B. YBBB

- Cameron-Clinton-Centre County cluster with expansion into Elk, McKean, Warren and Jefferson Counties
- Erie County surrounding with expansion into Warren County

C. RPBB and YBBB

- Bradford-Sullivan-Luzerne –Lackawanna County cluster with expansion into Tioga, Lycoming, Columbia, Monroe, Pike, and Northampton Counties

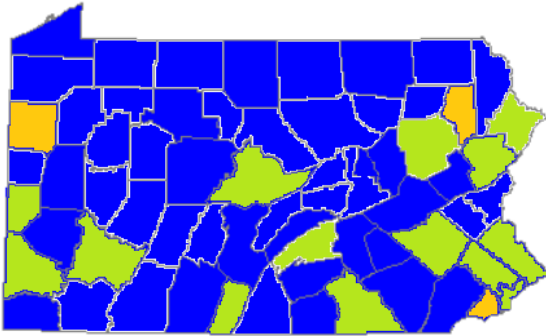


Figure 1. Historic (blue) distribution, pre-1990 distribution (green) and priority areas with post-1990 sightings (orange) of Rusty Patched Bumble Bee (*Bombus affinis*) in Pennsylvania.

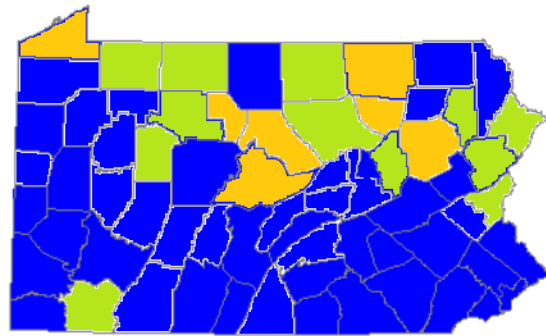


Figure 2. Historic (blue) distribution, pre-1990 distribution (green) and priority areas with post-1990 sightings (orange) of Yellow Banded Bumble Bee (*Bombus terricola*) in Pennsylvania.

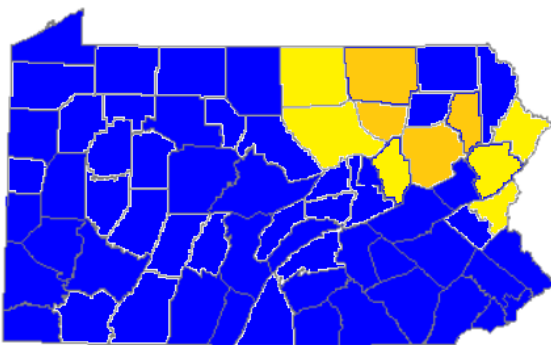


Figure 3. Priority areas (orange) with expansion areas (yellow) based on post-1990 sightings for both species in Pennsylvania.

Habitat Sub-Types and Target Species

- 1) Low density woodland habitats bordering meadow areas in rural and suburban settings
 - a. Meadows with adult nectar sources (at least 50% of site)
 - blooming from late March to October
 - at least ten species of flowers blooming in all three seasons
 - frost and drought hardy plants in all three seasons
 - no or low density (1 hive/2 acres) of domestic honeybees

