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Project Title:	Willow Rock Energy Storage Center
TN #:	248949
Document Title:	Communication between CEC staff and applicant regarding Crotch's bumblebee
Description:	Emails dated February 10, 2023 and February 15, 2023. Also U.S. Fish and Wildlife Service Survey Protocols for the Rusty Patched Bumble bee and U.S. Fish and Wildlife Service California Bumble Bee Atlas Participant Handbook 2022
Filer:	Lisa Worrall
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	2/24/2023 10:52:39 AM
Docketed Date:	2/24/2023

From:	Knight, Eric@Energy
To:	Worrall, Lisa@Energy
Subject:	FW: CBB Meeting Next Week
Date:	Friday, February 24, 2023 9:44:38 AM
Attachments:	Survey_Protocols_RPBB_12April2019.pdf image001.png cabba_participant_handbook_03_15_2022.pdf

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From: Knight, Eric@Energy
Sent: Wednesday, February 15, 2023 11:54 AM
To: Nyree Grimes <nyree.grimes@hydrostor.ca>
Cc: Babula, Jared@Energy <Jared.Babula@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>; Hilliard, Jon@Energy <jon.hilliard@energy.ca.gov>; Payne, Leonidas@Energy <leonidas.payne@energy.ca.gov>; Anderson, Kari@Energy <Kari.Anderson@energy.ca.gov>; Stroud, Andrea@Energy <Andrea.Stroud@energy.ca.gov>
Subject: RE: CBB Meeting Next Week

Hi Nyree –

On behalf of CEC staff, I am responding to your email below and your follow-up voice mail to Lon Payne yesterday about a meeting to discuss Crotch's bumble bee.

CEC staff does not believe a meeting to discuss the "need and basis" for CBB surveys is necessary. CEC staff and CDFW have demonstrated in our filing on 2/9/23 (TN#248720) that CBB surveys are necessary if the applicant does not elect to assume species presence.

Attached are two documents that CDFW's Dr. Hillary Sardiñas, PhD says are needed for Hydrostor's consultants to develop a CBB survey protocol specific to the project. If applicant decides to conduct the CBB survey, please provide the project specific protocol to Lon Payne who will coordinate with CEC biological resources staff to ensure the appropriate individuals at CDFW review the protocol prior to the surveys being conducted, consistent with CDFW's usual process. If your consultants have any questions as they develop the project specific survey, they can contact Dr. Sardiñas directly.

Regards,
Eric

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From: Nyree Grimes <nyree.grimes@hydrostor.ca>
Sent: Friday, February 10, 2023 8:12 AM
To: Payne, Leonidas@Energy <leonidas.payne@energy.ca.gov>
Subject: CBB Meeting Next Week

Hi Lon,

We're looking forward to meeting with the CDFW and CEC team next week. We're particularly keen to meet as soon as possible as we're starting the rest of our surveys over the next couple weeks. Can you please provide a draft of the CBB survey protocol rolled out to the CEC on February 3rd prior to the meeting? This will allow our experts to review. As previously discussed, our CBB expert will be attending to discuss with the CDFW designated expert.

Proposed Agenda:

- **Discussion between Hydrostor and CDFW CBB expert: Need** and basis for CBB survey requirements
- If required, Discussion regarding CBB survey protocol

Please let us know the best times that work for you.

Regards,

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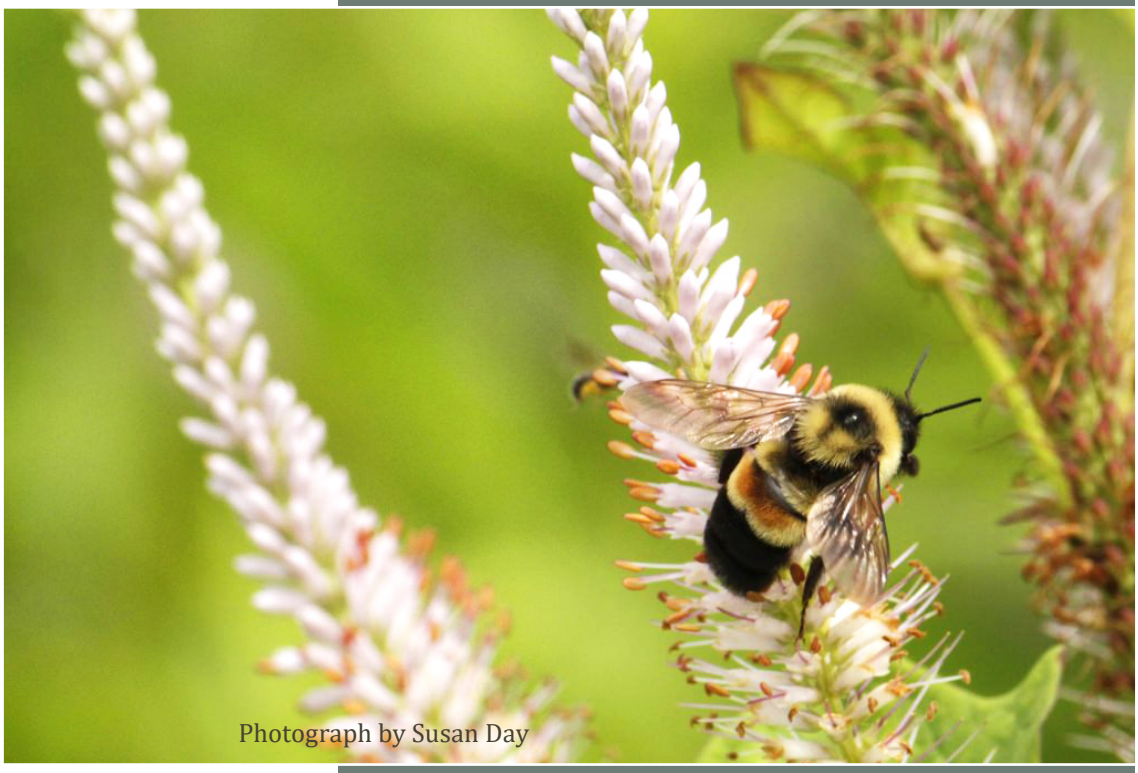
U.S. Fish and Wildlife Service
U.S. Department of the Interior

Survey Protocols *for the* Rusty Patched Bumble Bee (*Bombus affinis*)

Version 2.2
April 12, 2019



Photograph by Susan Day

Contents

Survey Protocol Guidance Development

A team of USFWS biologists developed survey protocols for *B. affinis* that are effective in meeting survey objectives and unlikely to negatively impact the species. We obtained informal peer review by bumble bee experts including biologists from local, State, and Federal agencies; scientific and academic institutions; and conservation organizations. We considered the best available information for all aspects of the guidance and will continue to work with surveyors to collect additional data on the distribution and ecology of *Bombus affinis*. This guidance document is subject to continual improvement and modification.

Acknowledgements

We would like to thank the following people for assistance with reviewing earlier drafts of this document (in alphabetical order): Michelle Boon, University of Minnesota; Crystal Boyd, Minnesota Department of Natural Resources; Dan Cariveau, University of Minnesota; Susan Carpenter, University of Wisconsin-Madison Arboretum; Sheila Colla, York University; David Cuthrell, Michigan Natural Features Inventory; Sam Droege, U.S. Geological Survey; Elaine Evans, University of Minnesota; Rich Hatfield, Xerces Society for Invertebrate Conservation; Robert Jean, Environmental Solutions & Innovations, Inc.; Jay Watson, Wisconsin Department of Natural Resources; and Amy Wolf, University of Wisconsin-Green Bay.

