Rusty Patched Bumble Bee (*Bombus affinis*)

Endangered Species Act Section 7(a)(2) Voluntary Implementation Guidance

Version 3.2

November 8, 2024

U.S. Fish & Wildlife Service

Rusty patched bumble bee
Photo courtesy of Tamara Smith, U.S. Fish and Wildlife Service

Recommended citations: U.S. Fish and Wildlife Service (USFWS). 2024. Rusty Patched Bumble Bee (*Bombus affinis*) Endangered Species Act Section 7(a)(2) Voluntary Implementation Guidance. Version 3.2. USFWS, Bloomington, MN. 49 pp.

Contents

What's New in this Version

Significant updates to version 3.2 include:

1. Refinements to survey recommendations under various proposed project scenarios.
2. Refinements to Table 1 and the determination key (Appendix A). For example, we removed the term woodland from the overwintering habitat and early spring foraging habitat definitions, which was often confused with open canopy areas such as oak savannahs.
3. Refinements to estimated spring emergence dates North and South of 42°N supported by spring bloom phenology and rusty patched bumblebee observations. These changes are reflected in the text, Table 1, and Appendix A.
4. Clarification on potential for effects from forage removal and citations regarding seed collections (Nevill et al. 2018).
5. Table (Table 2), which provides some examples of calculations to determine the percentage of forage loss.
6. Refined definition of ground disturbance in nesting areas.
7. Discussion and literature citations regarding the potential for road mortality.
8. Discussion and literature citations regarding potential for effects from other activities.
9. Fixed broken website links (e.g., rusty patched bumble bee USFWS webpage, link to the high potential zone map, link to the rusty patched bumble bee species status assessment, and the link to the rusty patched bumble bee conservation management guidance).
10. Updated range-wide determination key (Appendix A).
11. Concurrence Request Form for Use with Assisted Determination Key (Appendix B).
12. Additional examples of stressors to rusty patched bumble bee (Appendix C).
13. Appendix D. Concurrence for activities that may affect, but are not likely to adversely affect rusty patched bumble bees per a programmatic biological opinion with the Natural Resources Conservation Service and Farm Service Agency Programs in Illinois, Minnesota, and Wisconsin.

Background and Purpose

In accordance with section 7(a)(2) of the Endangered Species Act (ESA), federal agencies must consult with the U.S. Fish and Wildlife Service (FWS) on any action that may affect species listed as endangered or threatened to ensure they do not jeopardize the species' continued existence. We intend for this voluntary guidance to help FWS, action agencies, and applicants carry out efficient and effective 7(a)(2) consultations and to plan and implement actions that would conserve the species.

The suggestions and alternatives provided in this document are subject to continual improvement and modification. Agencies may use any approach or methodology that ensures compliance with ESA Section 7 and implementing regulations at 50 Code of Federal Regulations Part 402. We encourage and expect deviation from these recommendations whenever appropriate to respond to distinct or differing conditions within an action area. We note that any use of mandatory language in this guidance refers to lawful obligations present in statute or regulation. This guidance does not bind agency personnel and does not create any new mandatory procedure or requirement for the public.

Current Version of this Guidance

Check to make sure that you have the most recent version by comparing the version number on the title page, above, to the guidance version number at the website, https://www.fws.gov/media/esa-section-7a2-voluntary-implementation-guidance-rusty-patched-bumble-bee.

Range, Status, and Recovery of the Rusty Patched Bumble Bee

The rusty patched bumble bee (*Bombus affinis*) occurs in the eastern and Midwestern United States and southern Canada. The species used to occur broadly across the eastern United States, upper Midwest, and southern Quebec and Ontario. Since about 2007 the species' distribution has declined across its range in the U.S. Similar declines have occurred in Canada where it was listed as Endangered on Schedule 1 of the Species at Risk Act in 2012 [U.S. Fish and Wildlife Service (USFWS) (USFWS 2016)]. For a map that shows the approximate current distribution of the species, refer to this USFWS website.

Section 7(a)(1) of the ESA directs each federal agency to carry out programs for the conservation of threatened and endangered species in consultation with the Service. The Service's recovery plan (USFWS 2021) and a pending recovery implementation strategy for the species will provide a basis for agencies to plan and implement actions that will help it fulfill their section 7(a)(1) mandate.

The recovery plan includes a phased approach to the species' recovery that focuses initially on halting and then reversing declines and ultimately, on securing the species' long-term viability. The recovery strategy's specific objectives include:

1. Preventing further loss of populations by (a) identifying and ameliorating the threats driving the declines, (b) increasing the health of individuals and the number of colonies comprising populations, and (c) ensuring appropriate connectivity between populations.
2. Ameliorating pervasive threats, including those from pathogens, pesticides, habitat loss, managed bees, and effects of climate change.

3. Buffering against catastrophes and environmental stochasticity (may require reintroduction into unoccupied areas within the historical range) by increasing the number of genetically and demographically healthy populations and the spatial distribution of those populations.
4. Buffering against novel changes in the species' physical and biological environment by restoring populations across the breadth of its natural adaptive diversity.
5. Protecting populations and their habitats and abating threats into the foreseeable future.

Section 7 Consultation with USFWS

The recovery objectives for the rusty patched bumble bee provide an essential foundation for section 7(a) consultations. Under section 7(a)(2), federal agencies must ensure, in consultation and with the assistance of USFWS, that their actions are not likely to appreciably diminish the likelihood of a species' survival and recovery. The status of the rusty patched bumble bee as it relates to the recovery criteria and the way in which the proposed federal action is likely to affect the species' progress towards recovery are key factors that the action agency and the USFWS must consider when planning the project and assessing its effects, respectively. The first steps in this assessment are to evaluate whether and how the action may affect the species in the affected area.

Below we clarify steps that agencies and their representatives may take to meet ESA section 7(a)(2) requirements relative to the rusty patched bumble bee. We invite agencies to use any alternative methodologies that meet these same ends.

Step 1. Define the Action Area

The action area is not only the immediate area involved in the action, but all areas that the action will affect directly or indirectly (50 CFR § 402.02). It is not always limited to the "footprint" of the action, but encompasses the biotic, chemical, and physical impacts to the environment resulting directly or indirectly from the action.

Step 2. Determine whether the rusty patched bumble bee is likely to be present in the action area.

Section 7 regulations require each Federal agency to review its actions at the earliest possible time to determine whether any action may affect listed species or critical habitat (50 CFR § 402.14). Below we provide two options for determining whether RPBB may be present in an action area. Option 1 involves the use of the USFWS Information for Planning and Conservation website (IPaC) website (https://ecos.fws.gov/ipac/). Agencies may use any alternative approach that accurately determines whether the species may be present in the action area. Mapping updates in IPaC are done once every year. So, if you are aware of new information that indicates that RPBB may be present in the action area that may not yet be represented in IPaC, please coordinate with your local USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)).

Option 1 – Use the FWS Information for Planning and Conservation (IPaC) Website

IPaC looks for overlap between the action area, as entered by the user, and underlying species distribution data, in this case, rusty patched bumble bee High Potential Zones (HPZ). As shown below, users may enter coarse information for the area of interest – for example a state or a county – or a precisely defined action area.

Screen a Precisely Defined Action Area

Agencies may define the action area in the FWS Information for Planning and Conservation website (IPaC) to determine if a federally listed species is present in their action area. The first step in the environmental review process is to enter a location to explore. IPaC will find species and resources that may be impacted by activities at that location. IPaC allows project proponents to draw a polygon or line that delineates their project area directly in the system to determine the project's potential overlap with federally listed species or designated critical habitats.

If the resulting IPaC query produces a species list that includes the rusty patched bumble bee, the species may be present in the action area [the action area overlaps with a rusty patched bumble bee High Potential Zone (HPZ)]. The agency may contact the USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)) to obtain what information may be available regarding the location, extent, and quality of the species' habitat in the action area (refer to Step 3).

If the rusty patched bumble bee is not on the list of species generated for the action area by IPaC, it is not likely to be present in the action area and we would advise the action agency to document this finding for its administrative record. Consultation under section 7(a)(2) is only required for federal actions that may affect listed species. Mapping updates are made once per year in IPaC. So, if you are aware of new information that indicates that RPBB may be present in the action area and may not yet have been incorporated into IPaC, please contact your local USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)).

Screening at the County or State Level

Agencies may first want to determine if a listed species is present in any county or state that their actions may affect. To obtain a list of endangered species that are likely to be present in a county or state, use the FWS Information for Planning and Conservation website (IPaC). You may upload a state or county boundary shapefile or use the drawing function in IPaC to delineate the project area. Eventually you may also be able to select states or counties directly within IPaC in lieu of uploading a shapefile.

If the rusty patched bumble bee is *not* on the list of endangered species you generate in IPaC, the species is not likely to be present. Consultation under section 7(a)(2) is only required for federal actions that may affect listed species. In this event, we would advise the action agency to document the finding for its administrative record.

Option 2 – Work directly with the FWS field office.

Agencies may sometimes prefer to work directly with FWS field offices or may have other established methods for screening projects that do not yet include the use of IPaC. In those cases, agencies may work directly with the USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)) to determine whether their action area may overlap with the current distribution of the rusty patched bumble bee.

Surveys

If the action area overlaps with an HPZ, the agency may assume that the species is present in suitable habitat (Fig. 1) and proceed to Step 4 or it may complete a *Project Review* survey for the species. Before planning or conducting surveys, check the USFWS website (https://www.fws.gov/media/survey-protocols-rusty-patched-bumble-bee) to be sure that you are using the most recent version of the survey

protocols. See the section, ***Rusty Patched Bumble Bee Habitat***, below for a description of what constitutes habitat for the species. The results of a Project Review survey, if they are negative and are carried out in accordance with the Project Review survey protocol could support an agency determination that the species is unlikely to occur in the action area. The action agency may conclude for any documented and valid reason that the species is not present in the action area. For example, an agency may document that their action area does not contain habitat for the species even when it overlaps with an HPZ (Fig. 1).

Among other things, USFWS survey protocols include surveys with sufficient effort to support a determination that the species is not likely present in the area surveyed (survey guidance is available online at https://www.fws.gov/media/survey-protocols-rusty-patched-bumble-bee). Negative survey results remain valid for projects initiated within one year of the survey. In those cases, USFWS considers the results valid for 2 years, or the duration of the project, whichever is shorter, unless new information (*e.g.*, new positive surveys) suggests that the species is likely to be present in the action area. In that case, action agencies and the USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)) should work together to ensure that the best available information is considered.

Surveys for projects with duration less than 2 years

USFWS considers the results valid for two years or the duration of the project, whichever is shorter, unless new information (*e.g.*, new positive surveys) suggests that the species is likely to be present in the action area. In that case, action agencies and the USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)) should work together to ensure that the best available information is considered, and an appropriate determination of effects is made.

Surveys for projects with duration greater than 2 years

USFWS considers negative survey results valid for two years unless new information (*e.g.*, new positive surveys) suggests that the species is likely to be present in the action area. Agencies should either assume presence present in suitable habitat (Fig. 1) and proceed to Step 4 or it may complete a *Project Review* survey within the action area every two years for the duration of the project.

Surveys for long-term projects, that affect only smaller proportions of a larger total action area over time

For projects that affect only a smaller proportion of the total action area and that action area changes over time, USFWS recommends assuming species presence in suitable habitat (Fig 1) and proceed to Step 4 or it may complete *Project Review* surveys in those area(s) that will be affected within the next two years. USFWS considers negative survey results valid for two years unless new information (*e.g.*, new positive surveys) suggests that the species is likely to be present in the action area.

Surveys for long-term projects affecting the same area repeatedly

For projects that anticipate affecting the same action area repeatedly over time[1], agencies should either assume species presence in suitable habitat (Fig. 1) and proceed to Step 4 or it may complete *Project Review* surveys within the action area every two years for the duration of the project. USFWS considers

[1] This does not include projects that make suitable habitat permanently unsuitable (e.g., flowering prairie converted to a paved parking lot).

negative survey results valid for two years unless new information (*e.g.*, new positive surveys) suggests that the species is likely to be present in the action area.

More complicated projects

For more complicated projects than described above, action agencies and the USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)) https://www.fws.gov/offices/should work together to understand if surveys are recommended, the frequency of surveys, and ensure that the best available information is considered and an appropriate determination of effects is made.

Step 3 – Evaluate the Potential Effects of the Action

If the rusty patched bumble bee occurs in the action area, the action agency should determine whether its action may affect the species and whether those effects are likely to be adverse. The section 7 regulations (50 CFR 402.02) define effects of the action as "*all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action."*

Federal actions may affect the rusty patched bumble bee if any of its components or consequences affect a resource on which the species relies or if any component or consequence of the action may interact directly with the species. Effects to a species' resource needs that can lead to an adverse individual response are stressors. Stressors act indirectly on a species through impacts to the resources it needs to fulfill its life cycle. Crushing an individual with a construction vehicle is an example of a direct interaction.

Answers to these three sets of questions can help to frame up an analysis:

1. Could the action or its consequences affect the species' resource needs or interact directly with the species?
2. If the action or its consequences could affect the species' resource needs, will that lead to an adverse individual response?
3. Is any individual of the species likely to interact directly with any feature or activity associated with the action or its consequences? If so, will that lead to an adverse individual response?