COMMON NAME	SPECIES	PERIOD	RANGE IN PA
Forbs			
Yellow Giant Hyssop ^{1,2}	<i>Agastache nepetoides</i>	SuAu	Southern and NJ border counties
White Snakeroot	<i>Ageratina altissima</i>	SuAu	Throughout
Eastern Goatsbeard	<i>Aruncus dioicus</i>	Su	South Central to Southwest counties
Field Thistle ¹	<i>Cirsium discolor</i>	SuAu	All but Erie Basin and Upper Allegheny River Basin
Tall Thistle ¹	<i>Cirsium altissimum</i>	SuAu	Southwest and Southeast counties
Swamp Thistle ¹	<i>Cirsium muticum</i>	SuAu	All but Susquehanna Basin
Pasture Thistle ¹	<i>Cirsium pumilum</i>	SuAu	All but lower Susquehanna Basin
Boneset ¹	<i>Eupatorium perfoliatum</i>	SuAu	Throughout
Trumpetweed ¹	<i>Eutrochium fistulosum</i>	SuAu	Throughout
Spotted Joe Pye Weed ^{1,2}	<i>Eutrochium maculatum</i>	SuAu	All but South Central and Southwest
Sweet Scented Joe Pye Weed ^{1,2}	<i>Eutrochium purpureum</i>	SuAu	Throughout
Wild Geranium	<i>Geranium maculatum</i>	Sp	Throughout
Spotted Geranium	<i>Geranium maculatum</i>	Sp	Throughout
Thin-Leaved Sunflower ²	<i>Helianthus decapetalus</i>	SuAu	Throughout
Woodland Sunflower ²	<i>Helianthus divaricatus</i>	SuAu	Throughout
Jewelweed	<i>Impatiens capensis</i>	Su	Throughout
Dense Blazing-Star	<i>Liatris spicata</i>	Su	Southeast Counties
Bee Balm/Wild Bergamot ^{1,2}	<i>Monarda fistulosa</i>	Su	Throughout
Wild Blue Phlox	<i>Phlox divaricata</i>	Sp	All but Northeast Counties
Creeping Phlox	<i>Phlox stolonifera</i>	Sp	Appalachian Ridge Counties
Mayapple	<i>Podophyllum peltatum</i>	Sp	Throughout
Mountain Mint ¹	<i>Pycnanthemum virginianum</i>	Su	All but Northern Tier except Erie County
Bloodroot	<i>Sanguinaria canadensis</i>	Sp	All but Upper Allegheny Basin
Atlantic Goldenrod ^{1,2}	<i>Solidago argute</i>	Au	Throughout
White Goldenrod ^{1,2}	<i>Solidago bicolor</i>	Au	Throughout
Wreath Goldenrod ^{1,2}	<i>Solidago caesia</i>	Au	Throughout
Canada Goldenrod ^{1,2}	<i>Solidago canadensis</i>	Au	Throughout
Zigzag Goldenrod ^{1,2}	<i>Solidago flexicaulis</i>	Au	All but Central counties
Giant Goldenrod ^{1,2}	<i>Solidago gigantean</i>	Au	Throughout
Early Goldenrod ^{1,2}	<i>Solidago juncea</i>	SuAu	Throughout
Gray Goldenrod ^{1,2}	<i>Solidago nemoralis</i>	Au	Throughout
Roundleaf Goldenrod ^{1,2}	<i>Solidago patula</i>	Au	All but Susquehanna Basin
Downy Goldenrod ^{1,2}	<i>Solidago puberula</i>	Au	Central and Eastern counties
Wrinkle Leaf Goldenrod ^{1,2}	<i>Solidago rugosa</i>	Au	Throughout
Common Blue Wood Aster ^{1,2}	<i>Symphyotrichum cordifolium</i>	Au	Throughout