Introduction and Purpose

Once widespread and abundant, the rusty patched bumble bee (*Bombus affinis*) has undergone precipitous declines and was listed as an endangered species under the Endangered Species Act on January 11, 2016 (FR 50 CFR 17 3816 January 11, 2017). Just 20 years ago, sightings of *B. affinis* were common, and it was considered relatively abundant across 28 states, the District of Columbia and two Canadian provinces (USFWS 2016, p.3). Since then, it has experienced a swift and dramatic decline in abundance and distribution of approximately 90 percent or more. We are aware of records of *B. affinis* in isolated places within 13 states and 1 province since 2000 (FR 50 CFR 17 3816 January 11, 2017). The species' distribution has declined across its range in the U.S., for example, since 2007; point records occur only in 10 states and 66 counties in the U.S. (USFWS unpublished geodatabase, February 22, 2018). Similar declines have occurred in Canada where it was listed as Endangered on Schedule 1 of the Species at Risk Act in 2012 (Environment and Climate Change Canada 2016, p. iv).

While we recognize the great importance of conducting surveys for bees (and other insects), we need to be particularly cautious in areas that may contain *B. affinis*. The rusty patched bumble bee is so imperiled that every remaining population is important for the continued existence of the species. We must carefully consider the benefits of bee (and other insect) survey versus their potential to negatively impact the rusty patched bumble bee. Therefore, we recommend non-lethal protocols in areas where we may encounter the species (*e.g.*, areas within **High Potential** and

Primary Dispersal Zones where the occupancy is uncertain, see definitions below and online at https://www.fws.gov/midwest/Endangered/insects/rpbb/rpbbmap.html).

Survey effort throughout the historic range of *B. affinis* has not been systematic and the occupancy of some sites is uncertain. For these reasons the Service recommends non-lethal survey protocols in areas where there is a relatively high potential of encountering the species and in areas where there is a low, but still some, potential of encountering the species. We have developed a habitat-dispersal distance model (the **Habitat Connectivity Model** is described online at https://www.fws.gov/midwest/Endangered/insects/rpbb/rpbbmap.html) that identifies geographic areas to focus survey effort and where to be cautious regarding potential take associated with surveys.

The objectives of the survey protocols are to: (1) Find and document new *B. affinis* locations; (2) Determine if *B. affinis* are still extant at previously documented locations; (3) Monitor bumble bee populations to determine long-term population trends, relative abundance and species richness; and (4) Provide protocol recommendations for areas locations we believe are unoccupied by *B. affinis*.

Because *B. affinis* surveys can result in take (by capture), such surveys should only be conducted by a qualified biologist[1]. Generally, a recovery permit for *B. affinis* authorizes the capture of bees for identification and handling of bees for photography. Following this guidance will meet standard USFWS requirements for conducting surveys and monitoring under a federal recovery/scientific permit under section 10(a)(1)(B) of the ESA. However, surveyors also need to ensure they meet all applicable state permitting and reporting requirements. For further information about obtaining a federal permit and surveyor qualifications please see **Obtaining a permit under the Endangered Species Act and Frequently Asked Questions** available online at www.fws.gov/midwest/endangered/insects/rpbb/surveyors.html.

This survey protocol provides the U.S. Fish and Wildlife Service's (USFWS) recommended guidance on survey methodology and outlines additional reporting requirements for permitees. Future changes to this guidance may occur and will be posted on the USFWS rusty patched bumble bee guidance website (www.fws.gov/midwest/endangered/insects/rpbb/surveyors.html) by February 28th of each year. Before conducting surveys, please check the website to ensure use of the most current version of this document. Contact the FWS Field Office near you (http://www.fws.gov/offices/) if you are interested in collecting data that is not discussed in this document.

[1] A qualified biologist is an individual who holds a USFWS Recovery Permit (Federal Fish and Wildlife 10(a)(1)(A) Permit) for *B. affinis* in the state/region in which they are surveying and/or has been authorized by the appropriate state agency to capture and handle *B. affinis*. See **Obtaining a permit under the Endangered Species Act and FAQs** available online at www.fws.gov/midwest/endangered/insects/rpbb/surveyors.html.

Definition of Terms used in this Document

For the purposes of this document, a **site** is defined as a record (observation point) and the surrounding area that would typically provide the foraging area for one colony. Studies of other bumble bee species typically exhibit foraging distances of less than 0.6 mi (1 km) from their nesting sites (Knight et al. 2005, p. 1816; Wolf and Moritz 2008, p. 422; Dramstad 1996, pp. 163-182; Osborne et al. 1999, pp. 524-526; Rao and Strange 2012, pp. 909-911). There may be one or more sites within any of the zones described below.

- **High Potential Zones** are based on the habitat connectivity model described in detail online (see **Habitat Connectivity Model** at https://www.fws.gov/midwest/Endangered/insects/rpbb/rpbbmap.html). These High Potential Zones contain **extant sites** (see definition below) and the surrounding area considered to have highest potential for the species to be present, as generated from the model. These zones are not of uniform size and have discrete boundaries that can be used to determine where non-lethal surveys or scientific recovery permits may be recommended (Fig.1 and https://www.fws.gov/midwest/Endangered/insects/rpbb/rpbbmap.html). The zones range from about 1 to 2 miles (1.6 to 3.2 km) from extant sites. For recommendations regarding protocols and scientific recovery permits in High Potential Zones, see Table 1.
- **Extant Sites** are defined as sites where *B. affinis* has been documented in 2007 or later, unless surveyed sufficiently to be considered unoccupied. Ideally, extant sites will have multiple years with records of the species. If no or little effort has been spent attempting to relocate the species at the site, then additional surveys are needed before considering the site to be unoccupied.
- **Low Potential Zones** include: **Uncertain Zones** (defined below and online at http://www.fws.gov/midwest/endangered/insects/rpbb/rpbbmap.html) and **Primary Dispersal Zones** surrounding **High Potential Zones** (Fig.1). For recommendations regarding protocols and scientific recovery permits in Low Potential Zones, see Table 1.
- **Primary Dispersal Zones** are based on the habitat connectivity model described in detail online (see **Habitat Connectivity Model** online at https://www.fws.gov/midwest/Endangered/insects/rpbb/rpbbmap.html). The model used to create the Primary Dispersal Zones considers the maximum dispersal potential from known sites and across the range. These zones, although not of uniform size, have discrete boundaries that can be used to determine where non-lethal surveys are recommended and where a scientific recovery permit for surveys might be recommended (Fig.1).
- **Uncertain Zones** have records of the *B. affinis* in 2000 to 2006 out to and including the surrounding dispersal area, but with fewer than 3 years of negative survey data with sufficient effort[2] since the last known record. If no or little effort has been spent attempting

[2] Sufficient effort would consist of four approximately equally spaced sampling periods during the sampling season (early June to mid-August); one-person hour of search time per three acres of suitable high quality habitat (defined below) using non-lethal netting techniques. This document provides further details on methods, techniques, and best practices and is subject to continual improvement and modification.

to relocate the species at the site, then additional surveys are needed before considering the site to be unoccupied. Areas remain uncertain until they have either (1) a positive detection, when the site would be considered extant or (2) have at least 3 years of negative survey data (*i.e.*, using the Project Review Protocol or equivalent effort), when they would be considered unoccupied.