Assisted Determination Key

USFWS has developed an assisted determination key (Appendix A) that may be used to help to determine the effects of proposed actions on the rusty patched bumble bee and an optional concurrence request form for use with assisted determination key (Appendix B). Refer to the key for instructions on their use.

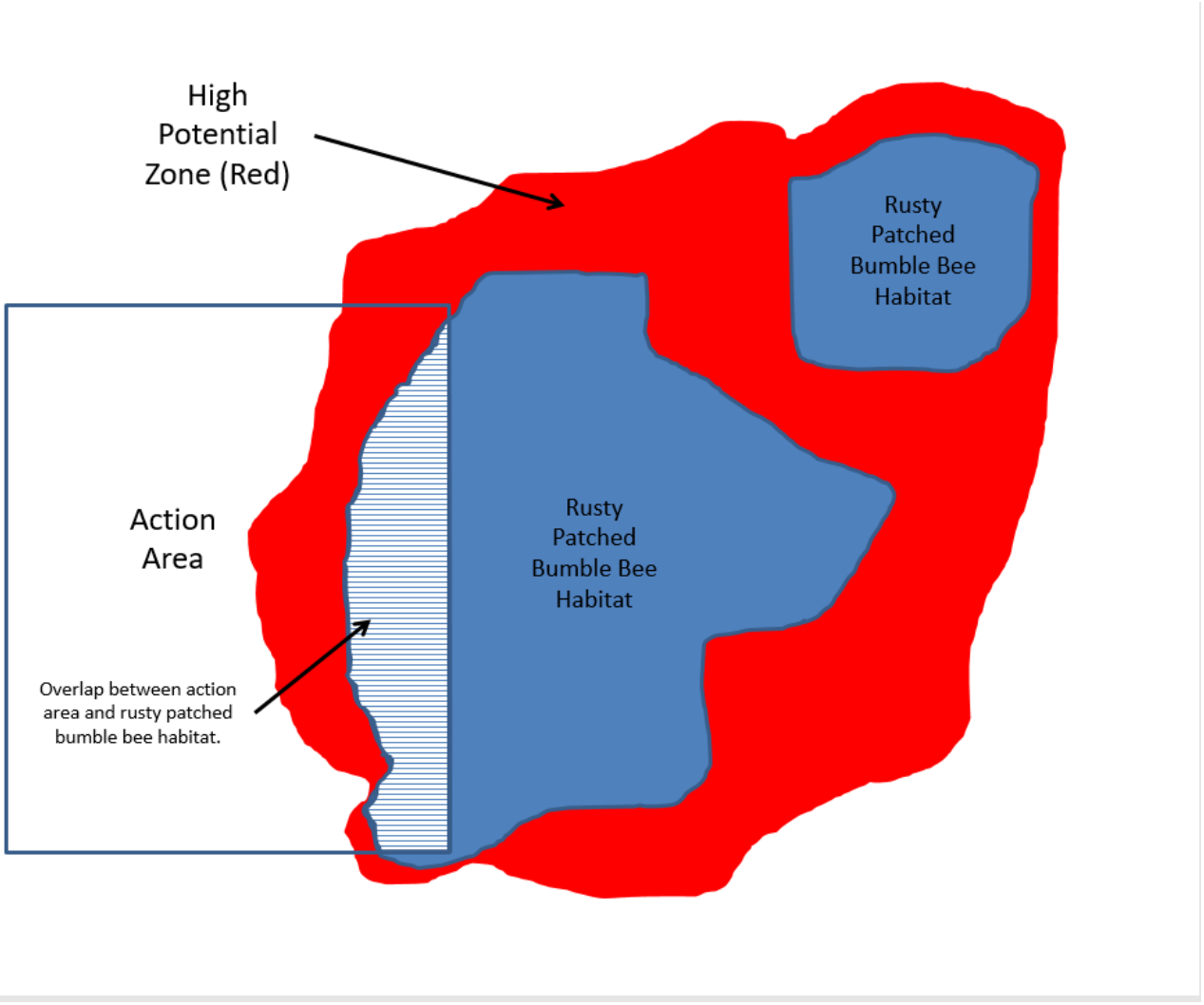

Figure 1. Example of a hypothetical High Potential Zone (HPZ) that, upon closer examination, is found to contain areas with and without rusty patched bumble bee (RPBB) habitat. In the area within the HPZ where RPBB habitat overlaps with the action area, the proposed action could indirectly affect the species through impacts to the resources it needs to fulfill its life cycle.

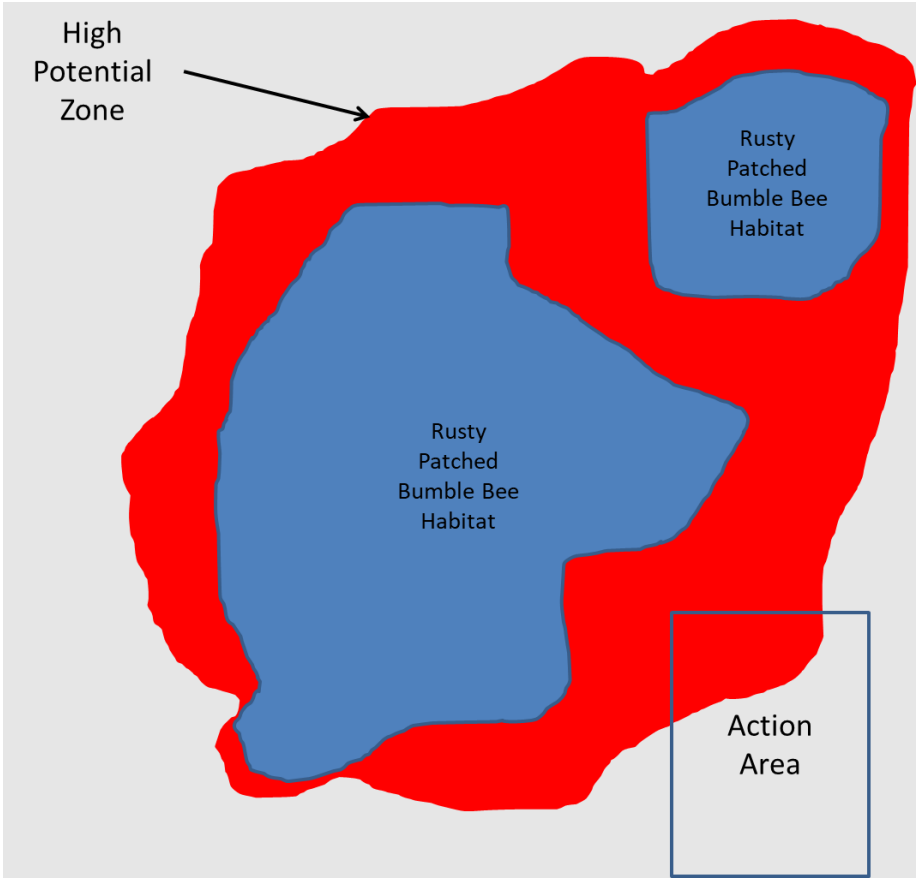

Figure 2. The same hypothetical High Potential Zone (HPZ) shown in Fig. 1. In this case, the area likely to be affected directly or indirectly by the proposed action – the action area – occurs partly inside the HPZ, but does not overlap rusty patched bumble bee habitat.

Rusty Patched Bumble Bee Habitat, Ecology, and Life Cycle

Colony Establishment and Growth

Bumble bees live in colonies – cooperative groups that include the offspring of one female and one male. Healthy rusty patched bumble bee colonies are large and may include more than one thousand workers (non-reproductive females). The workers protect the colony, forage for nectar and pollen, and care for the young. Healthy colonies with many workers can produce dozens to hundreds of new queens (Macfarlane 1974, Macfarlane et al. 1994).

Initially, colonies include only foundress queens, but grow to include workers, males, and new queens. In spring, queens emerge from their overwintering chambers to initiate colonies, having stored sperm from mating the previous autumn to fertilize eggs. Access to blooming flowers and a suitable nesting site – typically a rodent burrow – enables the queen to rear the first workers on her own. A "continuous supply of floral resources is required to support the nest-founding stage…because each queen must forage for food as well as tend the nest, potentially limiting her mobility" (Lanterman et al. 2019). Colony survival and productivity relies on continual access to blooming plant species throughout the spring, summer, and early fall and protection from outside threats. Workers facilitate the production of the males and queens, which disperse from the nest to mate with reproductive progeny from other colonies that comprise the population (Plath 1922, Macfarlane et al. 1994, Colla and Dumesh 2010). Before winter, the original (foundress) queen, workers, and males all die. Only the new queens, referred to as gynes, can overwinter to initiate new colonies in the spring.

Nesting

Rusty patched bumble bee nests are typically one to four feet underground in abandoned rodent nests or other mammal burrows and occasionally at the soil surface or aboveground (Plath 1922, Macfarlane 1974, Boone et al. 2022). Among the 43 rusty patched bumble bee nest records cited by Macfarlane (1974), 95% were underground. Queens may locate abandoned rodent burrows by using olfactory or chemical cues (Lanterman et al. 2019). Most recent rusty patched bumble bee nest observations were associated with rodent burrows (Boone et al. 2022, p. 381, Smith et al. in review).

A recent paper by Lanterman et al. (2019) summarized 451 observations of nest-searching behavior by queens belonging to nine bumble bee species. Rusty patched bumble bee was not among the species observed, but their observations may shed some light on the manner by which the species searches for nest sites:

> "Several criteria by which bumble bee queens select nest sites have been proposed – that the site should require little preparation by the queen, be situated in well-drained soil, and be sheltered from the elements (Frison 1923, Alford 1969). The greater abundance of nest seeking queens found in transitional zones between wooded and open habitats in our study, along with the large numbers of queens investigating areas with dense leaf litter, fallen logs and other features of woody habitats, supports these criteria."

The authors observed queens searching for nesting sites in open grassland habitats, but nest-seeking queens favored woody transitional habitats over open habitats (Lanterman et al. 2019). The transition zone between forest and grassland, as well as field boundaries, meadow margins, and forest edges, can be particularly valuable bumble bee nesting habitat due to the presence of abandoned rodent nests and undisturbed habitat with diverse floral resources (Hines and Hendrix 2005, p. 1483). Forest edge is the

interface between forested and non-forested habitats that extends approximately 30 meters into the forest (Harper et al. 2005, pp. 771, 774).

Overwintering - Locations of Wintering Queens

Little is known about the overwintering habitats of rusty patched bumble bee foundress queens, but based on observations of other species we assume that rusty patched bumble bee queens overwinter in upland closed-canopy interior forest (Table 1). Forest interiors are large blocks of unfragmented forest with continuous canopy that shows no detectable edge influences (Harper et al. 2005, p. 771). Other species of *Bombus* typically form a chamber in loose, soft soil, a few centimeters deep in bare earth, moss, under tree litter, or in bare-patches within short grass" and may avoid areas with dense vegetation (Alford 1969 p. 156, Liczner and Colla 2019, p. 792). Overwintering habitat preferences may be species-specific and dependent on factors such as slope orientation and timing of emergence. Most bumble bee queens in England in were found in well-drained soil, shaded from direct sunlight in banks or under trees, and free from living ground vegetation (Alford 1969, pp. 150-152). Queens have also been documented using loose compost in flower pots to overwinter (Goulson 2010, p. 11). A recent review of published literature shows that overwintering queens have been found mostly in shaded areas, usually near trees and in banks without dense vegetation (Liczner and Colla 2019). The only known documented overwintering rusty patched bumble bee queen, discovered in a hemlock grove within a maple oak-forest (about 0.5 km into the forest) in Wisconsin in 2016, was found under a few centimeters of leaf litter and loose soil (B. Herrick, University of Wisconsin-Madison Landscape Arboretum, pers. comm. 2016 and 2024).

Williams et al. (2019, pp. 2-3) provide the first paper on overwintering habitat for any bumble bee in western North America. They found all ten yellow-faced bumble bees (*B. vosnesenskii*) queens "burrowed beneath 3.5–5 cm of cypress tree litter in a thin layer of duff between needle litter and mineral soil". All were within 1.5 meters of tree trunks, directly shaded from sun, which is consistent with other bumble bees studied in Britain (e.g., Alford 1969). The only North American bumble bee overwintering documented prior to the Williams et al. study and the 2016 UW Madison Arboretum observation (B. Herrick, University of Wisconsin-Madison Landscape Arboretum, pers. comm. 2016), was of the common eastern bumble bee (*B. impatien*s), which was found overwintering beneath sod in loose aggregations of individuals at a depth of 7 cm (Plath 1927, pp. 183-184). Some social bees, such as the common eastern bumble bee, have been observed overwintering in aggregations near the nesting sites (Alford 1969, Pugesek et al. 2023), however there is no clear evidence that shows rusty patched bumble bees overwintering near nesting sites.