White Panicle Aster ^{1,2}	<i>Symphyotrichum lanceolatum</i>	Au	Throughout
Calico Aster ^{1,2}	<i>Symphyotrichum lateriflorum</i>	Au	Throughout
New England Aster ^{1,2}	<i>Symphyotrichum novae-angliae</i>	Au	Throughout
Late Purple Aster ^{1,2}	<i>Symphyotrichum patens</i>	Au	Eastern counties
Hairy White Oldfield Aster ^{1,2}	<i>Symphyotrichum pilosum</i>	Au	Throughout
Purplestem Aster ^{1,2}	<i>Symphyotrichum puniceum</i>	Au	Throughout
Foamflower	<i>Tiarella cordifolia</i>	Sp	All but Southeast and South Central
Culver's Root	<i>Veronicastrum virginicum</i>	Su	All but North Central, Erie, Susquehanna, and Wayne
Shrubs			
Gray Alder	<i>Alnus incana</i>	Sp	All but Southeast and Southwest
Hazel Alder	<i>Alnus serrulata</i>	Sp	All but Northern most counties, excluding Erie and Wayne
New Jersey Tea	<i>Ceanothus americanus</i>	Su	Throughout
Buttonbush	<i>Cephalanthus occidentalis</i>	Su	All but extreme North Central
Silky Dogwood	<i>Cornus amomum</i>	Sp	Throughout
Dwarf Bush Honeysuckle	<i>Diervilla lonicera</i>	Su	Throughout
American Black Current ¹	<i>Ribes americanum</i>	Sp	All but Southwest and North Central
Eastern Prickly Gooseberry ¹	<i>Ribes cynosbati</i>	Sp	All but Southeast and South Central
Appalachian Gooseberry ¹	<i>Ribes rotundifolium</i>	Sp	All but Southwest and Northeast
Carolina Rose ¹	<i>Rosa carolina</i>	Su	Throughout
Swamp Rose ¹	<i>Rosa palustris</i>	Su	Throughout
Virginia Rose ¹	<i>Rosa virginiana</i>	Su	Southeast and Northeast
Blackberries/Raspberries ¹	<i>Rubus spp.</i>	Su	Throughout
Common Elderberry	<i>Sambucus nigra canadensis</i>	Su	Throughout
White Meadowsweet ¹	<i>Spiraea alba</i>	SuAu	Throughout
Steeplebush ¹	<i>Spiraea tomentosa</i>	SuAu	All but South Central and Southwest
Lowbush Blueberry ^{1,2}	<i>Vaccinium angustifolium</i>	Su	Throughout
Highbush Blueberry ^{1,2}	<i>Vaccinium corymbosum</i>	Su	Throughout
Trees			
Box Elder	<i>Acer negundo</i>	Sp	Throughout
Red Maple	<i>Acer rubrum</i>	Sp	Throughout
Silver Maple	<i>Acer saccharinum</i>	Sp	Throughout
Sugar Maple	<i>Acer saccharum</i>	Sp	Throughout
Ohio Buckeye ¹	<i>Aesculus glabra</i>	Sp	Southwest
Common Serviceberry	<i>Amelanchier arborea</i>	Sp	Throughout

Hackberry	<i>Celtis occidentalis</i>	Sp	All but Erie Basin and Upper Allegheny River Basin
Redbud	<i>Cercis canadensis</i>	Sp	Southern Counties
Flowering Dogwood	<i>Cornus florida</i>	Sp	Throughout
Cucumber Tree	<i>Magnolia acuminata</i>	Sp	All but counties bordering NJ and lower Susquehanna River
Big Tooth Aspen	<i>Populus grandidentata</i>	Sp	Throughout
Quaking Aspen	<i>Populus tremuloides</i>	Sp	All except Southwest
American Plum ¹	<i>Prunus americana</i>	Sp	All but Northeast
Pin Cherry ¹	<i>Prunus pensylvanica</i>	Sp	All but Southwest
Black Cherry ¹	<i>Prunus serotina</i>	Sp	Throughout
Chokecherry ¹	<i>Prunus virginiana</i>	Sp	Throughout
Black Willow	<i>Salix nigra</i>	Sp	Throughout
Silky Willow	<i>Salix sericea</i>	Sp	Throughout
Sassafras	<i>Sassafras albidum</i>	Sp	Throughout
Basswood	<i>Tilia americana</i>	Su	Throughout
¹ RPBB and/or YBBB observed on plants in this genus (Williams et al. 2014); natives within genus selected			
² Bumble bee superfood based on nectar and pollen quantity or immune boosting benefits (USFWS 2018b; Xerces 2017)			

- b. nesting habitat with evidence of rodent burrows (20% of site)
 - unmowed, low density, predominantly native grass mix
 - bare, loose soil in patches between plants
 - robust burrowing mammal populations
- c. overwintering habitat (20% of site)
 - woodland edges with open understory
 - at least ten species of native spring blooming flowers, trees, and shrubs
 - grass and leaf litter accumulation along woodland edge

Restoration Approaches

Objective: The preferred habitats are high diversity wildflower meadows with woodland edge with open understory supporting spring ephemeral wildflowers in rural and suburban (e.g., parks) settings (USFWS 2018b).