- **Unoccupied Zones** are areas where the likelihood of encountering *B. affinis* is so low that the area is considered unoccupied and includes: Areas outside of the High Potential and Primary Dispersal Zones; sites where last known *B. affinis* record is from before 2000; and unoccupied sites (defined below) with at least 3 years of negative surveys with sufficient effort[3] since the last known record. For recommendations regarding protocols and scientific recovery permits in Unoccupied Zones, see Table 1.
- **Unoccupied Sites** are where the species has been previously documented since 2000, but where there have been at least 3 years of negative surveys since the last known record (*i.e.*, using protocol 2 or equivalent effort). Sites that only have records older than 2000 are also assumed to be unoccupied unless new information (*e.g.*, recent surveys) suggests otherwise.

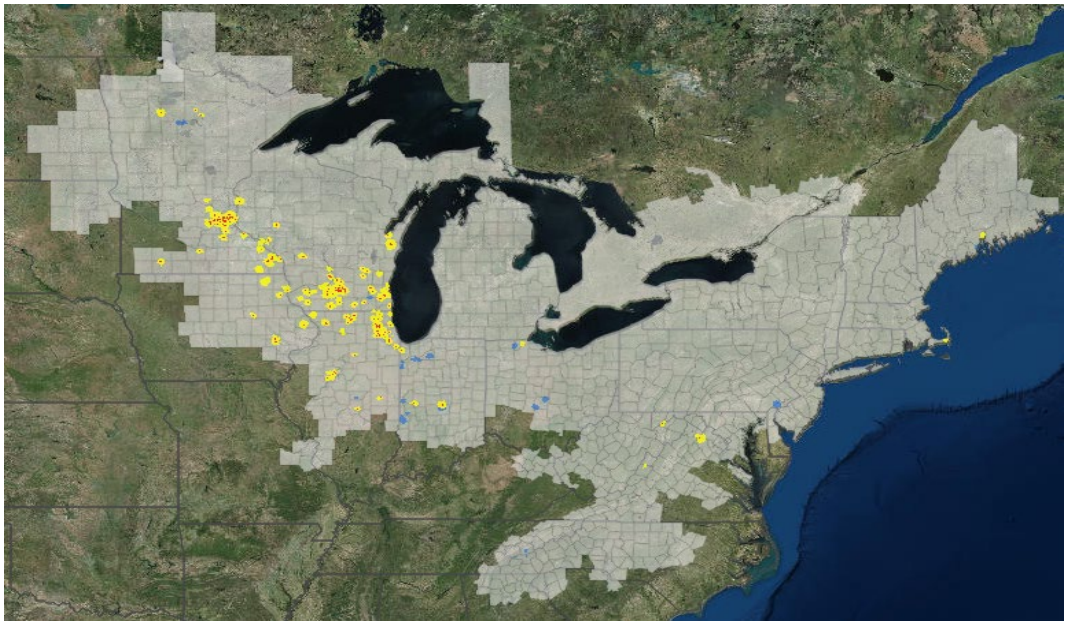


Figure 1. "**High Potential Zones**" (red dots), Uncertain Zones (blue), and Primary Dispersal Zones yellow) (together, the Uncertain and Primary Dispersal Zones comprise the "**Low Potential Zones**") for *B. affinis*, based on a habitat connectivity model and on species survey data compiled through the previous field season. The gray shaded area is the historical range of *B. affinis*, and is called the "**Unoccupied Zone"**. This map is updated regularly, so we recommend that surveyors visit the FWS RPBB website for the most current information. Description of the habitat model, an interactive map, and downloadable shapefiles are available on the RPBB website (https://www.fws.gov/midwest/endangered/insects/rpbb/rpbbmap.html).

[3] Sufficient effort would consist of four approximately equally spaced sampling periods during the sampling season (early June to mid-August); one-person hour of search time per three acres of suitable high quality habitat (defined below) using non-lethal netting techniques. This document provides further details on methods, techniques, and best practices and is subject to continual improvement and modification.

Recommendations for Surveys and ESA Permits within these Zones

Our recommendations for survey protocols and for obtaining a recovery permits within the High Potential, Low Potential, and Unoccupied Zones is described below (also, see Table 1).

High Potential Zone - With respect to typical foraging distances and potential dispersal movements of *B. affinis*, the high potential zones provide a reasonable basis for describing where the species is likely to be present and *where federal agencies and others should consult with the FWS to evaluate the potential effects of their actions* (Table 1). In addition, researchers surveying for or studying *B. affinis* in these zones are advised to obtain a scientific recovery permit.

Low Potential Zone – Since the late 1990s, marked and precipitous declines have been recorded in spatial extent and in the number of existing populations of *B. affinis*. Initial *recovery efforts* are needed around existing populations to avoid extinction of this species. Due to the low number and small size of most existing populations, looking for additional sites to support recovery may help prevent the extinction of this species. Low potential zones buffer high potential zones and are much less likely to support existing populations. However, we are hopeful that *B. affinis* may be found in some of these areas based on observed dispersal distances of a closely related species (*B. terrestris*, 0.6 to 6.2 mi (1 to 10 km, Kraus et al. 2009, p. 249; Lepais et al. 2010, pp. 826-827)). Therefore, since there is some chance (though low) that a surveyor looking for *B. affinis* may find one, we recommend that surveyors in low potential zones obtain a scientific recovery permit (Table 1).

Unoccupied Zones – We believe the likelihood of finding a *B. affini*s in these areas is so low, that we do not recommend scientific recovery permits in these areas (Table 1). However, if an insect researcher is surveying for bees in these areas and is concerned that they may accidentally collect a *B. affinis* and would like to obtaina recovery permit, then they may apply for such a permit and would be authorized to use lethal survey methods, until such time, if ever, that they happen to collect a *B. affinis*. At that time, the permit would specify that they switch to non-lethal methods within the occupied area.

Zone	Purpose	Recommended Protocol	Is a Scientific Recovery Permit Recommended?	Effort (per visit)	Effort (per season)	Duration	Transects	Count or Estimate of each individual bee?	RPBB Habitat Assessment?	Notes
High Potential Zone	"Presence - Absence" Survey for Section 7/10 Consultation/HCP	Project Review	Yes	1 person-hr per 3 acres of best habitat	4 equally spaced sampling periods from mid-June to mid-August	1 flight season, at minimum	No	Estimates or Counts	Not required, but recommended	
High Potential Zone	Bumble bee community and *B. affinis* population monitoring	Recovery Monitoring	Yes	1 person-hr per 3 acres of best habitat	4 equally spaced sampling periods from mid-June to mid-August	3+ years	Optional	Counts	Highly Recommended	
High Potential Zone	Document bumble bee presence without handling *B. affinis*	Photo Only	No	At your discretion	At your discretion	At your discretion	No	Estimates or Counts	Not required	A photo only can only verify presence, so the survey may **not provide sufficient effort** necessary for project reviews.
Low Potential Zone	Bumble bee community and population monitoring	Recovery Monitoring	Yes	1 person-hr per 3 acres of best habitat	4 equally spaced sampling periods from mid-June to mid-August	3+ years	Optional	Counts	Highly Recommended	
Low Potential Zone	Document bumble bee presence without handling *B. affinis*	Photo Only	No	At your discretion	At your discretion	At your discretion	No	Estimates or Counts	Not required	
Unoccupied Zones	Find new locations of *B. affinis*	Rapid	No	1 person-hr per 3 acres of best habitat	One time visit	1 flight season, at minimum	No	Estimates or Counts	Not required	If *B. affinis* is observed, stop survey and notify USFWS.
Unoccupied Zones	Document bumble bee presence without handling *B. affinis*	Photo Only	No	1 person-hr per 3 acres of best habitat	At your discretion	At your discretion	No	Estimates or Counts	Not required	If *B. affinis* is observed, stop survey and notify USFWS.
Unoccupied Zones	Other bee surveys	See Protocol Suggestions for Unoccupied Zones	No	At your discretion	At your discretion	At your discretion	No	At your discretion	Not required	If *B. affinis* is observed, stop survey and notify USFWS.