Nectar and Pollen Resources

Rusty patched bumble bees need access to both nectar and pollen from spring to fall to support all stages of colony development. Nectar is a source of both carbohydrates (energy) and water, whereas pollen is the main source of proteins and lipids (fats) (USFWS 2016, p. 15, Vaudo et al. 2020). Bumble bees rely on some plant species for pollen and others for nectar, even during single foraging bouts (Plowright and Laverty 1984, p. 187). Availability of pollen, may limit population growth more often than shortages of nectar (Plowright and Laverty 1984, p. 187, Colla 2016, p. 187) and the number of queens that a colony can produce is related directly to pollen availability (Burns 2004, p. 150). Production of sexual offspring (new queens and males) can be limited in simple landscapes with a low availability of diverse and high-quality pollen sources, even if nectar carbohydrates are present in abundance (Requier et al. 2020). Some plant species may hold special importance for bumble bees due to their especially high value nutritionally and for immune-support (refer to https://www.fws.gov/media/plants-favored-rusty-patched-bumble-bee).

Queens must locate nesting areas where plant species diversity is sufficient to ensure that forage will be available throughout its long active season, from mid-March into October (Macfarlane et al. 1994, p. 5, USFWS 2021 unpublished data). There is a brief period when the queen ceases to forage as she cares for the first batch of newly eclosed workers (Goulson 2010, p. 7), however the exact timing of this pause may vary from one colony to the next. Workers may forage up to about a kilometer from nests, but most likely stay within a few-hundred meters (Dramstad 1996, Osborne et al. 1999, Knight et al. 2005, Wolf and Moritz 2008, Rao and Strange 2012). Floral resources close to the nest "might be especially important during the establishment phase of a colony, when only few workers are available for foraging" (Herrmann et al. 2007). Forest spring ephemerals whose flowering period coincides with the species' early spring emergence during this phase and colony growth in the spring may play an outsized role in the production of males and new queens later in the season (Colla and Dumesh 2010, pp. 45 -46, Requier et al. 2020, p. 6. 9). Late-season flower abundance and diversity also helps maximize queen production (Bukovinszki et al. 2017, p. 316).

Rusty Patched Bumble Bee Habitat

To facilitate section 7 analyses, we divide rusty patched bumble bee habitat conceptually into nesting and wintering habitats and into a variety of foraging habitat types based on relative timing of pollen and nectar availability (Table 1). The locations of pollen and nectar sources for the rusty patched bumble bee may vary throughout the growing season. In an HPZ that contains both forest and grassland, for example, the species may forage primarily in forest in the spring and in grassland habitats in the summer and fall. We assume that the rusty patched bumble bee nests in upland grasslands and shrublands that contain forage during the summer and fall and also as far as 30 meters into the edges of forest (Table 1). We also assume that the species winters exclusively beneath trees in upland forests. Palustrine wetlands – vegetated wetlands traditionally called by such names as marsh, swamp, bog, and fen (Federal Geographic Data Committee 2013) – provide nectar and pollen, but are not suitable for nesting or overwintering (Table 1) due to their flooded or saturated soils. Seasonally flooded wetlands may be used as nesting habitat; in 2023, one rusty patched bumble bee nest was documented in a palustrine, forested, broadleaf deciduous, and seasonally flooded site within a floodplain in Wisconsin (J. Arneson, USFWS, pers. comm. 2023). There is evidence that *B. impatiens*, the common Eastern bumble bee, can survive underwater for seven days ((Rondeau and Raine 2024), although this has not been studied for rusty patched bumble bee.

Natural or semi-natural vegetation[2] typifies rusty patched bumble bee habitats. We typically expect the species to nest only in habitats that contain natural or semi-natural vegetation (Table 1), but the species also forages in certain 'cultivated' habitats – sunflower (*Helianthus annuus*) fields, gardens, plant

[2] Vegetation where ecological processes primarily determine species and site characteristics; that is, vegetation comprised of a largely spontaneously growing set of plant species. Human activities influence these characteristics to varying degrees (e.g., logging, livestock grazing, fire), but do not eliminate or dominate the spontaneous processes. Wherever doubt exists as to the naturalness of a vegetation type (e.g., old fields, various forest plantations), it is classified as part of the natural/semi-natural vegetation. Semi-natural vegetation typically encompasses vegetation types where the species composition and/or vegetation growth forms have been altered through anthropogenic disturbances such that no clear natural analogue is known, but they are a largely spontaneous set of plants shaped by ecological processes. Includes areas planted to restore native plant communities. National Vegetation Classification Standard (Federal Geographic Data Committee 2008, p. 9).

nurseries, etc. – and has been documented to nest in other areas where there was evidence of rodent activity (Boone et al. 2022). Reconstruction of a variety of natural habitats – e.g., native prairie (Tonietto et al. 2017, p. 711)– appears to hold significant potential to provide areas for foraging, nesting, and overwintering, depending on the habitat type restored. If forage species are present, for example, reconstructed prairies can become important nesting and foraging habitat for the species as soon as 2-3 years after seeding (Griffin et al. 2017, p. 650).

Behavioral Assumptions

Seasonal Activity

Based on a review of rusty patched bumble bee observation records, in most years, the rusty patched bumble bee may only be active above ground between about April 1 and October 10 and April 15 and October 10 south and north of 42º latitude, respectively (Figures 3-4; USA National Phenology Network 2020; USFWS, 2023 unpubl. data) (Figures 3-4; USA National Phenology Network 2020; USFWS, 2023, unpubl. data). Although air temperatures may be conducive to activity later in the fall, cessation of flight "appears to be timed with the passing of native fall flowers" (Schweitzer et al. 2012, p. 6).

A latitude map can be referenced here: https://www.arcgis.com/apps/mapviewer/index.html?layers=ece08608f53949a4a4ee827fd5c30da1. To understand where your action area is in relation to latitude, zoom in to the map to view the latitude lines in 1-degree increments. Selecting any of the latitude lines will highlight the line and display the degree label. To find the 42º latitude line quickly, click on the line that runs through the Chicago area.

Daily Activity

The rusty patched bumble bee is active under a broad range of conditions, but remains inactive when conditions are too cold or rainy. A study that included four bumble bee species found minimum calculated air temperature for activities that ranged from 3.6 to 12.6°C. We don't have similar data for the rusty patched bumble bee, but we think it's reasonable to assume that the species could be active between dawn and dusk at temperatures as low as about 4°C (39°F) within the seasons described above. Male bumble bees typically do not return to the nest and may be found spending the night on flowers (Goulson 2010). Bumble bees do not typically fly when conditions are foggy, rainy, or drizzling. Sunny days with low wind speeds (less than 8 mph) may be optimal, but they will fly during sub-optimal conditions.

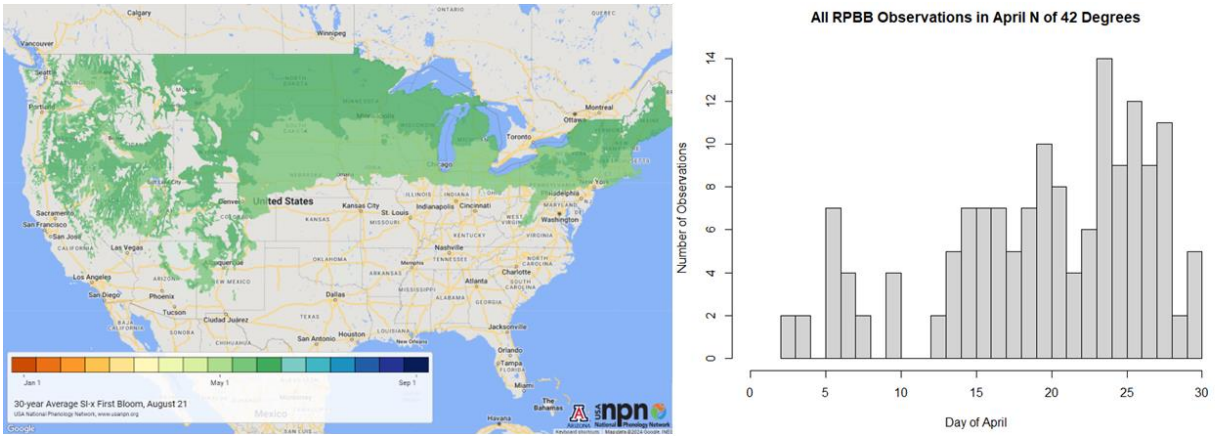

Figure 3. USA National Phenology Network First Bloom Spring Index (30-Year Average from 08/21/2024) for May 1- May 31 (USA National Phenology Network 2020) and distribution of all known rusty patched bumblebee observations north of 42° latitude in April by day (USFWS 2023 unpubl. data. R Core Team 2021).

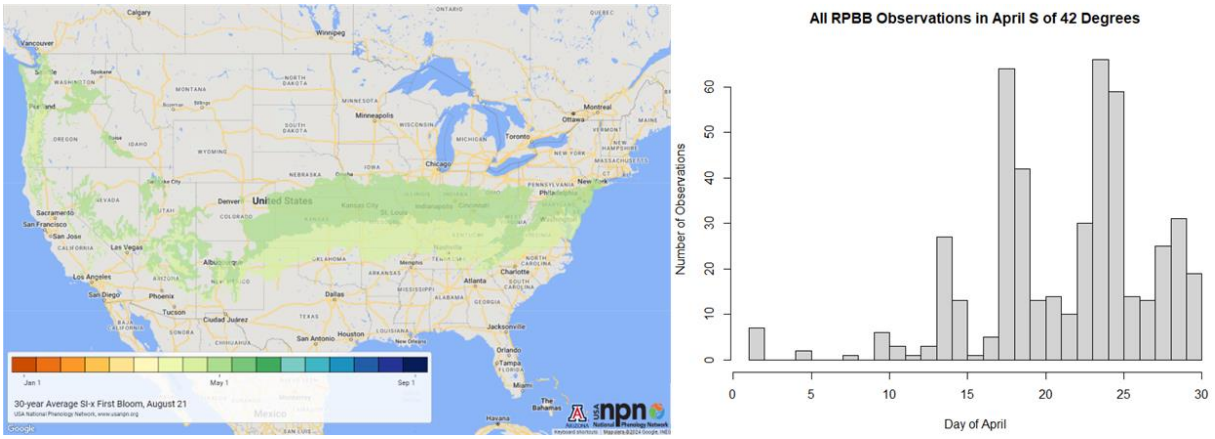

Figure 4. USA National Phenology Network First Bloom Spring Index (30-Year Average from 08/21/2024) for April 1- April 30 (USA National Phenology Network 2020) and distribution of all known rusty patched bumblebee observations south of 42° latitude in April by day (USFWS 2023 unpubl. data. R Core Team 2021).

Table 1. Habitats and their typical seasons of use by the rusty patched bumble bee (RPBB). Rusty patched bumble bee habitat is typified by natural or semi-natural vegetation and often contains plants used by the species. The species' use of flower gardens, certain cultivated cropland (e.g., sunflower fields), and similar areas in which forage is concentrated are exceptions to this rule.

Habitat Category	Nesting	Wintering	Spring Foraging	Summer and Fall Foraging	When RPBB May be Present North of 42º	When RPBB May be Present South of 42º	Comments and Examples
Upland Forest– Interior (>30 m from edge)		X			October 11 – April 14	October 11 – March 31	Includes Maple-Basswood; Oak-Hickory and other forests; observations of overwintering bumble bee queens are mostly in shaded areas usually near trees and in banks without dense vegetation (Liczner and Colla 2019).
Upland Forest – Interior (>30 m from edge)			X	(X) Refer to Comments and Examples	April 15 until forage is unavailable	April 1 until forage is unavailable	Functions as foraging habitat when forage species are present and blooming. Duration of use varies due to a range in plant species composition and other variables. In some areas of the eastern U.S., for example, the blooming period of understory species may extend well into summer due to local elevation and aspect.
Upland Forest – Edge (30 meter edge)	X	X	X	X	All year	All Year	The interface between forested and non-forested habitats (Harper et al. 2005). We assume the edge influence extends 30 meters into forest.
Upland Grassland & Shrublands, Open Woodlands, Glades, Barrens, and Early Successional (0-19 years old) Forest	X		X	X	April 15 – October 10	April 1- October 10	Native meadows, prairie, etc. – remnants and reconstructed grassland habitats; other examples include oak savanna, pine and oak barrens and old fields. Value to the RPBB likely to depend on the density and diversity of forage species.
Palustrine wetlands and seasonally -flooded wetlands, excluding ponds, and other areas where forage is not present			X	X	April 15 – October 10	April 1 – October 10	Marsh, swamp, bog, fen, wet meadow, etc.; forested wetlands (e.g., Silver Maple - Floodplain Forest). RPBB is likely only present if, and when, nectar or pollen are available.
Flower gardens, certain cropland (e.g., sunflower fields, blueberry fields), and similar areas within one kilometer of natural or semi-natural vegetation.			X	X	April 15 – October 10	April 1 – October 10	Cultivated vegetation that provides floral resources; accessed by RPBB from nearby natural and semi-natural areas where they may nest or overwinter; RPBB is likely only present if, and when, nectar or pollen are available.

Assuming Presence and Interpreting Species Records

When an action area overlaps with an HPZ, FWS recommends that an agency conduct a survey to develop adequate information to assess effects of the project to the species (refer to ***Surveys***, above). Without adequate survey data, FWS will give the benefit of the doubt to the species and will assume it to be present in any suitable habitat (Table 1). In these cases, we recommend that agencies evaluate the nature, extent, and quality of habitat types present (refer to Table 1) to help assess the potential of the species to be using various habitat types in the action area and the effects of the proposed action. If surveys were conducted, agencies should consider implications of the methods used, including the extent of the area that was surveyed. Project proponents may also use Robinson (2024) to help assess habitat in the action area.