- 1) Crop field conversion adjacent to forest edge
 - Herbicide – One application to control weeds
 - Soil-appropriate meadow seed mixes for nectar areas -
 - autumn with winter rye or spring without
 - include at least ten target forbs for each season (i.e., spring, summer, autumn)
 - include at least three superfood plants
 - Patches of native grasses or predominantly grass mixes
- 2) Scrub conversion within or along woodland edge (Spring and Autumn)
 - Thin understory - stump treat and/or grub (Spring); repeat treatment (Autumn)
 - Spring nectar areas - plant target wildflowers, shrubs, and trees (Autumn only)

- 3) Enhancement of warm season grass plantings or native meadow enhancement (spring only)
 - Remove grasses to create bare soil patches
 - Clear patches to plant plugs of target forbs to improve nectar areas
 - include at least ten target forbs for each season (i.e., spring, summer, autumn)
 - include at least three superfood plants

LONG-TERM MAINTENANCE

1) Existing Habitat

- The species presence should be documented. Local naturalists should be queried to document their observations. Surveys should be conducted using the methods and schedule from USFWS (2019b). Vouchers are not permitted for RPBB, but can be collected for YBBB. Photo documentation is warranted for both species.
- If present, evaluate the existing disturbance regime (e.g., grazing, mowing, burning, herbicides). Disturbances should be used on small proportions (less than one-third) of the occupied habitat in any one year and in scattered patches to ensure the colonies have enough nectar and pollen, as well as nesting and overwintering habitat (USFWS 2018b). Management activities should be during the dormant season. Native grass areas that serve as overwintering habitat should not be disturbed until after queens emerge in spring. Intervals of 4-6 years should be used to accommodate nectar, nesting, and overwintering areas. Shrub control cycle can be longer depending on species' growth rates.
- Mowing is more conducive to maintaining mosaics on divergent schedules than burning or grazing. Mowing can be used to improve select areas while protecting overwintering habitat for queens in the native grass litter and nesting sites. Mowing to 12 inches can continue before March or after October (USFWS 2018b).
- Where an existing population has been maintained without fire, do not introduce fire. Sites currently managed with prescribed burning should be divided into several units with less than one-third of the habitat burned in each year using a 4-6 year rotation (USFWS 2018b).
- RPBB and YBBB could be at risk from pesticides if habitat is in proximity to treated areas. Bumble bee populations are uniquely susceptible to pesticides, particularly neonicotinoids, when the application overlaps with colony establishment in the spring (Leza et al. 2018, Baron et al. 2017, Arena and Sgolastra 2014). If occupied habitat is adjacent to crops, implement a 125-foot buffer to prevent effects from neonicotinoids and 40-foot buffer from other ground-applied pesticides (Xerces 2017).
- In areas where vegetation is controlled by herbicides, management should be shifted to mowing. Limit herbicide use for invasive plant control to spot, injections and stump treatments to prevent loss of target plants.

2) Restored Habitat

- Disturbances should be used on small proportions (less than one-third) of the occupied habitat in any 1 year and in scattered patches to ensure the colonies have enough nectar and pollen, as well as nesting and overwintering habitat (USFWS 2018b).
- Winter mowing is the preferred management tool. Overwintering habitat should not be mowed (USFWS 2018b).
- Maintain connectivity of colonies where they are clustered (less than 2 km separation) as it is likely to be critical for long-term persistence of populations (USFWS 2016).
- Maintain nectar areas on 4-6 year mowing cycle.
- Maintain tree and shrub edge habitat with early spring wildflowers
- If habitat is adjacent to crops, implement a 125-foot buffer to prevent effects from neonicotinoids

- and 40-foot buffer from other ground-applied pesticides (Xerces 2017). Limit herbicide use for invasive plant control to spot, injections and stump treatments to prevent loss of target plants.
- Conduct surveys and/or use citizen scientists to monitor bumble bee occupancy and adjust management based on occupancy

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