Table 1 . Quick guide to protocol recommendations based on the location and purpose of the survey, including recommendations whether or not to obtain a scientific recovery permit. The primary differences between the protocols are the amount of effort that is recommended and whether or not you anticipate handling *B. affinis*. For each protocol, the recommended amount of effort per field visit, effort per active season (year), survey duration, and habitat assessment is given. We recommend that surveyors conduct detailed habitat assessments (available online at https://www.fws.gov/midwest/Endangered/insects/rpbb/pdf/HabitatAssessmentFormGuideByXercesForRPBB.pdf) at sites with a positive identification of *B. affinis*.

Guidelines and Methods

General Guidelines and Best Practices for Surveys

We recommend following the guidelines below.

- ***Adhere to the Endangered Species Act and determine if you need a survey permit.*** Details on how to apply for a permit are provided online at -**Obtaining a Recovery Permit under the ESA and FAQs** (https://www.fws.gov/midwest/Endangered/insects/rpbb/surveys.html). FWS only has regulatory authority over listed species.

- ***Obtain land-owner permission*.** Written permission is recommended.

- ***Conduct surveys during suitable survey conditions*** (below).
    - **Time of Year** - Surveys (if handling *B. affinis*) must be conducted between early-June and mid-August, for the highest detection probability and to reduce potential impacts to *B. affinis* queens.
    - **Weather -** Surveys should take place when temperatures are above 60°F (15.5°C) and not during wet conditions (*e.g.*, foggy, raining, or drizzling). Wait at least 1 hour after rain subsides before conducting a survey. Sunny days with low wind speeds (less than 8 mph) are optimal. Partially cloudy days or overcast conditions are permissible if you can still see your shadow.
    - **Time of Day -** Surveys should be conducted at least 2 hours after sunrise and 3 hours before sunset.

Netting Technique. Collect bumble bees directly from flowers. Videos on netting techniques are available here: https://www.youtube.com/watch?v=SwYbv5bySPQ. If possible, capture one bee at a time or immediately separate bees into individual containers.

- ***Handling.*** Do not hold a bee in a container for longer than 15 minutes, unless you place it in a cooler with ice to later photograph the bee. Hold only one bee per container. Do not hold bees in a cooler with ice for more than 2 hours and do not place bees directly onto ice. If the air temperatures are above 90°F (32°C), do not hold for longer than 5 minutes. Bumble bees can easily overheat, so do not keep vials/bags in direct sunlight. Keep the bees in the shade, if possible. Be careful not to get stung!

- ***Release.*** Release bees back on or near flowers on which they were found. If you held bees in a cooler with ice, first transfer bees to a warm container after being in cooler (as the original container will fog up when it hits the warm humid air). Place the open vials (or bags) in a shaded area to allow the bees time to warm up and fly away. Release *B. affinis* within 15 minutes of capture, if possible.

- ***Reporting.*** Report sightings of *B. affinis* as required on your permit(s). Any collections or sightings of *Bombus bohemicus* (formerly *B. ashtoni*) should also be reported as this is a nest parasite of rusty patched bumble bee (and *B. terricola*) and thus could potentially indicate the presence of *B. affinis* in the area. Although not required, FWS is also requesting that surveyors report *B. terricola* observations and flower use.

- ***Salvage.*** *B. affinis* that are found dead or killed accidentally (during authorized surveys) may be salvaged. Prior to collecting specimen(s), photograph the specimen to document the condition. Notify the USFWS within 48 hours. Preserve the specimen(s) using standard museum practices[4] including proper identification and data [include date, complete scientific and common names, and geographic location (township, range, section, and UTM) where salvaged], or place in a freezer if unsure how to preserve. All specimens of *B. affinis* collected under your federal permit are the property of the United States Government and should clearly be identified as such. All dead specimens should be sent to a public scientific or educational facility or museum in the state the individuals were collected along with a copy of the permit(s) under which they were collected.

- ***Equipment basics*** – *We suggest bringing the following equipment:*
    - **Nets.** Use cloth aerial hand nets. Do not use sweep, beater, or wire nets. Netting should be fairly transparent. In rare cases, some individuals may be permitted to directly collect *B. affinis* into vials (see **Obtaining a Recovery Permit under the ESA and FAQs** available online at https://www.fws.gov/midwest/Endangered/insects/rpbb/surveys.html).
    - **Bags and/or clear vials.** If using vials, make sure vials allow for clear photographing of specimens inside (test before you go into the field). If using plastic bags, bring extra bags in case moisture builds up or bags get wet. There will be sufficient air in any of these containers while taking photographs.
    - Binoculars - butterfly binoculars are recommended for visual surveys
    - **Camera** (see **Appendix A - Standardized Bee Photography** for more details)
    - **Cooler with ice, if applicable**
    - **GPS unit**
    - **Data sheets** (digital or paper, for both bee surveys and habitat assessments)
    - **Pencils**
    - **Timer or stopwatch**
    - **Hand lens or loupe**
    - **Long measuring tape (100+ft)**
    - **Flags or stakes to mark transects**
    - **Field guides**
    - Federal, State, and Local **Permits, if applicable**

[4] You may find tutorials and protocols on the World Wide Web, for example, see methods on the University of Minnesota webapge http://www.extension.umn.edu/youth/mn4-H/projects/environment/entomology/collecting-and-preserving-insects/

Methods for Surveys within the High and Low Potential Zones

The following methods are common to all of the recommended protocols in this section (Table 1). Methods specific to each protocol are provided under each protocol description, below.

Site Selection

- Site selection will depend on the objectives and purpose of your study. Examine recent aerial photography using Google Earth or other tools to identify potential habitat for bees (see **Appendix B - Habitat for *B. affinis***). Examine and consider vegetation surveys or floral lists, if available for the location.

Define the Survey Area

- Determine the area that you would like to survey. The size of the survey area is at your discretion, but sufficient effort should be applied to the amount of area surveyed (see **Survey Effort,** defined for each protocol, below).
- On the field sheet, roughly estimate the size of the surveyed area and/or sketch site. Delineate the survey area using a GPS program such as ArcGIS to draw polygons around the area sampled.
- Use a portable GPS device (or map) to record the coordinates (decimal degrees is preferred) from, at minimum, the four corners of the surveyed area and at the approximate center of the surveyed area (latitude of eastern and western boundaries and longitude of northern and southern boundaries).

In Field Habitat Assessments

- If possible, prior to the survey date (if time permits), field-truth the selected area. Check the area for floral resources.
- On the day of the survey, take representative photographs, showing areas of suitable (high quality) and unsuitable (poor) habitat.
- At minimum, collect the basic habitat information on the **Survey Protocol Data Sheets** (available online at https://www.fws.gov/midwest/Endangered/insects/rpbb/surveys.html) to quantify the bees observed and survey conditions, which can affect the species observed. The sheets also ask for basic information about the available floral resources and major stressors at the site.
- You may conduct more detailed habitat assessments at your discretion – we recommend using the Xerces Rusty Patched Bumble Bee Habitat Assessment Form and Guide (https://www.fws.gov/midwest/Endangered/insects/rpbb/pdf/HabitatAssessmentFormGuideByXercesForRPBB.pdf). This Assessment can help conservation planners and landowners prioritize conservation actions and quantify habitat or land management improvements for *B. affinis* on a single site. It also helps identify specific actions for habitat improvement and management practices to help protect *B. affinis* from potential threats. We recommend that surveyors conduct detailed habitat assessments, particularly at sites with a positive identification of *B. affinis*.