The rusty patched bumble bee may be present anywhere within High Potential Zones where there is suitable habitat, but the timing and nature of its presence and activities in these areas is dependent on habitat type (Table 1). Refer to the section, *Rusty Patched Bumble Bee Habitat, Ecology, and Life Cycle*, above, for a description of suitable habitat.

Analyzing Effects of Actions

The USFWS recommends a two-step process to determine whether and how an action may affect a species: 1) determine whether the species will be exposed to one or more stressors caused by the action and whether it will interact directly with any component or consequence of the project; and, 2) determine how the species will respond when exposed to the stressors or as a result of the direct interactions. A stressor is any physical, chemical, or biological alteration of the environment (i.e., increase, decrease, introduction, or removal) that can lead to an adverse individual response. Stressors act indirectly on a species through impacts to the resources it needs to fulfill its life cycle. Direct interactions are methods or means by which an activity or structure acts directly upon individuals of a species. Examples include crushing, collection, vehicle strikes, burial, disease, or displacement.

USFWS has identified several factors that pose a risk to the rusty patched bumble bee and that agencies and their representatives should consider when evaluating potential stressors associated with federal actions. Refer to Appendix C for a brief summary and USFWS (2016) for additional details.

Portions of HPZs may be unsuitable for the rusty patched bumble bee (Fig. 2). A project would not affect the rusty patched bumble bee if it only affects areas that lack the habitat (Table 1) and if none of the project's components or consequences will interact directly with the species. When this is the case, the action agency may conclude that their action will have no effect to the species and document this finding for its administrative record. When making this determination, we caution action agencies to define carefully the full extent of the action area to ensure they consider any effects of the action that may extend outside of the immediate project footprint.

Potential for Effects from Temporary or Permanent Forage Removal

Bumble bees do not store much pollen and nectar in their nests and, thus, must have continuous access to flowers with available pollen and nectar during their entire active season to maximize production of new queens (Williams et al. 2012, p. 1055).

A wide variety of factors can lead to reductions in the abundance and diversity of forage available to bumble bees. Conversion of natural habitat that is rich in floral abundance and diversity to farmlands, urban and suburban development, and other land uses are the primary causes of the loss of bumble bee habitat (Goulson et al. 2015, p. 2). In addition, spring forage critical to foundress queens has declined in

existing forests in the Midwest (Mola et al. 2021*a*, p. 1431) and similar declines could be occurring elsewhere. Similar declines of primarily mid-summer forage resources in grassland and wetland habitats was not evident, but the overall extent of grassland habitats has declined (Mola et al. 2021*a*, p. 1431). Even well-intentioned activities such as seed collection from native flowering species for habitat restoration may also result in loss of forage if seeds are overharvested (Nevill et al. 2018, p. 1387).

Actions that reduce forage abundance or diversity for rusty patched bumble bees may adversely affect the species and the extent of such impacts may not have to be large to cause an adverse outcome if it occurs near a nest. In the spring, for example, a queen may not be able to optimize both foraging and brooding temperatures of nests if the diversity and abundance of forage species is low near the nest (Evans and Raine 2014). Later in the nesting cycle, rusty patched bumble bee workers may typically forage within about 200 m (656 feet) of their nest based on the study of the closely related buff-tailed bumble bee discussed above (Wolf and Moritz 2008, p. 422; see above). The likelihood of adverse effects is likely to increase based on the extent of the area where foraging habitat is degraded or removed and the proportion of the area around nests that is suitable for foraging (e.g., refer to Table 2). Removal or degradation of suitable foraging habitat in more than 0.6 ha (2 acres) of foraging habitat will reduce foraging by more than 5%[3], even if the entire area (100%) is suitable foraging habitat, whereas removal or degradation of 0.4 ha (1 ac) of foraging habitat in a similar area (i.e., 100% of area is suitable foraging) does not reach the 5% significance threshold (e.g., refer to Table 2).

Table 2. Percentage reductions in foraging habitat based on an assumed rusty patched bumble bee foraging range of 200 meters (656 feet) around nests (31-acre 'home range') and varying proportions of pre-project foraging habitat and foraging habitat removal. This purpose of this table is to help project proponents and reviewers think about foraging loss in the context of the project. Bolded text illustrates forage removal that reaches the 5% significance threshold. If this threshold is exceeded, USFWS will work with the action agency to assess the estimated foraging loss and its impact on the rusty patched bumble bee.

Proportion of Home Range Covered by Foraging Habitat - Before Project	Extent of Foraging Habitat Removed (acres)	% Reduction in Foraging Habitat
100%	0.1	0.3%
66%	0.1	0.5%
33%	0.1	1.0%
100%	1	3.2%
66%	1	4.9%
33%	**1**	**9.8%**
100%	**2**	**6.4%**
66%	**2**	**9.8%**
33%	**2**	**19.5%**
100%	**10**	**32.2%**
66%	**10**	**48.8%**
33%	**10**	**97.6%**

[3] We use the 5% level as the conventional maximum acceptable probability for determining statistical significance (Cowles and Davis 1982).

Note that sometimes foraging resources are removed only temporarily and this should also be taken into account when assessing effects to the species. In those cases, any adverse effects may only be temporary.

Management of foraging habitat carried out at some times of the year would not result in a reduction in foraging resources – for example, when summer foraging habitat is burned in the autumn after October 10.

Additionally, management of prairie or grassland foraging habitat using prescribed fire specifically may not result in a significant reduction of pollen and nectar resources for RPBB if completed early in spring before RPBB queens establish nests with active foraging workers that need floral resources (i.e., before April 15 north of 42°N and before April 1 south of 42°N). Most forage plant species in open habitats are not yet flowering at this time and queens are more likely to be found in upland forests foraging on spring ephemerals (Appendix D; Mola et al. 2021*a*, *b*, Wolf et al. 2022). Therefore, the probability of adverse effects to RPBB from prescribed burns in open habitats directly through interactions with fire or indirectly through the temporary loss of foraging habitat are low. Further, spring prescribed burns have been shown to increase floral genus richness and density without negative impacts to pollinator activity or abundance (Adedoja et al. 2022, Tai et al. 2022).

Potential for Direct Effects from Ground Disturbance – Nest Density Assumptions

When site-specific information for the rusty patched bumble bee is insufficient to estimate abundance, it may be useful to apply nest density estimates derived for another member of the subgenus *Bombus sensu stricto*, the buff-tailed bumble bee, to develop useful assumptions. These assumptions can help to analyze effects of federal actions that are likely to cause ground disturbance in a structured and transparent way.

Researchers have used genetic analyses of tissue samples collected from wild workers to estimate nest density of several bumble bee species, including the closely related buff-tailed bumble bee (Darvill et al. 2004, Knight et al. 2005, Kraus et al. 2009, Chapman et al. 2003 (as cited in Charman et al. 2010), Wolf et al. 2012, Dreier et al. 2014, Wood et al. 2015). Current colony density estimates of rusty patched bumble bee have not yet been determined, although recent genetic analyses were used to estimate the number of unique colonies for twelve extant sites (Mola et al. 2024, p. 9).

Due to the uncertainty with applying estimates derived for another species, we propose considering a range of assumed nest densities as opposed to a single estimate (Table 3; refer to Table 1 for an overview of nesting habitat). This may increase the odds that our analysis accurately reflects the actual density of the rusty patched bumble bee in the action area. The species is now rare at continental and regional scales, but was abundant and widespread historically (USFWS 2016, p. 4). By basing our analyses on a range of assumed nest densities, we may capture the possibility that nests occur at what may be relatively high densities in the action area.

Table 3. Quartiles for ten nest density estimates for the buff-tailed bumble bee (*B. terrestris*) (Darvill et al. 2004, Knight et al. 2005, Kraus et al. 2009, Chapman et al. 2003 (as cited in Charman et al. 2010), Wolf et al. 2012, Dreier et al. 2014, Wood et al. 2015). As a basis for analyzing the effects of actions on the rusty patched bumble bee, we will assume that their nests may occur in nesting habitat at any of the three densities shown.

Quartile	Nest Density Category	Nest Density(Nests/km^2)
First/25th Percentile	Low	14
Median/50th Percentile	Medium	34
Third/75th Percentile	High	45

Data from another rare bumble bee species – the precipitously declining great yellow bumble bee (*B. distinguendus*) – may indicate that our proposed assumptions for the rusty patched bumble bee are reasonable. The great yellow bumblebee relies "on the continued presence of flower-rich, unimproved grassland that provides floral resources throughout the colony cycle (June to September) and contains, or is close to, suitable sites for nesting, mating and hibernation." (Charman et al. 2010, p. 2671). Its nests occurred at an estimated density of 19/km^2 in a coastal grassland landscape (Charman et al. 2010). As with the studies conducted on the buff-tailed bumble bee, the authors estimated nest density for the great yellow bumble bee at the landscape scale. Estimated nest density would have been higher if it were estimated only for the specific portions of the landscape that were suitable for nesting. The nest density most appropriate for evaluating a project may depend on the nature of the habitat likely to be affected by the proposed activities.

Using Empirical Data to Estimate Site-Specific Nest Density

Agencies may use the methods summarized above to estimate nest density for the buff-tailed bumble bee in an action area. This would require capture of rusty patched bumble bees, removal of a leg tip, and genetic analyses. Action agencies who are interested in carrying out such a study should contact the USFWS.

Effects of Ground Disturbance on Rusty Patched Bumble Bee Nests

If ground disturbance[4] is likely to be sufficient to collapse underground rodent burrows or to close their entrances on more than 0.1 hectare (0.25 acre) of nesting habitat within an HPZ during the nesting season, USFWS will work with the action agency to assess the likelihood that a rusty patched bumble bee nest will be affected. Key factors in this analysis, in addition to timing, are the anticipated extent of such disturbance, whether it affects areas where we think nests may be present, and the likely nest density (e.g., refer to Table 3). This is based on the assumption that rusty patched bumble bee nest in rodent burrows and may be present in nesting habitat at a density as high as 45/km^2 (Table 3). That density is equivalent to one nest for every 2.2 ha (5.4 acres) of nesting habitat. At that density, and assuming that rusty patched bumble bees are equally likely to nest anywhere in the available nesting habitat, ground disturbance that exceeds 0.1 ha (0.25 acre)[5] during the nesting season[6] in nesting habitat would have a >5% probability of destroying a nest and may no longer be a discountable effect.

---

[4] We define ground disturbance as any activity that compacts or disturbs the soil and is intense enough to either (1) collapse underground rodent burrows or to close their entrances (nesting season) or (2) crush, harm, or expose queens in overwintering chambers (overwintering period). This could occur as a result outrigging, seismic surveys, directional drilling, use of heavy equipment, grading, disturbance related to the construction, alteration, trenching, borrow pits, utility lines, bridges, development, some forestry activities, the placement of fill or spoil dirt, material stockpiling, blasting, cultivation, or rodent control if rodent burrows are intentionally collapsed or filled in. A project may cause ground disturbance sufficient to harm or kill rusty patched bumble bees if it will leave depressions or wheel tracks on the soil, remove forest floor layers, or displace, compact, or erode soil.

[5] A density of 45 nests/km^2 is equal to 0.45 nests/ha. The probability that ground disturbance to 0.1 ha of nesting habitat would affect a rusty patched bumble bee nest, therefore, would be 0.045, assuming that nests are distributed uniformly in nesting habitat. We rounded 0.045 up to 0.05.

Road Effects

The construction of new roads or the addition of new travel lanes within an HPZ may result in direct effects and indirect effects to rusty patched bumblebees. Bumble bees have demonstrated high foraging site fidelity alongside roads and rail lines, rarely crossing these barriers if suitable floral resources were already available (Bhattacharya et al. 2003, p. 42, Hopwood et al. 2010). Barriers to movement may result in indirect effects due to decreased availability in foraging resources. However, direct effects via collision mortality for bees and other bumble bee species has been documented (Keilsohn 2018, p. 3, Dániel-Ferreira 2022, p. 5) and may be more likely to occur in areas with greater speed limits, increase in traffic, and fewer foraging resources. There is one recorded instance of a mortality of a rusty patched bumble bee queen along a highway in Minnesota with a 55mph speed limit (C. Smith, MNDOT pers comm, July 2024).

Potential for Effects from Other Activities

Other activities that may cause direct and indirect effects to rusty patched bumble bees include surface flooding or soil saturation in suitable nesting habitat, whether intentional or not. Rusty patched bumble bees typically nest in abandoned rodent nests or at the soil surface (Plath 1922, MacFarlane 1974; Boone et al 2022) and surface flooding or soil saturation could inundate existing nests, causing abandonment or mortality). Likewise, rodent control in suitable nesting habitat could decrease the number of rodents and, by extension, the number of burrows and potential nest sites for rusty patched bumble bees.