Record Floral Use

- Note the flower (species of plant) being used by any *B. affini*s found, if applicable. If you are unsure of the plant species or need help with plant identification, photograph the flower and diagnostic parts (*e.g*., stem and leaves) to aid with later identification.

Photographs

- Take several photographs of each *B. affinis* (and other species of interest in your area, *e.g., B. terricola* and *B. pensylvanicus*). Photographs are required to verify *B. affinis* observations.
- Representative photographs of each bumble bee species in each sampling location is highly preferred.
- Photograph the bee from the top (dorsal view) showing the entire bee, including the top of thorax and abdomen. Also photograph the face from the front and top, and side view of thorax and abdomen (**see Appendix A - Standardized Bee Photography**). Short videos of *B. affinis* are also recommended.
- If using vials, make sure vials provide clear pictures (test before you go into the field).
- Record GPS location with each associated observation.

Survey Methods

- Start your timer when you begin surveying.
- **Catch bumble bees according to protocol specifications**, preferably one at a time. Move bee from aerial net to clear vial, baggie, or plastic bag.
- Pause your timer while you are not actively searching for bees (*e.g.*, while you are putting bees in your cooler, walking between habitat patches, or taking photographs).
- Depending on the specifics of your survey, you may choose to use blue chalk dust, paint pens, or nail polish to temporarily mark bees, other than *B. affinis*, to avoid recapture of individual bees (*e.g.*, if you process bees right away). Do not mark bees on the wings. In some cases, marking *B. affinis* may be permitted for individuals highly experienced in marking bumble bees - contact your state's FWS Ecological Services Field Office, if this is something you are considering.
- In some cases, visual surveys (*e.g.*, using butterfly binoculars) to count or estimate species other than *B. affinis* (and *B. terricola*) may be the preferred method for individuals highly experienced in identifying bumble bees. Photographic documentation is a necessary secondary component to visual surveys (*e.g.*, if *B. affinis* is observed).

Identification and Verification

- **See Appendix C – Bee Identification.**
- See **Appendix D - How to Verify Records.**

Release

- Release all *Bombus* at site of capture, on or near flowers (see *Release* in **General Guidelines and Best Practices for Surveys**, above).
- Process and release *B. affinis* within 15 minutes of capture, if possible.

- You may choose to release other species of *Bombus* at the end of the survey to avoid double counting individual bees.

Reporting

- **Report** all surveys (positive and negative) as required on state and federal permits.
    - We recommend submitting the **Survey Protocol Data Sheets** (available online at https://www.fws.gov/midwest/Endangered/insects/rpbb/surveys.html) for annual permit reports. Using the data sheets will help standardize data collection and increase efficiency in reporting.
- **Record** survey and habitat information on **Survey Protocol Data Sheets** (available online at https://www.fws.gov/midwest/Endangered/insects/rpbb/surveys.html).
- **Contact the FWS Field Office** near you (http://www.fws.gov/offices/) if you find and verify a *B. affinis* observation, particularly if it is observed in a new location.

Survey Protocols

Photograph Only Surveys

Photo-only surveys are recommended for people who will not be handling B.affinis. You do not need a permit if you do not handle B. affinis. Surveys to find new populations should place emphasis on maximizing the possibility of finding additional B. affinis populations through surveying many areas, rather than repeated sampling in one area (Table 1). Although photographic surveys can be conducted anywhere, we do not recommend photo only surveys for project reviews.

- We recommend using the photograph techniques described in **Appendix A - Standard Bee Photography**.
- We recommend that you submit photos to Bumble Bee Watch (www.bumblebeewatch.org), BeeSpotter (https://beespotter.org), or a similar website that employs bumble bee experts to verify the identifications. Qualified scientific experts may also be used to verify photographic records.
- Only good photographs that show key characteristics will be verified.
- Notify FWS Field Office near you (http://www.fws.gov/offices/) as soon as possible if you observe *B. affinis,* particularly if you observe it in a new location.
- Try to count and photograph all *B. affinis,* at minimum estimate the number of *B. affinis* observed. Note the flower that *B. affinis* is using.
- If possible, estimate and note the numbers observed of each species as well as the flower(s) the bee was using.
- Photographic documentation of *B.affinis* is required to verify the record.

Rapid Survey Protocol – Surveying Areas to find New Populations

Surveys to find new populations should place emphasis on maximizing the possibility of finding additional B. affinis populations through surveying many areas, rather than repeated sampling in one area (Table 1). Rapid surveys are recommended for quick searches for B.affinis within the ***Unoccupied Zones****. You do not need a permit in the Unoccupied Zones. Depending on the purpose of your study, you may also choose to use other protocols, such as those described below.*

Site Selection – If you have discretion on where you will conduct surveys, we recommend prioritizing your survey locations near recent records of the species and in areas with high quality habitat in your geographic area of interest in the **Unoccupied Zones**. Contact the USFWS Field Office (http://www.fws.gov/offices/) to help find priority areas within in your area of interest or use our guidance to help identify **priority survey areas** (online at https://www.fws.gov/midwest/Endangered/insects/rpbb/surveys.html).

Distance Between Sites – If you would like to survey multiple sites, spacing of sites will depend on the size of the survey area you are covering and the available time. In general, we suggest that surveyed sites be spaced approximately 3 to 5 km (2 to 3 mi) apart to maximize detection of regional populations of *B. affinis*.

Survey Effort – Survey for at least **one (1) person-hour per three acres of highest quality habitat** in your survey area or continue to sample until at least 150 bumble bees are sighted, whichever comes first[5]. Spend minimal time in lesser quality habitat. Scan the areas for bumble bee activity and move towards those areas. If bumble bees are not obvious, then travel from flower patch to flower patch looking for active bumble bees. Do not spend more than a minute at any one patch if you don't see any bumble bee activity. Because the purpose of the **Rapid Protocol** is to find new locations for the species, preferentially capture bees that match descriptions of *B. affinis.*

Survey Technique and Methods – *Use non-lethal netting techniques.*

- Because the purpose of the **Rapid Protocol** is to find new locations for the species, **preferentially capture bees that match descriptions of *B. affinis.*** Catch bumble bees of interest, preferably one at a time.
- You may use visual surveys to count or estimate numbers of each species besides *B. affinis* (and *B. terricola*), however, this method is only advised for individuals highly experienced in identifying bumble bees in the field and is recommended only for commonly observed species. Indicate degree of confidence in identifications on the data sheets. Photographic documentation of *B.affinis* is required to verify the record.
- As you are surveying, make a mental note of other *Bombus* species observed, if not captured for photographs. The data sheet will provide space to approximate the numbers of each species observed. Note how these were counted (i.e. actual counts or estimates) on the data sheets, to ensure that numbers are not misinterpreted.

[5] See Appendix E - Further Information Regarding Sampling Effort.

Project Review Survey Protocol

Surveys to confirm extant or uncertain site locations should have a standard level of effort at any given visit, plus repeated sampling during at least one year of the active flight season (Table 1). Because the purpose of these surveys is to detect B. affinis, sampling may be biased towards finding that species, however a full Bombus species list is also requested. Surveys should be conducted within a year of project initiation, however locations can be surveyed for multiple years (e.g., if you want to be reasonably certain that the species no longer exists in the area, see definitions of an unoccupied zones and unoccupied sites, above). More information is given in ***Appendix F –About Surveys for Proposed or Ongoing Actions that May Impact B. affinis.***

Site Selection – Select sampling locations within the High Potential Zone or Low Potential Zone.