Rusty Patched Bumble Bee - Potential Stressors

In addition to the potential for direct interactions with the species, agencies must also determine whether components or consequences of their actions could cause effects to a species' resource needs that can lead to an adverse individual response (i.e., *stressors*). Agencies must base this determination on the best available information on the nature and extent of habitats in the action area and a full examination of the effect of the action. For any action that will affect an HPZ, the action agency can work with USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)) to assess whether – and how – the action is likely to affect the species' resource needs. (refer to Appendix D and the next paragraph for an example brief review of important risk factors for the rusty patched bumble bee and related stressors.) For a detailed review of the major stressors that agencies should consider when evaluating the effects of proposed federal activities on the rusty patched bumble bee, refer to the section **Risk Factors** in the *Rusty Patched Bumble Bee (Bombus affinis) Species Status Assessment* (USFWS 2016). For additional information regarding these stressors and measures to avoid or reduce relevant adverse effects, refer to the Rusty Patched Bumble Bee Conservation Guidelines (USFWS 2018, or as updated).

Effects of the Action on the Species - Evaluating the Species Response to Stressors

After identifying the stressors and direct interactions to which the rusty patched bumble bee will be exposed, the action agency should determine the species' likely response to each relevant factor – that is, the likely effects of the action on the species. Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. (50 CFR § 402.02). This analysis of effects is the primary responsibility of the action agency, but USFWS field office personnel can assist with this analysis. For a discussion of how a reduction in available forage – a

common stressor – may affect the rusty patched bumble bee, refer to the section *Potential for Effects from Temporary or Permanent Forage Removal*, above.

Step 4 - Incorporate Measures to Avoid or Minimize Effects to the Rusty Patched Bumble Bee

When the rusty patched bumble bee is likely to respond negatively to one or more stressors or direct interactions associated with the federal action or its consequences, the action agency or applicant may implement measures to avoid or minimize the adverse effects. Please refer to the Rusty Patched Bumble Bee Conservation Guidelines (USFWS 2018, or as updated).

When Adverse Effects are not likely to Occur – Informal Consultation

When an action agency determines that its action may affect the rusty patched bumble bee, but is not likely to affect the species adversely, it may request concurrence from the USFWS. Informal consultation would conclude with the written concurrence of the USFWS [50 CFR § 402.13(a)].

When Adverse Effects Are Likely – Formal Consultation

When an action is likely to affect adversely the species, the action agency should contact the local USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)). This is appropriate, for example, when agencies incorporate conservation measures into a project to minimize its effects, but some adverse effects are still likely. If the effects of the action is reasonably certain to include incidental take of the species, USFWS would include an incidental take statement (ITS) with the biological opinion. The ITS would include terms and conditions that the agency or the applicant must follow to ensure that any take is not a violation of the ESA's section 9 prohibitions.

Literature Cited

Adedoja, O. A., R. M. Crandall, and R. E. Mallinger. 2022. Season of prescribed burns and management of an early successional species affect flower density and pollinator activity in a pine savanna ecosystem. PeerJ 10:e14377.

Alford, D. V. 1969. A Study of the Hibernation of Bumblebees (Hymenoptera:Bombidae) in Southern England. Journal of Animal Ecology 38:149–170.

Bhattacharya, M., R. B. Primack, and J. Gerwein. 2003. Are roads and railroads barriers to bumblebee movement in a temperate suburban conservation area? Biological Conservation.

Boone, M. L., E. Evans, A. Wolf, H. Minser, J. Watson, and A. S. Tamara. 2022. Notes from rusty patched bumble bee (Bombus affinis Cresson) nest observations. 1–5.

Brown, M. J. F., R. Loosli, and P. Schmid-Hempel. 2000. Condition-dependent expression of virulence in a trypanosome infecting bumblebees. Oikos 91:421–427.

Bukovinszki, T., Ij. Rikken, S. Evers, F. L. Wäckers, J. C. Biesmeijer, H. H. T. Prins, and D. Kleijn. 2017. Effects of pollen species composition on the foraging behaviour and offspring performance of the mason bee Osmia bicornis (L.). Basic and Applied Ecology 18:21–30.

Burns, I. 2004. Social Development and Conflict in the North American Bumblebee Bombus impatiens Cresson. Doctor of Philosophy, University of Minnesota, St. Paul, MN.

Charman, T. G., J. Sears, R. E. Green, and A. F. G. Bourke. 2010. Conservation genetics, foraging distance and nest density of the scarce Great Yellow Bumblebee (Bombus distinguendus). Molecular Ecology 19:2661–2674.

Colla, S. R. 2016. Status, Threats and Conservation Recommendations for Wild Bumble Bees (Bombus spp.) in Ontario, Canada: A Review for Policymakers and Practitioners. Natural Areas Journal 36:412–426.

Colla, S. R., and S. Dumesh. 2010. The Bumble Bees of Southern Ontario: Notes on Natural History and Distribution. 141:30.

Cowles, M., and C. Davis. 1982. On the Origins of the .05 Level of Statistical Significance. American Psychologist 37:553–338.

Dániel-Ferreira, J. 2022. Bumblebee queen mortality along roads increase with traffic. Biological Conservation.

Darvill, B., M. E. Knight, and D. Goulson. 2004. Use of genetic markers to quantify bumblebee foraging range and nest density. Oikos 107:471–478.

Dramstad, W. E. 1996. Do bumblebees (Hymenoptera: Apidae) really forage close to their nests? Journal of Insect Behavior 9:163–182.

Dreier, S., J. W. Redhead, I. A. Warren, A. F. G. Bourke, M. S. Heard, W. C. Jordan, S. Sumner, J. Wang, and C. Carvell. 2014. Fine-scale spatial genetic structure of common and declining bumble bees across an agricultural landscape. Molecular Ecology 23:3384.

Evans, L. J., and N. E. Raine. 2014. Foraging errors play a role in resource exploration by bumble bees (Bombus terrrestris). Journal of Comparative Physiology A 200:475–484.

Federal Geographic Data Committee. 2008. National vegetation classification standard, Version 2. Federal Geographic Data Committee Secretariat, Reston, VA.

Federal Geographic Data Committee. 2013. Classification of Wetlands and Deepwater Habitats of the United States. Federal Geographic Data Committee, Reston, VA. <https://www.fgdc.gov/standards/projects/wetlands/nwcs-2013>.

Feltham, H., K. Park, and D. Goulson. 2014. Field realistic doses of pesticide imidacloprid reduce bumblebee pollen foraging efficiency. Ecotoxicology (London, England) 23:317–323.

Frison, T. H. 1923. Biological studies of the Bremidae, or bumblebees, with special reference to the species occurring in Illinois. Doctor of Philosophy, University of Illinois, Urbana, Illinois.

Goulson, D. 2010. Bumblebees: Behavior, Ecology, and Conservation. Osford University Press.

Goulson, D., E. Nicholls, C. Botías, and E. L. Rotheray. 2015. Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. Science 347:1255957.
Griffin, S. R., B. Bruninga-Socolar, M. A. Kerr, J. Gibbs, and R. Winfree. 2017. Wild bee community change over a 26-year chronosequence of restored tallgrass prairie. Restoration Ecology 25:650–660.
Harper, K. A., S. E. MacDonald, P. J. Burton, J. Chen, K. D. Brosofske, S. C. Saunders, E. S. Euskirchen, D. Roberts, M. S. Jaiteh, and P.-A. Esseen. 2005. Edge influence on forest structure and composition in fragmented landscapes. Conservation Biology 19:768–782.
Hatfield, R. G., S. Jepsen, E. Mader, S. Hoffman Black, and M. Shepherd. 2012. 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. 32 pp. Portland, OR: The Xerces Society for Invertebrate Conservation. The Xerces Society for Invertebrate Conservation. <https://www.xerces.org/sites/default/files/2018-05/12-028_01_XercesSoc_Conserving-Bumble-Bees-Guidelines_web.pdf>.
Herrmann, F., C. Westphal, R. F. A. Moritz, and I. Steffan-Dewenter. 2007. Genetic diversity and mass resources promote colony size and forager densities of a social bee (Bombus pascuorum) in agricultural landscapes. Molecular Ecology 16:1167–1178.
Hines, H. M., and S. D. Hendrix. 2005. Bumble Bee (Hymenoptera: Apidae) Diversity and Abundance in Tallgrass Prairie Patches: Effects of Local and Landscape Floral Resources. Environmental Entomology 34:1477–1484.
Hopwood, J., L. Winkler, B. Deal, and M. Chivvis. 2010. Use of roadside prairie plantings by native bees. Iowa State University, Ames, Iowa. <http://www.iowalivingroadway.com/ResearchProjects/90-00-LRTF-011.pdf>.
Keilsohn, W. 2018. Roadside habitat impacts insect traffic mortality. Journal of Insect Conservation 22:183–188.
Knight, T., J. Steets, J. Vamosi, S. Mazer, M. Burd, D. Campbell, M. Dudash, M. Johnston, R. Mitchell, and T.-L. Ashman. 2005. Pollen Limitation of Plant Reproduction: Pattern and Process. Annu. Rev. Ecol. Evol. Syst 36:467–97.
Kraus, F. B., S. Wolf, and R. F. A. Moritz. 2009. Male flight distance and population substructure in the bumblebee Bombus terrestris. Journal of Animal Ecology 78:247–252.
Lanterman, J., P. Reeher, R. J. Mitchell, and K. Goodell. 2019. Habitat Preference and Phenology of Nest Seeking and Foraging Spring Bumble Bee Queens in Northeastern North America (Hymenoptera: Apidae: Bombus). The American Midland Naturalist 182:131.
Larson, J. L., C. T. Redmond, and D. A. Potter. 2014. Impacts of a neonicotinoid, neonicotinoid–pyrethroid premix, and anthranilic diamide insecticide on four species of turf-inhabiting beneficial insects. Ecotoxicology 23:252–259.
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.
Macfarlane, R. P. 1974. Ecology of Bombinae (Hymenoptera: Apidae) of southern Ontario, with emphasis on their natural enemies and relationships with flowers. University of Guelph.
Macfarlane, R. P., K. D. Patten, L. A. Royce, B. K. W. Wyatt, and D. F. Mayer. 1994. Management potential of sixteen North American bumble bee species. Melanderia 50:1–12.
Mola, J. M., J. Hemberger, J. Kochanski, L. L. Richardson, and I. S. Pearse. 2021*a*. The Importance of Forests in Bumble Bee Biology and Conservation. BioScience 71:1234–1248.
Mola, J. M., I. S. Pearse, M. L. Boone, E. Evans, M. J. Hepner, R. P. Jean, J. M. Kochanski, C. Nordmeyer, E. Runquist, T. A. Smith, J. P. Strange, J. C. Watson, and J. B. U. Koch. 2024. Range-wide genetic analysis of an endangered bumble bee (Bombus affinis, Hymenoptera: Apidae) reveals population structure, isolation by distance, and low colony abundance. Journal of Insect Science 24.

Mola, J. M., L. L. Richardson, G. Spyreas, D. N. Zaya, and I. S. Pearse. 2021*b*. Long-term surveys support declines in early season forest plants used by bumblebees. Journal of Applied Ecology 58:1431–1441.
Nevill, P. G., A. T. Cross, and K. W. Dixon. 2018. Ethical seed sourcing is a key issue in meeting global restoration targets. Current Biology 28:R1378–R1379.
Osborne, J. l., S. j. Clark, R. j. Morris, I. h. Williams, J. r. Riley, A. d. Smith, D. r. Reynolds, and A. s. Edwards. 1999. A landscape-scale study of bumble bee foraging range and constancy, using harmonic radar. Journal of Applied Ecology 36:519–533.
Plath, O. E. 1922. Notes on the nesting habits of several North American bumblebees. Psyche XXIXX:189–202.
Plath, O. E. 1927. Notes on the Hibernation of Several North American Bumblebees*. Annals of the Entomological Society of America 20:181–192.
Plowright, R. C., and T. M. Laverty. 1984. The Ecology and Sociobiology of Bumble Bees. Annual Review of Entomology 29:175–199.
Pugesek, G., J. A. Thuma, and E. E. Crone. 2023. First field-based estimates of bumblebee diapause survival rates showcase high survivorship in the wild. Journal of Insect Conservation 27:547–556.
R Core Team. 2021. R: The R Project for Statistical Computing. Vienna, Austria. <https://www.r-project.org/>. Accessed 27 Aug 2024.
Rao, S., and J. P. Strange. 2012. Bumble Bee (Hymenoptera: Apidae) Foraging Distance and Colony Density Associated With a Late-Season Mass Flowering Crop. Environmental Entomology 41:905–915.
Requier, F., K. K. Jowanowitsch, K. Kallnik, and I. Steffan-Dewenter. 2020. Limitation of complementary resources affects colony growth, foraging behavior, and reproduction in bumble bees. Ecology 101:e02946.
Robinson, J. L. 2024. Project-specific bumble bee habitat quality assessment. MethodsX 12:102571.
Rondeau, S., and N. E. Raine. 2024. Unveiling the submerged secrets: bumblebee queens' resilience to flooding. Biology Letters 20:20230609.
Rundlöf, M., C. Stuligross, A. Lindh, R. L. Malfi, K. Burns, J. M. Mola, S. Cibotti, and N. M. Williams. 2022. Flower plantings support wild bee reproduction and may also mitigate pesticide exposure effects. Journal of Applied Ecology 59:2117–2127.
Schweitzer, D. F., N. A. Capauno, B. E. Young, and S. R. Colla. 2012. Conservation and management of North American bumble bees. Pollinator Partnership.
Smith, T. A., M. L. Boone, S. Choy, E. Evans, J. Everett, J. E. Palmer, I. Pearse, G. Pugesek, B. M. Sadd, J. Szymanski, A. E. Tessnow, J. C. Watson, and J. M. Mola. in review. Answering key bumble bee conservation questions by studying discovered wild nests: A Bombus affinis case study. Insect Conservation and Diversity.
Straw, E. A., E. N. Carpentier, and M. J. F. Brown. 2021. Roundup causes high levels of mortality following contact exposure in bumble bees. Journal of Applied Ecology 58:1167–1176.
Tai, T. M., A. Kaldor, D. Urbina, and C. Gratton. 2022. Within-Year Effects of Prescribed Fire on Bumble Bees (Hymenoptera: Apidae) and Floral Resources. M. Simone-Finstrom, editor. Journal of Insect Science 22:7.
Tonietto, R. K., J. S. Ascher, and D. J. Larkin. 2017. Bee communities along a prairie restoration chronosequence: similar abundance and diversity, distinct composition. Ecological Applications 27:705–717.
USA National Phenology Network. 2020. USA-NPN Geoserver Request Builder. Spring indicies, 30-year first bloom -spring index date 1991-2020. Region: Contiguous US. <https://data.usanpn.org/geoserver-request-builder/?service=wms&layer=si:30yafbd&date=2024%E2%80%9108%E2%80%9119&format=pdf&projection=nad83&width=1700&height=800.>. Accessed 19 Aug 2024.
USFWS. 2016. Rusty Patched Bumble Bee (Bombus affinis) Species Status Assessment. 1–94.

USFWS. 2018. Conservation management guidelines for the rusty patched bumble bee. U.S. Fish and Wildlife Service, Bloomington, MN.
USFWS. 2019. Survey protocols for the rusty patched bumble bee (Bombus affinis). U.S. Fish and Wildlife Service, Bloomington, MN.
USFWS. 2021. Recovery plan for the rusty patched bumble bee (Bombus affinis). U.S. Fish and Wildlife Service, Bloomington, MN.
USFWS. 2024. Programmatic Biological Opinion: Natural Resources Conservation Service and Farm Service Agency programs in Illinois, Minnesota, and Wisconsin and their effects on the rusty patched bumble bee. U.S. Fish and Wildlife Service, Bloomington, MN.
Vaudo, A. D., J. F. Tooker, H. M. Patch, D. J. Biddinger, M. Coccia, M. K. Crone, M. Fiely, J. S. Francis, H. M. Hines, M. Hodges, S. W. Jackson, D. Michez, J. Mu, L. Russo, M. Safari, E. D. Treanore, M. Vanderplanck, E. Yip, A. S. Leonard, and C. M. Grozinger. 2020. Pollen Protein: Lipid Macronutrient Ratios May Guide Broad Patterns of Bee Species Floral Preferences. Insects 11:132.
Williams, N. M., J. M. Mola, C. Stuligross, T. Harrison, M. L. Page, R. M. Brennan, N. M. Rosenberger, and M. Rundlöf. 2019. Fantastic bees and where to find them: locating the cryptic overwintering queens of a western bumble bee. Ecosphere 10:e02949.
Williams, N. M., J. Regetz, and C. Kremen. 2012. Landscape-scale resources promote colony growth but not reproductive performance of bumble bees. Ecology 93:1049–1058.
Wolf, A. T., J. C. Watson, T. J. Hyde, S. G. Carpenter, and R. P. Jean. 2022. Floral Resources Used by the Endangered Rusty Patched Bumble Bee (Bombus affinis) in the Midwestern United States. Natural Areas Journal 42. <https://bioone.org/journals/natural-areas-journal/volume-42/issue-4/22-2/Floral-Resources-Used-by-the-Endangered-Rusty-Patched-Bumble-Bee/10.3375/22-2.full>. Accessed 25 Nov 2022.
Wolf, S., and R. F. A. Moritz. 2008. Foraging distance in *Bombus terrestris* L. (Hymenoptera: Apidae). Apidologie 39:419–427.
Wolf, S., T. Toev, R. L. V. Moritz, and R. F. A. Moritz. 2012. Spatial and temporal dynamics of the male effective population size in bumblebees (Hymenoptera: Apidae). Population Ecology 54:115–124.
Wood, T. J., J. M. Holland, and D. Goulson. 2015. A comparison of techniques for assessing farmland bumblebee populations. Oecologia 177:1093–1102.

Appendix A. Rusty patched bumble bee assisted determination key.

Rusty-Patched Bumble Bee Assisted Determination Key

U.S. Fish and Wildlife Service, Version 1.1

Updated November 1, 2024

Purpose of the Key

The primary purpose of this assisted determination key is to help federal agencies and their non-federal representatives to determine whether their proposed actions may affect the rusty patched bumble bee (*Bombus affinis*); and, if they might, to facilitate consultation with U.S. Fish and Wildlife Service (USFWS) under section 7 of the Endangered Species Act. Although intended primarily for federal agency actions and section 7, it may also be useful for reviewing non-federal actions.

Use of the Key

The key is intended to function range-wide for any type of project. For some projects, it will allow the user to reach a determination of 'no effect' or 'may affect, not likely to adversely affect.' For others, the key directs the user to coordinate with a U.S. Fish and Wildlife Service Ecological Services field office. Contact the local USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)) if you have any questions, concerns, or suggestions regarding the key.

*If working in IPaC, note that the answer to some questions will be automatically generated according to the proposed project polygon drawn in IPaC. Those questions are marked with an asterisk.

Definitions of acronyms within the Key

NE = no effect determination

NLAA = not likely to adversely affect

MA = may affect. Please contact the local USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)) to discuss the specifics of this project. This may or may not result in a "may affect" determination.

How to Request Concurrence – Use of the Concurrence Request Form

To request concurrence from the USFWS on a determination of '*may affect, not likely to adversely affect'*, submit a completed copy of the attached form to the local USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)).

Versions of the Key

If you have accessed this key on the USFWS RPBB website, you are using the most recent version. If you are not, check our website (https://www.fws.gov/media/esa-section-7a2-voluntary-implementation-guidance-rusty-patched-bumble-bee) for most recent version. We intend for the key to be incorporated into the USFWS Information for Planning and Consultation (IPaC) webpage. We will aim to keep this key and the IPaC Determination Key functionally identical.

Determination Key

*If working in IPaC, note that the answer to some questions will be automatically generated according to the proposed project polygon drawn in IPaC. Those questions are marked here with an asterisk.

Number	Rusty Patched Bumble Bee Range-wide Determination Key	If Yes, then proceed to the number as indicated	If No, then proceed to the number as indicated
1.0	Does the action area overlap with a rusty patched bumble bee high potential zone?	**1.1**	**14.0**
1.1	Is the proposed action within Illinois?*	1.2	1.1.1
1.1.1	Is the proposed action within Minnesota?*	1.2	1.1.2
1.1.2	Is the proposed action within Wisconsin?*	1.2	13.0
1.2	Is the action being implemented under a Natural Resources Conservation Service (NRCS) or FSA (Farm Service Agency) program? Note: Farm Bill programs include, the Conservation Reserve Program, Environmental Quality Incentive Program, NRCS Easement Program, Farm Loan Program, Farm Storage Facility Loan Program.	2.0	13.0
2.0	Does the action area overlap with a rusty patched bumble bee high potential zone? Use the most up to date map as available on the RPBB website (https://www.fws.gov/species/rusty-patched-bumble-bee-bombus-affinis).	3.0	No Effect
3.0	Is there habitat for nesting, foraging, and/or overwintering for the rusty patched bumble bee in the action area? Note: Please refer to the ESA Section 7(a)(2) Voluntary Implementation Guidance for Rusty Patched Bumble Bee at: "https://www.fws.gov/media/esa-section-7a2-voluntary-implementation-guidance-rusty-patched-bumble-bee" If the current cover within the action area is exclusively non-habitat (e.g. cropland, pasture, or water), answer NO. If the action area currently contains RPBB habitat (e.g. native grassland with flowering species or forest), answer YES	5.0	4.0

4.0	Will the proposed action result in creation of new RPBB habitat?	May Affect, Contact your local field office to discuss the details of the project	No Effect
5.0	Will the action include management/maintenance of RPBB habitat?	May Affect, Contact your local field office to discuss the details of the project	6.0
6.0	Will the action involve one or more "Not Likely to Adversely Affect" (NLAA) actions ONLY?	Not Likely to Adversely Affect	7.0
7.0	Will the action result in ground disturbance in forested habitat?	7.1	9.0
7.1	Will the ground disturbance be greater than 0.25 acres?	8.0	9.0
8.0	Does the proposed action intersect the south of 42N geometry?*	8.1	8.2
8.1	Will the ground disturbance occur during the overwintering season **(October 11 to March 31)**?	May Affect, Contact your local field office to discuss the details of the project	9.0
8.2	Will the ground disturbance occur during the overwintering season **(October 11 to April 14)**?	May Affect, Contact your local field office to discuss the details of the project	9.0
9.0	Will the action result in ground disturbance greater than 0.25 acres in foraging/nesting habitat?	10.0	11.0
10.0	Does the proposed action intersect the south of 42N geometry?*	10.1	10.2

10.1	Will the ground disturbance occur during the active flight period (**April 1 to October 10**)?	May Affect, Contact your local field office to discuss the details of the project	11.0
10.2	Will the ground disturbance occur during the active flight period **(April 15 to October 10)**?	May Affect,- Contact your local field office to discuss the details of the project	11.0
11.0	Will the action result in vegetation disturbance ? Note: Disturbance may be from any activity, including application herbicide, prescribed fire, grazing, mowing, or haying.	11.1	Not Likely to Adversely Affect
11.1	Will the vegetation disturbance affect greater than two acres of suitable RPBB habitat Note: Disturbance may be from any activity, including application herbicide, prescribed fire, grazing, mowing, or haying.	12.0	Not Likely to Adversely Affect
12.0	Does the proposed action intersect the south of 42N geometry?*	12.1	12.2
12.1	Will the action occur during the active flight period (**April 1 to October 10**)?	May Affect, Contact your local field office to discuss the details of the project	Not Likely to Adversely Affect
12.2	Will the action occur during the active flight period (A**pril 15 to October 10**)?	May Affect, Contact your local field office to discuss the details of the project	Not Likely to Adversely Affect

13.0	Does the action include - or is it reasonably certain to cause - intentional take of rusty patched bumble bee (RPBB)? Note: This could include, for example, surveys or studies that include handling or capture of the species.	May Affect, Contact your local field office to discuss the details of the project	14.0
14.0	Does the action area overlap with the Monongahela, George Washington, or Jefferson National Forest?*	14.1	17.0
14.1	Will the action be authorized, funded, or carried out by the U.S. Forest Service for implementation on the Monongahela, George Washington, or Jefferson National Forest?	15.0	17.0
15.0	Does the action area overlap with a rusty patched bumble bee high potential zone? * Note: A map that shows the locations of the HPZs is available on the RPBB website (link).	18.0	16.0
16.0	Does the action include activities that the U.S. Fish and Wildlife Service and U.S, Forest Service have agreed will have wholly beneficial effects to the rusty patched bumble bee?	Not Likely to Adversely Affect	No Effect
17.0	Does the action area overlap with a rusty patched bumble bee high potential zone?* Note: A map that shows the locations of the HPZs is available on the RPBB website (link)	18.0	No Effect
18.0	Does the action include – or is it reasonably certain to result in – construction of one or more new roads or rail lines that will increase vehicle traffic in a rusty patched bumble bee HPZ?	May Affect, Contact your local field office to discuss the details of the project	19.0
19.0	Does the action include – or is it reasonably certain to result in – the addition of travel lanes that are likely to increase vehicle traffic on one or more existing roads that will increase vehicle traffic in a rusty patched bumble bee HPZ?	May Affect, Contact your local field office to discuss the details of the project	20.0
20.0	Does the action include – or is it reasonably certain to result in – construction of structures or activities that will increase vehicle traffic in a rusty patched bumble bee HPZ?	May Affect, Contact your local field office to	21.0

		discuss the details of the project	
21.0	Does the action include – or is it reasonably certain to cause – the use of commercial/managed bees (e.g., the use of honeybees or managed bumble bees to pollinate crops).	May Affect, Contact your local field office to discuss the details of the project	22.0
22.0	Is there habitat for nesting, foraging, and/or overwintering for the rusty patched bumble bee in the action area? Note: Please refer to the ESA Section 7(a)(2) Voluntary Implementation Guidance for Rusty Patched Bumble Bee at: https://www.fws.gov/media/esa-section-7a2-voluntary-implementation-guidance-rusty-patched-bumble-bee	24.0	23.0
23.0	Will the proposed action restore habitat for the species in the action area? For a description of rusty patched bumble bee nesting and foraging habitats, refer to the section 7 guidelines. Note that if the action may affect areas outside of the immediate project footprint that contain rusty patched bumble bee habitat, answer 'yes.' This may include, for example, use of application of any pesticide (e.g., insecticide, herbicide, or fungicide) that may drift or be otherwise transported outside of the targeted area.	24.0	No Effect
24.0	Have "Project Review" surveys for rusty patched bumble bees already been conducted in the action area according to Service-approved protocols?	25.0	26.0
25.0	Were rusty patched bumble bees observed during "Project Review" surveys? Note: Surveys must be consistent with FWS-approved protocols with emphasis on recommended survey effort, timing, site selection, and survey technique and methods. Surveys must be conducted within a year before the project initiation for negative survey results to remain valid. USFWS considers the results valid for two years or the duration of the project, whichever is shorter, unless new information (*e.g.*, new positive surveys) suggests that the species is likely to be present in the action area.	26.0	Not Likely to Adversely Affect
26.0	Does the action include collection of seed from native species?	27.0	29.0