Survey Effort - Conduct surveys during four evenly (approximately) spaced sampling periods during the sampling season (as defined in the **General Guidelines and Best Practices** section, above). For each sampling event, survey each suitable habitat patch for a **one (1) person-hour per three acres of the highest quality habitat** in your survey area or continue to sample until at least 150 bumble bees are sighted, whichever comes first[6]. Because the purpose of Project Review Protocol is to find new locations for the species, preferentially capture bees that match descriptions of *B. affinis* and estimate the number of other *Bombus* species. Surveys should be conducted within a year before the project initiation for negative survey results to remain valid for the duration of the project unless new information (e.g., new positive surveys) suggests that the species is likely to be present in the action area. Although not required for project review, repeat sampling events in the same areas (if still suitable) for at least 3 consecutive years are advisable if you are trying to be reasonably certain that the species no longer occupies the area (see **Unoccupied** site in **Definitions** section, above).

Survey Technique and Methods – *Use non-lethal netting techniques*

- **Preferentially capture bees that match descriptions of *B. affinis*** and other species that are of particular interest to you. Catch bumble bees of interest, preferably one at a time.
- As you are surveying, note of other *Bombus* species observed, even if not captured for photographs. The data sheets provide space to approximate the numbers of each species observed. Note how each species was counted/approximated on the data sheets, to ensure that numbers are not misinterpreted.
- You may also choose to capture other species to help you count and photographs them.
- You may use visual surveys to count or estimate numbers of each species besides *B. affinis* (and *B. terricola*), however, this method is only advised for individuals highly experienced in identifying bumble bees in the field and is recommended only for commonly observed species. Indicate degree of confidence in identifications on the data sheets. Photographic documentation of *B.affinis* is required to verify the record.

[6] See Appendix E - Further Information Regarding Sampling Effort.

Recovery Monitoring (*Bombus* Community) Survey Protocol

Long-term monitoring should be conducted in extant sites or any site where you are interested in population trends, species richness, and relative abundance of all Bombus species over time (Bombus community data)(Table 1). Surveys should have a standard level of effort in order to detect changes in relative abundances over time. Surveys should be conducted multiple times per year for multiple years. Here, we give three options - one using transects, one without transects, and distance sampling with transects.

Background – Recovery monitoring can be conducted to detect trends in known populations at **extant sites or at other sites at your discretion**. The quantity of bumble bees changes throughout the warm months as worker populations increase or decrease. For example, bees are subject to many environmental and health factors that impact the number of workers produced by each bumble bee colony. Additionally, over time, bumble bee habitat suitability changes as floral landscapes change composition. Because suitable habitat may change locations from one year to the next and bumble bee numbers fluctuate throughout the season, quantifying populations can be difficult and those variabilities should be accounted for in your monitoring effort.

Define the Fixed Survey Area - Determine and define your long-term survey area. This survey area should remain fixed across years. Focus survey effort in areas with the highest quality habitat.

Define and Map Suitable Habitat – High quality habitat should be delineated on a map or drawing each year (see **Appendix B - Habitat for *B. affinis***).

Survey Effort - Conduct surveys during four evenly (approximately) spaced sampling periods during the sampling season (as defined in the **General Guidelines and Best Practices** section). Survey all or a random subset of the highest quality habitat in the survey area. If the survey area is greater than 50 ac (20 ha), divide the survey area and survey separately in increments of 50 ac (20 ha). We recommend that surveyors use one of the three options below:

- ***Option 1 - Surveying with Transects:*** We recommend surveying transects (meandering transects are okay) that can be repeatedly visited over the course of the survey season and/or multiple years.
    - Maintaining the exact location of each transect is not as important as recording the transect length and width because these measurements will give us an estimate of the area sampled.
    - Multiple transects at each site is recommended to adequately cover the highest quality habitat at the site; transect spacing will depend on the habitat. You may preferentially place transects through good floral patches.
    - Use a GPS unit to track transects (it will give you transect length), or flag the transect and measure the transect length using a measuring tape.
    - For each 100m transect length (we recommend a minimum length of 300m), survey for a minimum of 15 minutes, use more time if needed; capture bees within 1 meter of one side of the transect line.

- Record the amount of time spent sampling each transect each visit.
- Repeat sampling events in the same areas (if still suitable) for at least 3 consecutive years.

- ***Option 2 - Surveys Without Transects:*** Alternatively, if you are not using transects, for each sampling event, survey for a minimum of **one (1) person-hour per three acres of the highest quality habitat** in the survey area or continue to sample until at least 150 bumble bees are captured, whichever comes first[7]. Estimate the area of the high quality habitat sampled. Repeat sampling events in the same areas (if still suitable) for at least 3 consecutive years.

- Option 3 – ***Distance Sampling with Transects:*** We recommend surveying transects that can be repeatedly visited over the course of the survey season and/or multiple years. Heirarchical Distance Sampling (HDS) has been used to estimate bumble bee densities (e.g., McNeil et al. 2018) and allows for spatial variability in abundance and detection across sites to be explained as a function of covariates (Kéry & Royle 2015).
    - Maintaining the exact location of each transect is not as important as recording the transect length and width because these measurements will give us an estimate of the area sampled.
    - Multiple transects at each site is recommended to adequately cover the highest quality habitat at the site; transect spacing will depend on the habitat. You may preferentially place transects through good floral patches.
    - Use a GPS unit to track transects (it will give you transect length), or flag the transect and measure the transect length using a measuring tape.
    - For each 100m transect length (we recommend a minimum length of 300m), survey for a minimum of 15 minutes, use more time if needed; capture/count bees within 3m of one side of the transect line.
    - Record distances as the perpendicular distance (to the closest 0.25m) from the transect to each bee and note the distance at which the bee was *first* detected. Avoid double-counting individuals.
    - Record the amount of time spent sampling each transect each visit.
    - Repeat sampling events in the same areas (if still suitable) for at least 3 consecutive years.

Survey Technique and Methods for both options– *Use non-lethal netting techniques*

- **Catch all bumble bees observed**, preferably one at a time.
- **Carefully count numbers of other *Bombus* species** captured. This information will be used to calculate relative abundances.
- You may use visual surveys to count or estimate numbers of each species besides *B. affinis* (and *B. terricola*), however, this method is only advised for individuals highly experienced in identifying bumble bees in the field and is recommended only for commonly observed

[7] See Appendix E - Further Information Regarding Sampling Effort.

species. Indicate degree of confidence in identifications on the data sheets. Photographic documentation of *B.affinis* is required to verify the record.

Habitat assessment - Within each defined survey area each year, we ask that surveyors conduct a detailed habitat assessment provided online at (https://www.fws.gov/midwest/Endangered/insects/rpbb/surveys.html). You may also use the "detailed habitat assessment" tab on the data sheets available online. Map suitable habitat within your survey area illustrating (1) area of high quality habitat and (2) amount of low quality habitat.