27.0	Will the seed collection be carried out more frequently than once every three years across the same 2.0 acre (or larger) area?	May Affect, Contact your local field office to discuss the details of the project	28.0
28.0	Does the action include only seed collection and no other activities that could affect the rusty patched bumble bee or its habitat?	Not Likely to Adversely Affect	29.0
29.0	Does the action include, or will it cause the application of insecticides or fungicides?	May Affect, Contact your local field office to discuss the details of the project	30.0
30.0	Does the action include, or will it cause activities to control native rodent species?	May Affect, Contact your local field office to discuss the details of the project	31.0
31.0	Does the action include, or will it cause planting or seeding of non-native plant species?	31.1	32.0
31.1	Will the non-native plant species degrade the quality of existing RPBB foraging habitat in the action area? Note: Decreasing the abundance or diversity of native RPBB forage plant species can affect the RPBB.	May Affect, Contact your local field office to discuss the details of the project	32.0
32.0	Will the action include or cause herbicide use?	33.0	35.0
33.0	Will herbicide application methods include only wiping individual plants with a wick or glove, cut-stump, spot-spraying, or basal bark treatments?	35.0	34.0
34.0	Will herbicides be applied when the rusty patched bumble bee is likely to be foraging on the affected plants in a manner that could result in direct exposure of individuals to the herbicide mixture?	May Affect, Contact your local field office to discuss the details of the project	35.0

35.0	Will the action cause an increase in the extent or duration of surface flooding or soil saturation in rusty patched bumble bee habitat in a High Potential Zone? Note: This may occur, for example, as a result of activities or structures that impound water, otherwise alter or interrupt existing drainage patterns, or that affect surface runoff.	May Affect, Contact your local field office to discuss the details of the project	36.0
36.0	Will the action cause ground disturbance in rusty patched bumble bee habitat within a High Potential Zone?	37.0	42.0
37.0	Will the ground disturbance within the High Potential Zone affect more than 0.25 acre (0.1 hectare) of rusty patched bumble bee nesting habitat (upland grasslands, shrublands, and forest edges that contain native sources of pollen and nectar)? Note: Please refer to the ESA Section 7(a)(2) Voluntary Implementation Guidance for Rusty Patched Bumble Bee at: https://www.fws.gov/media/esa-section-7a2-voluntary-implementation-guidance-rusty-patched-bumble-bee	38.0	40.0
38.0	Will the ground disturbance occur during the nesting season?	39.0	40.0
39.0	Will the ground disturbance likely be sufficient to collapse underground rodent burrows or their entrances?	May Affect, Contact your local field office to discuss the details of the project	40.0
40.0	Will the ground disturbance within the High Potential Zone affect more than 0.25 acre (0.1 hectare) of rusty patched bumble bee overwintering habitat (forest that contains native plants that provide pollen and nectar)? For a more detailed description of rusty patched bumble bee overwintering dates and habitat, refer to the section 7 guidelines.	41.0	42.0
41.0	Will the ground disturbance occur during the overwintering season?	May Affect, Contact your local field office to discuss the details of the project	42.0

42.0	Will the action include or cause effects to native vegetation in rusty patched bumble bee habitat?	43.0	No Effect
43.0	Will the action cause effects to native vegetation in rusty patched bumble bee habitat within the High Potential Zone during the nesting period? Note: Effects could occur as a result of mowing, cutting, grazing, prescribed fire, tree removal, spot-application of herbicide, tree clearing, and/or other activities. Effects could occur as a result of activities carried out outside of the nesting period if they result in reduced forage availability during a subsequent nesting period.	44.0	46.0
44.0	Will the action remove or otherwise make foraging resources unavailable to the rusty patched bumble bee on 2.0 acres (0.8 ha) or more of foraging habitat within an HPZ? Note: Answer 'yes' even if the forage is unavailable only temporarily. Effects could occur as a result of activities carried out outside of the nesting period if they result in reduced forage availability during a subsequent nesting period on 2.0 acres (0.8 ha) or more within an HPZ. This excludes effects to vegetation in newly planted habitats if they occur before the beginning of the third growing season after the initial seeding. For a description of foraging habitat, refer to the rusty patched bumble bee section 7 guidelines.	45.0	46.0
45.0	Will removal of foraging resources within the HPZ occur during the nesting season?	May Affect, Contact your local field office to discuss the details of the project	46.0
46.0	Does the action include the use of prescribed fire during the overwintering period? Overwintering dates are October 11 to March 31 south of 42N latitude, and October 11 to April 14 north of 42N latitude.	47.0	48.0
47.0	Is the burn unit within upland forest habitat?	May Affect, Contact your local field office to discuss the details of the project	48.0

48.0	Will the action result in the regular, re-occurring, or permanent removal, reduction, or conversion of any existing rusty patched bumble bee habitat?	49.0	Not Likely to Adversely Affect
49.0	Will the action result in the permanent removal of more than 2.0 acres (0.8 ha) of rusty patched bumble bee habitat?	May Affect, Contact your local field office to discuss the details of the project	Not Likely to Adversely Affect

Appendix B. Concurrence request form for use with assisted determination key.

Use this form to request concurrence from the U.S. Fish and Wildlife Service for federal actions that may affect, but are not likely to adversely affect the rusty patched bumble bee, based on the use of the USFWS Assisted Determination Key.

Complete Table B.1 and submit this form along with your request for concurrence to the local USFWS Ecological Services Field Office (Our Locations | U.S. Fish & Wildlife Service (fws.gov)) to discuss the specifics of this project. Along with the form, include a brief description of the proposed federal action and a shapefile (preferred) or map of the area likely to be affected by the action (the action area[7]) along with your request for concurrence.

Table B.1. Information for concurrence requests. RPBB = rusty patched bumble bee; HPZ = High Potential Zone.

Description of Action	Check if Applies	Acres RPBB Habitat Affected in HPZ
The action includes seed collection that will not affect the same 2.0 acres (or larger) area of RPBB habitat more frequently than once every three years.		
The action will include herbicide use in RPBB habitat within one or more HPZs, but only spot spraying (application to individual weeds using a hand-held sprayer) and/or other methods that include only applications to individual weeds (e.g., wick wiping, cut-stump, or basal bark treatments).		
The action will remove or convert RPBB foraging habitat, but the amount of habitat removal or conversion is less than 2.0 acres. Ground disturbance in nesting habitat and in wintering habitat during the nesting and overwintering seasons, respectively, will not exceed 0.25 acres.		
The action will cause ground disturbance that affects *less* than 0.25 acre of RPBB nesting habitat (upland grasslands, shrublands, and forest edges that contain native sources of pollen and nectar) in a HPZ during the nesting season.		
The action will cause ground disturbance on *less* than 0.25 acre of RPBB overwintering habitat (upland forest) in a HPZ during the overwintering period.		
The action will cause effects during the nesting period to *less than* 2.0 acres (0.8 ha) of RPBB foraging habitat. Ground disturbance in nesting habitat during the nesting period will not exceed 0.25 acres.		
The action will affect 2.0 acres or more of *newly planted foraging habitat* during the nesting period, but only before the beginning of the third growing season after the initial seeding. Ground disturbance in nesting habitat during the nesting period will not exceed 0.25 acres.		

[7] Action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.

Appendix C. Partial list of potential stressors and responses associated with important rusty patched bumble bee risk factors.

We based the Potential Responses in part on studies of other bumble bee species with similar life history traits - generalist foragers that collect pollen from the same food sources. For more details on some of the following risk factors, refer to USFWS 2016.

Table C.1.Potential stressors to rusty patched bumble bee. Note, this list contains some, but not all potential risk factors.

Risk Factor	**Potential Stressor(s)**	**Potential mode(s) of exposure**	**Potential Response(s)**	**Reference(s)**
Pathogens and Parasites	Introduction, expansion, or increased abundance of honeybees or commercial bumble or other managed bees that carry pathogens	Collection and consumption of infected pollen	Larval mortality; queen sterility; deformed wings, abdomen distension in queens and inability to mate; reduced body fat and increased mortality of overwintering queens	(USFWS 2016, p. 40-43)
Insecticides	Insecticide applications	Consumption of contaminated nectar or collection of contaminated pollen	Decreased brain function; reduced feeding; decreased queen production; decrease male production; decreased worker production; increased worker mortality; decreased colony weight; decrease foraging efficiency (pollen delivery to nest); diminished defensive behavior; decreased worker weight; decreased egg production; decreased larval production; delayed nest building; impaired ovary development; increased susceptibility to parasite infection in queens	(Feltham et al. 2014, Larson et al. 2014, p. 1, USFWS 2016, pp. 43, 90-93)
Insecticides	Insecticide applications	Direct contact/absorption	Contact mortality; Sub-lethal effects – e.g., reduced or no male production; egg infertility; reduced queen production	
Insecticides	Insecticide – Seed treatments	Consumption of contaminated nectar	Decreased queen production; decreased worker production; lower colony density; decreased colony weight	(USFWS 2016, p. 90, Rundlöf et al. 2022, p. 79)
Fungicides	Fungicide use	Reduced availability of nectar and pollen	Nutritional stress that leads to increased susceptibility to pathogens	(Brown et al. 2000, p. 421, USFWS 2016, p. 42)
Fungicides	Fungicide use	Increased transmission and prevalence of parasites due to reduced genetic diversity.	Refer to responses to collection and consumption of infected pollen, above.	(USFWS 2016, p. 42)

Risk Factor	Potential Stressor(s)	Potential mode(s) of exposure	Potential Response(s)	Reference(s)
Herbicides	Herbicide Use	Reduced availability of nectar and pollen	Nutritional stress that leads to increased susceptibility to pathogens; direct mortality	(Brown et al. 2000, p. 421, USFWS 2016, p. 42, Straw et al. 2021, p. 5)
Loss or Alteration of Vegetation or Leaf Litter	Loss of bunchgrasses and other vegetation that supports suitable nesting habitat	Limited or no nesting sites in proximity to summer foraging areas	Avoidance of area; deterioration in body condition and reduced reproductive output due to need to find appropriate nesting habitat elsewhere	
Loss or Alteration of Vegetation or Leaf Litter	Actions that directly or indirectly reduce or eliminate nectar plant density or diversity; examples include plowing, growing season fire; mowing; herbicide application; collection of seeds from native plant species	Inability to find suitable amounts of nectar and pollen.	Avoidance of area; potential deterioration of body condition and reduced or no reproductive output for affected queens; increased mortality of immature life stages already present in nests; reduced overwinter survival of queens	(Burns 2004, p. 150, Williams et al. 2012, p. 1055, USFWS 2016, p. 15, Nevill et al. 2018, Requier et al. 2020, Vaudo et al. 2020)
Ground Disturbance or Compaction	Direct disturbance	Direct disturbance	Immediate death or harm of individuals present in nests or overwintering sites (queens);	(Hatfield et al. 2012, p. 18)
Ground Disturbance or Compaction	Compaction of soils by heavy equipment	Loss of potential nesting sites	Avoidance of area; deterioration in body condition and reduced reproductive output due to need to find appropriate nesting habitat elsewhere	
Ground Disturbance or Compaction	Construction matting or other temporary covering of ground surfaces	Temporary loss of potential nesting sites	Avoidance of area; deterioration in body condition and reduced reproductive output due to need to find appropriate nesting habitat elsewhere	
Competition for Resources from Commercial or managed bees	Reduced availability of nectar and pollen	Reduced availability of nectar and pollen	Negative effects on the reproductive success; Nutritional stress that leads to increased susceptibility to pathogens	(Burns 2004, p. 150, Williams et al. 2012, p. 1055, USFWS 2016, p. 15, Requier et al. 2020, Vaudo et al. 2020)
Competition for Resources from Commercial or managed bees	Disease transmission	Refer to Pathogens and Parasites, above	Refer to Pathogens and Parasites, above	

Risk Factor	Potential Stressor(s)	Potential mode(s) of exposure	Potential Response(s)	Reference(s)
Loss of Potential Nesting Sites	Rodent control in suitable nesting habitat	Loss of rodent burrows that could provide nest sites	Avoidance of area; deterioration in body condition and reduced reproductive output due to need to find appropriate nesting habitat elsewhere	
Surface Flooding or Soil Saturation	Inundation of existing nest sites or suitable nesting habitat	Direct disturbance	Mortality; Avoidance of area; deterioration in body condition and reduced reproductive output due to need to find appropriate nesting habitat elsewhere	

Appendix D. Concurrence for activities that may affect, but are not likely to adversely affect rusty patched bumble bees.