Protocol Suggestions for Unoccupied Zones

*Here, we recommend established protocols for bumble bee surveys and inventories in areas within the **Unoccupied Zones**, within the historical county range, or beyond the boundaries where the species was thought to occur. Your choice of technique is based on the objectives of the study and is not limited to those listed here. Survey Protocols discussed above may also be conducted outside of the Unoccupied Zones, if you desire.*

Some Considerations. Research on bees or pollinators in general often uses lethal survey techniques including hand netting, bowl traps, malaise traps, and window traps. Such techniques, while lethal, are thought not to significantly impact most (*e.g.*, relatively healthy) bee populations following the survey year (*e.g.*, Gezon et al. 2015, pp. 4-6). Passive traps (such as those discussed below) should still be used with caution and common sense. **Any situations where queens may be harmed should be avoided.**

Site Selection – Sites should be within the **Unoccupied Zones** (see Survey Protocol map, https://www.fws.gov/midwest/Endangered/insects/rpbb/rpbbmap.html), updated by February 28th of each year).

Time of the Year - Sampling may occur any time during the active season of bees (primarily March-October).

Recommended Survey Protocols
See the USFWS National Protocol Framework for the Inventory and Monitoring of Bees (https://ecos.fws.gov/ServCat/DownloadFile/47682?Reference=47400) or for more details on some of the protocols listed below.

- **Netting at flowers with kill jars**- Bumble bees can be netted on flowers using timed intervals, transects or a combination. Potassium cyanide or soapy water are preferred as DNA is not degraded but ethyl acetate and calcium carbonate may also be used. See the Bumble Bee Megatransect Project (https://www.handsontheland.org/environmental-

monitoring/bumble-bee-megatransect.html) or, more generally, roadside surveys (http://www.slideshare.net/sdroege/bumblebee-roadside-surveys-a-pilot-survey-and-recommendations),

- **Bowl/Pan/Cup traps -** These are traps that are usually colored blue, yellow, and white and set out on the ground or slightly elevated. Bees are attracted to the color and drown either in soapy water or diluted propylene glycol. Bumble bees are captured relatively uncommonly in most bowl and pan traps. However, cup traps, deployed continuously, often collect reasonable number of bumble bees and are a good choice for long-term surveys. Their use is outlined in the National Protocol Framework for the Inventory and Monitoring of Bees (https://ecos.fws.gov/ServCat/DownloadFile/47682?Reference=47400).
- **Malaise traps -** Use of tent-like traps made of mesh fabric that act as flight intercept traps with insects funneled into a collecting head filled with alcohol, glycol, no-pest strips, or cyanide. Costs for individual traps are high thus they are not commonly deployed despite capturing substantial number of bumble bees. Catch is highly dependent on location and habitat type.
- **Quick assessment** of bees at planted sites (*i.e.*, Ward et al. 2014) can be found at (http://www.xerces.org/wp-content/uploads/2014/09/StreamlinedBeeMonitoring_web.pdf).
- **Other passive survey techniques** occasionally catch or are used to collect bees. These include pheromones, window pane traps, sticky traps, pitfall traps, etc. These usually catch only very small numbers of bees or bees other than *Bombus* and the catch is often accidental.

Other Techniques (not recommended)

- **Blue Vane Traps** - Plastic bucket-like traps with fluorescent blue vanes. The bucket contains no-pest strips or propylene glycol as a kill agent. Blue vane traps can, at times, collect large numbers of bees when floral resources are limiting and should be used with caution during times when queens are out. Blue vane traps should be particularly used with caution throughout the historic range as they can catch bumble bees and *Melissodes (*also *Eucera* and *Peponapis, R. Jean pers.comm. 2018)* in large numbers. However, blue vane traps can also be used to capture bees alive, if they are monitored throughout the day to avoid stress from heat, etc. At least two *B.affinis* records were documented to be caught in blue vane traps (USFWS unpublished geodatabase) and bumble mortality is documented from blue vane traps (*e.g.*, Gibbs et al. 2017).

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Appendix A – Standardized Bee Photography

- Type of camera - Point and shoot digital cameras, DLSR and phones with cameras (>= 8 megapixels) will be the best options for use after aerial netting and moving the bee into a clear vial or clear baggie (zip net) to take photos.
- To properly identify a bumble bee it is best to take photos that clearly show the entire top side of the abdomen, the side of the thorax/abdomen and the face/head. Take several photos of each specimen to show these various characteristics.
- Hair color patterns vary with lighting. Examine photos to ensure that coloration is clear and that shadows and the underlying integument are not creating deceptive color patterns.
- If you are not handling bees, photograph them as they forage, taking a series of photos of each individual to document the bee's characteristics clearly, as described above. Take a "spacer" photo between the series, so you can distinguish between individual bees when you archive photos and report findings.
- If you are handling bees, vials with a flat side may provide higher quality photos. Placing the bee in a cooler will slow them down making them easier to photograph. You need a scientific recovery permit to handle *B. affinis* within High and Low Potential zones (see Table 1).
- Do not hold a bee in a container for longer than a few minutes, unless you place it in a cooler with ice. Bumble bees can easily overheat, so do not keep vials/bags in direct sunlight. Do not keep bees in a cooler longer than two hours, and not directly on the ice.
- If using a cooler with ice, bees may take a few minutes to warm up before flying away. Place vials or bags in a shaded area to give the bees time to fly away.
- Archive photographs for long-term storage.
- Link each photograph to the corresponding specimen. Use standardized naming conventions that provide the following information:
    - Permit number
    - Site location code
    - Specimen number
    - Photograph number
    - Date
    - For example, label PERMITNUMBER_SITECODE_SPECIMEN#_PHOTO#_DATE (*e.g.*, TE5555-7_STPAUL28_Specimen12_photo2_12July2017)

Appendix B - Habitat for *B. affinis*

Bombus affinis has been observed and collected in a variety of habitats, including prairies, oak savanna, woodlands, marshes, parks, and residential areas (Colla and Packer 2008, p. 1381; Colla and Dumesh 2010, p. 46; USFWS rusty patched bumble bee unpublished geodatabase 2016). *B. affinis* needs areas that contain sufficient food (nectar and pollen from diverse and abundant flowers), nesting sites that are predominantly free from ground-disturbing activities and near floral resources, and overwintering sites for hibernating queens (Goulson et al. 2015, p. 2; Potts et al. 2010, p. 349). It is a generalist forager for pollen and nectar like other bumble bees (Xerces 2013, pp. 27–28), but relies on diverse and abundant flowering plant species (Goulson *et al.* 2015, p. 2; Potts *et al.* 2010, p. 349). Due to the early emergence of *B. affinis* (roughly, mid-March through April), woodlands that support early blooming spring ephemerals are likely important habitats (Colla and Dumesh 2010, p. 45-46), especially when they are near open areas that are also used for summer foraging. *B. affinis* nests are typically in abandoned rodent nests or other similar cavities, one to four feet below ground (Plath 1922, pp. 190-191; Macfarlane *et al.* 1994, p. 4). *B. affinis* nests have also been occasionally observed above ground (Plath 1922, p. 190). Little is known about the overwintering habitats of *B. affinis* foundress queens, but other species of *Bombus* typically form a chamber in soft soil, a few centimeters deep (often in forests or in forest edges) and sometimes use compost or mole hills to overwinter (Goulson 2010, p. 11). Overwintering (roughly, mid-October through mid-March) sites may typically be in loose, uncompacted and often sandy, moss-covered soils on northwest exposures (E. Evans, University of Minnesota, pers. comm. 2017).

While *B. affinis* will use early spring floral blooms near the edge of forests and woodlands, ultimately they are dependent on open habitats to complete their life cycle. Consequently, potentially suitable habitat can be defined as any open, vegetated habitat within your survey region, such as prairies, roadsides, and meadows (Figures B.1, B. 3 and B.4). However, open habitats vary in quality for bumble bees. Open habitats with high floral diversity and abundance should be considered "high quality" habitat (Figures B.1, B. 3 and B.4). Areas dominated by grasses or sedges with few flowering plants or a low diversity of flowering plants should be considered low quality.