This example concurrence is from the Programmatic Biological Opinion Natural Resources Conservation Service and Farm Service Agency Programs in Illinois, Minnesota, and Wisconsin, and Their Effects on the Rusty Patched Bumble Bee (USFWS 2024). *Note that some refinements have been made to the section 7 guidance since the issuance of this 2024 Biological Opinion (e.g., phenology dates). Also note that the last two rows of this table should read "increased forage and improved fitness" in the expected change and response columns, respectively. Minor editorial changes have been made to this table for accessibility purposes (e.g., split merged cells).*.

Activity	Expected Change to Land, Water, or Air (Stressors) and Response	Response	Rationale
Prescribed burning of foraging habitat if under two acres during the nesting season	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; prescribed burning may temporarily reduce the availability of blooming forbs; less than 5% of the assumed foraging range of RPBB would be affected if the action area is 2 acres or less; we anticipate the effects to be insignificant
Prescribed burning of foraging habitat if under two acres during the nesting season	Heat, smoke, ash	Mortality of adults outside of nests	RPBB may be killed by heat, smoke, and ash from prescribed burns; adult RPBB outside of nests would be able to evade fire, smoke, and ash produced by prescribed burns if the action area is 2 acres or less; we anticipate the effects to be discountable
Prescribed burning of foraging habitat if under two acres during the nesting season	Heat, smoke, ash	Mortality of eggs, larvae, and adults in nests	RPBB may be killed by heat, smoke, and ash from prescribed burns; RPBB nests are typically constructed in rodent burrows 1-4' underground and eggs, larvae, and adults in nest would be protected from heat, smoke and ash from fire; we anticipate the effects to be discountable
Prescribed burning of foraging habitat during the overwintering season	Heat, smoke, ash	Mortality of eggs, larvae, and adults in nests	RPBB may be killed by heat, smoke, and ash from prescribed burns; burning foraging habitat when RPBB are not present is not likely to

Activity	Expected Change to Land, Water, or Air (Stressors) and Response	Response	Rationale
			adversely affect RPBB; we anticipate effects to be discountable
Grazing of foraging habitat if under two acres during the nesting season	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; grazing may temporarily reduce the availability of blooming forbs; less than 5% of the assumed foraging range of RPBB would be affected if the action area is 2 acres or less; we anticipate the effects to be insignificant
Grazing of foraging habitat during the overwintering season	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; grazing may temporarily reduce the availability of bloomig forbs; grazing foraging habitat when RPBB are not present is not likely to adversely affect RPBB; we anticipate the effects to be discountable
Haying of foraging habitat if under two acres during the nesting season	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; haying may temporarily reduce the availability of bloomig forbs; less than 5% of the assumed foraging range of RPBB would be affected if the action area is 2 acres or less; we anticipate the effects to be insignificant
Haying of foraging habitat during the overwintering season	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; haying may temporarily reduce the availability of blooming forbs; haying foraging habitat when RPBB are not present is not likely to adversely affect RPBB; we anticipate the effects to be

Activity	Expected Change to Land, Water, or Air (Stressors) and Response	Response	Rationale
			discountable
Mowing of foraging habitat if during the first year following conservation practice establishment	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; mowing may temporarily reduce the availability of blooming forbs; most forage species will not be flowering during the first year following practice establishment and therefore forage would not be available to begin with and RPBB are not likely to be present; we anticipate the effects to be insignificant and discountable
Mowing of foraging habitat if under two acres during the nesting season	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; mowing may temporarily reduce the availability of blooming forbs; less than 5% of the assumed foraging range of RPBB would be affected if the action area is 2 acres or less; we anticipate the effects to be insignificant
Mowing of foraging habitat during the overwintering season	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; mowing may temporarily reduce the availability of blooming forbs; mowing foraging habitat when RPBB are not present is not likely to adversely affect RPBB; we anticipate the effects to be discountable

Activity	Expected Change to Land, Water, or Air (Stressors) and Response	Response	Rationale
Mowing fire breaks during the nesting season immediately before a burn is planned if less than two acres of RPBB foraging habitat is affected or the mowing is conducted outside of the nesting period, March 15 to October 10 (south of 42˚ N) or April 10 to October 10 (north of 42˚N).	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; mowing may temporarily reduce the availability of blooming forbs; less than 5% of the assumed foraging range of RPBB would be affected if the action area is 2 acres or less and mowing foraging habitat when RPBB are not present is not likely to adversely affect RPBB; we anticipate the effects to be insignificant and discountable
Spot-treatment of non-native weeds by mowing or spot applications of herbicide.	Exposure to pesticides	Reduction in fitness; mortality	RPBB may be killed or exhibit sub-lethal effects from exposure to pesticides; spot treatments will minimize exposure to RPBB; we anticipate the effects to be insignificant and discountable
Spot-treatment of non-native weeds by mowing or spot applications of herbicide	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; herbicide application may reduce the availability of blooming forbs; spot treatments will minimize effects to non-target plant species; we anticipate the effects to be insignificant and discountable
Mowing or clipping of weeds or companion crops during the first three years of practice establishment. This may include mowing or clipping of entire fields, depending on the extent of the area where weeds or companion crops may be shading or otherwise competing with planted native species.	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; mowing may temporarily reduce the availability of blooming forbs; weeds and companion crops are not high quality sources of nectar and pollen for RPBB and RPBB are not likely to be present in fields of weeds or companion crops; we anticipate the effects to be insignificant
Control of competing plants up to four feet around trees and shrubs by using cultivation, mulch, or chemical control	Exposure to pesticides	Reduction in fitness; mortality	RPBB may be killed or exhibit sub-lethal effects from exposure to pesticides; spot treatments will minimize exposure to RPBB; we anticipate the

Activity	Expected Change to Land, Water, or Air (Stressors) and Response	Response	Rationale
[i.e., as described in Minnesota NRCS Job Sheets for CP4 and CP31 (NRCS 2017; 2020)]. Further consultation with USFWS would be necessary if the activity is proposed in a tree/shrub planting that was carried out in an area where native grasses or wildflowers were established (e.g., in a CP25 planting).			effects to be insignificant and discountable
Control of competing plants up to four feet around trees and shrubs by using cultivation, mulch, or chemical control [i.e., as described in Minnesota NRCS Job Sheets for CP4 and CP31 (NRCS 2017; 2020)]. Further consultation with USFWS would be necessary if the activity is proposed in a tree/shrub planting that was carried out in an area where native grasses or wildflowers were established (e.g., in a CP25 planting).	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; cultivation may reduce the availability of blooming forbs; impacts to 4 foot areas around trees would not likely significantly reduce the amount of available forage; we anticipate the effects to be insignificant
Repair of gullies (i.e., in filter strips).	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; repair of gullies (i.e., in filter strips) may temporarily reduce the availability of blooming forbs; filter strips typically contain non-pollinator seed mixes and are not of high value to RPBB (Horton, pers. comm. 6/27/23); we anticipate the effects to be insignificant
Periodic removal of accumulated sediment and regrading in filter strips if it is done outside of the nesting period, March 15 to October 10 (south of 42˚ N) or April 10 to October 10 (north of 42˚N)	Ground disturbance	Mortality	RPBB may be killed due to ground disturbance; ground disturbance when RPBB are not present or to 0.25 acres or less of nesting habitat has a low (<5%) probability of destroying a nest based on assumptions about nest density and is not

Activity	Expected Change to Land, Water, or Air (Stressors) and Response	Response	Rationale
or affects less than 0.25 acre of RPBB nesting habitat.			likely to adversely affect RPBB; we anticipate the effects to be discountable
Periodic removal of accumulated sediment and regrading in filter strips if it is done outside of the nesting period, March 15 to October 10 (south of 42˚ N) or April 10 to October 10 (north of 42˚N) or affects less than 0.25 acre of RPBB nesting habitat.	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; removal of accumulated sediment and regrading in filter strips may temporarily reduce the availability of blooming forbs; removal of accumulated sediment and regrading in filter strips when RPBB are not present is not likely to adversely affect RPBB; we anticipate the effects to be discountable
Mechanical or manual control of brush in filter strips and in other herbaceous plantings.	Ground disturbance	Mortality	Mechanical or manual control of brush in filter strips and in other herbaceous plantings may cause mortality to RPBB through crushing if the ground is disturbed; filter strips are designed to capture runoff from the landscape and would most likely not be suitable nesting or overwintering habitat for RPBB; we anticipate the effects to be discountable
Mechanical or manual control of brush in filter strips and in other herbaceous plantings.	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; mechanical or manual control of brush in filter strips and in other herbaceous plantings may temporarily reduce the availability of blooming forbs; filter strips typically contain non-pollinator seed mixes and are not of high value to RPBB (Horton, pers. comm. 6/27/23); we anticipate the effects to be insignificant
Woody plant control with the use of cut-stump or basal bark herbicide treatments.	Exposure to pesticides	Reduction in fitness	RPBB may be killed or exhibit sub-lethal effects from exposure to pesticides; spot treatments will

Activity	Expected Change to Land, Water, or Air (Stressors) and Response	Response	Rationale
			minimize exposure to RPBB; we anticipate the effects to be insignificant and discountable
Woody plant control with the use of cut-stump or basal bark herbicide treatments.	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; herbicide application may reduce the availability of blooming forbs; spot treatments will minimize effects to non-target plant species; we anticipate the effects to be insignificant and discountable
Mechanical cultivation for weed control in herbaceous cover if it is done outside of the nesting period, March 15 to October 10 (south of 42˚ N) or April 10 to October 10 (north of 42˚N) or affects less than 0.25 acre of RPBB habitat.	Ground disturbance	Mortality	RPBB may be killed due to ground disturbance; ground disturbance when RPBB are not present or to 0.25 acres or less of nesting habitat has a low (<5%) probability of destroying a nest based on assumptions about nest density and is not likely to adversely affect RPBB; we anticipate the effects to be discountable
Mechanical cultivation for weed control in herbaceous cover if it is done outside of the nesting period, March 15 to October 10 (south of 42˚ N) or April 10 to October 10 (north of 42˚N) or affects less than 0.25 acre of RPBB habitat.	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; mechanical cultivation for weed control may temporarily reduce the availability of blooming forbs; mechanical cultivation for weed control when RPBB are not present or to less than 0.25 acres of habitat is not likely to adversely affect RPBB; we anticipate the effects to be discountable and insignificant
Mowing or haying during August on land that has less than 2% coverage of nectar-bearing plants – for example, in areas dominated by reed canary grass (Phalaris arundinacea), nettles (Urtica dioica or *Laportea canadensis*) or ragweed (*Ambrosia* spp.).	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; mowing or haying may temporarily reduce the availability of blooming forbs; land with less than 2% coverage of nectar-bearing plants are not considered high quality habitat; we anticipate the

Activity	Expected Change to Land, Water, or Air (Stressors) and Response	Response	Rationale
			effects to be discountable and insignificant
Installing or replacing fence. Fencing plan cannot include grubbing and clearing of existing fence-line containing suitable foraging habitat.	Ground disturbance	Mortality	RPBB may be killed due to grubbing; excluding grubbing and clearing of existing fence-line in suitable foraging habitat from fencing plans will minimize ground disturbance; we anticipate the effects to be discountable
Installing or replacing fence. Fencing plan cannot include grubbing and clearing of existing fence-line containing suitable foraging habitat.	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; installing or replacing fence may reduce the availability of blooming forbs if grubbing or clearing occurs in suitable foraging habitat; excluding grubbing and clearing of existing fence-line in suitable foraging habitat from fencing plans will minimize loss of forage; we anticipate the effects to be discountable and insignificant
Grazing according to an NRCS plan except when it is likely to affect more than two acres of RPBB foraging habitat during the period, March 15 to October 10 (south of 42˚ N) or April 10 to October 10 (north of 42˚N).	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of blooming forbs to meet nutritional requirements and maintain healthy colonies; grazing may temporarily reduce the availability of blooming forbs; less than 5% of the assumed foraging range of RPBB would be affected if the action area is 2 acres or less; we anticipate the effects to be insignificant
Pruning activities on tree contracts completed after August 1 or before May 15, unless spring-blooming trees are pruned. If spring-blooming trees are pruned, activity may only be likely to avoid adverse effects to the RPBB if it is carried out after trees have ceased	Loss of forage	Reduction in fitness	RPBB require a high diversity and abundance of nectar and pollen sources to meet nutritional requirements and maintain healthy colonies; pruning spring-bloom trees temporarily reduce the availability of nectar and pollen; pruning non-blooming trees between August 1 and May 15 or after trees have ceased flowering will

Activity	Expected Change to Land, Water, or Air (Stressors) and Response	Response	Rationale
flowering.			minimize loss of nectar and pollen sources; we anticipate the effects to be insignificant
Interplanting to add diversity to shrub/tree contracts.	Loss of forage	Reduction in fitness	We anticipate effects to RPBB from interplanting to be neutral or positive
Dormant seeding on grass contracts.	Loss of forage	Reduction in fitness	We anticipate effects to RPBB from dormant seeding on grass contracts to be neutral or positive