Habitat can be characterized in part by percent of vegetative cover that is forbs, flowering shrubs, or pollinator-friendly trees; especially areas that bloom all season long. Estimates of the number of species of forbs, flowering shrubs, or pollinator-friendly trees in bloom during each survey can help define "high quality" habitat and can help surveyors focus their effort (see **Survey Protocol Data Sheets** available online at https://www.fws.gov/midwest/Endangered/insects/rpbb/surveys.html).

Surveyors should spend less time in poor and/or questionable habitat. Questionable habitat includes areas that are not clearly poor habitat, and should be checked for 5-10 minutes for bumble bee activity (Figures B2.a and B2.b) before moving on to better habitat or deciding not to survey an area. Poor habitat can be defined as areas without an abundance of floral resources, areas with

compacted soils, sod-forming grasses, or large monoculture agricultural fields (although some flowering agricultural crops, like alfalfa, may provide foraging habitat). Some examples of poor habitat include open water, regularly maintained turfgrass monocultures, and pavement. Areas that meet the following descriptions are not suitable for the rusty patched bumble bee for nesting, overwintering, or foraging.

- permanently flooded areas/open water;
- paved areas;
- mowed turf lawns without clover;
- areas planted to annual row crops, such as corn and soybeans which do not provide mass flowering resources for bees;
- forest where invasive shrubs are dominant and spring ephemeral flowers are absent; and,
- areas mowed too frequently to allow development of diverse wildflower resources (*e.g.,* road shoulders).

In addition to the above, wetlands, where standing water may be absent but near the ground surface, are unsuitable for nesting or overwintering. Some wetland areas, however, could provide function as important foraging habitat.

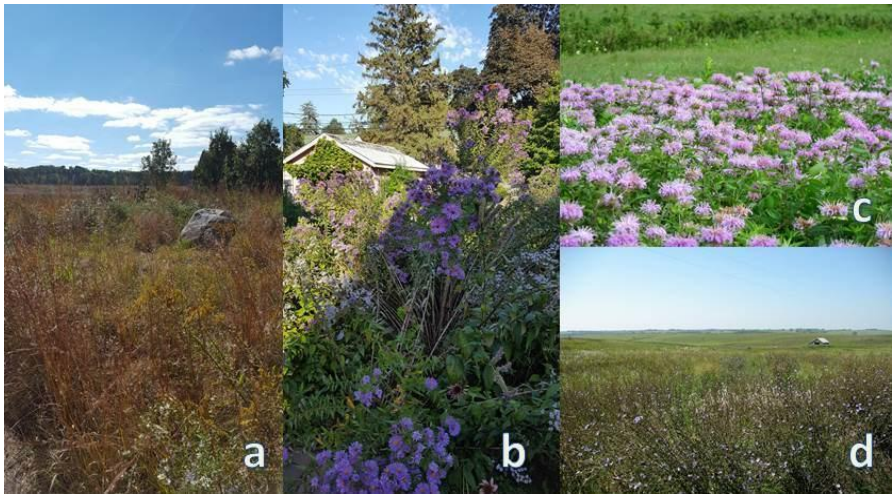
Special note on urban areas: Some of the last refuges for *B. affinis* appear[8] to be in large urban areas, such as Minneapolis/St. Paul, Madison, Milwaukee and Chicago. From a landscape perspective, these cities have a network of natural areas that include parks, greenways, public gardens and other public or undeveloped lands. Interspersed among these natural areas are residential areas - - yards, gardens and boulevards that provide additional sources of flowering plants and nesting/overwintering habitat – and habitat for dispersal (Fig. B2.b). Areas considered high quality habitat in urban areas have the same characteristics as high quality habitat outside of urban areas. They are generally open areas with an abundance and diversity of plants that flower from mid-March through mid-October; that have undisturbed areas without landscaping mulch or landscape fabric; and that are managed with minimal use of pesticides; particularly insecticides and fungicides.

In the urban landscape, high quality habitat is most likely in or near natural areas that support open, or mostly open, habitats such as prairie, savannas, grasslands, or grassland/shrub mix (Fig. B1.a). Small woodlots and the edges of larger tracts of forested lands also provide high quality habitat if located adjacent to areas with abundant flowering plants or have interspersed meadows. These woodlots or wood edges may provide important early spring habitat if they support spring ephemerals or early spring blooming trees and shrubs. Natural areas within urban areas may be in blocks (small or large) or may be linear. In general, the larger the block of contiguous habitat, the higher the quality the habitat is. The value of any of these tracts is higher if surrounding areas also provide flowering plants and some undisturbed areas, such as residential

[8] Some urban areas have been surveyed more than other areas, indicating that there may be a sampling bias. On the other hand, many additional (e.g., rural) areas have been intensively surveyed and have resulted in no/few observations of *B. affinis*.

areas with gardens. The habitat quality of small or linear tracts may be negated if surrounding areas are dominated by roads and buildings with little to no natural areas or gardens.

Roadsides and rights-of-way may provide open habitats (Fig. B1.c), but their value is dictated by the type of vegetation (quality is poor if dominated by grasses) and frequency of mowing or other management actions. Rights-of-way may provide better habitat than roadsides because they are mowed or otherwise maintained less frequently. Rights-of-way may also provide corridors of dispersal, allowing for genetic exchange among sites.



Figures B1 a - d. Examples of high quality habitat and/or connectivity habitat for *B. affinis*; (a) native prairie habitat within an urban landscape, (b) large patch of diverse floral resources within an urban landscape for connectivity, (c) large patch of wild bergamot along a roadside, and (d) open meadow with an abundance of floral resources. Photographs were taken by T. Smith, USFWS (a,b) and Rob Jean, ESI (c,d).

Figures B2 a - b. Examples of questionable habitat for *B. affinis*; (a) area that appears dominated by sod grass (b) predominantly grassy area with little or no floral resources. These areas should be checked for approximately 5 minutes for bumble bee activity during the flight season. If no activity is observed, we would not recommend a survey in these areas. Photographs were taken by Rob Jean, ESI.

Appendix C – Bee Identification

This section lists basic key diagnostics for field identification. These should be documented clearly when using photography survey protocols. For detailed and technical descriptions, see **Bumble Bees of North America: An Identification Guide** by Paul H. Williams, Robbin W. Thorp, Leif L. Richardson and Sheila R. Colla; and Discover Life (http://www.discoverlife.org/mp/20q). Other helpful resources include: http://pollinator.org/PDFs/BumbleBeeGuide2011.pdf, http://www.xerces.org/bumble-bee-identification/ and https://www.flickr.com/photos/usgsbiml/sets/72157664851159091.

Bombus affinis gynes and queens are entirely yellow on the first two abdominal segments; the rest of the abdominal segments are black (Figure C.1). In workers and males, the first abdominal segment is yellow, and the second has a medial patch of rusty hairs on the anterior portion of the segment, with yellow hairs on the posterior portion (Figure C.1). *B. affinis* can vary from pale tan to a bright rusty brown. The other abdominal segments are black. Occasionally, abdominal segments 3-6 may have reddish hairs or a reddish patch.

B. affinis has a mostly yellow upper thorax with a black spot or band that may extend toward the posterior in a v-shape. The bottom of the thorax is black. Queens and workers have black hairs on the head and at the back of the head. Males have black hairs on the head, with some yellow hairs intermixed at the back of the head. Overall, hairs are moderately long and even.
B. affinis is a short-tongued species, and sometimes is observed nectar-robbing on tubular flowers. It has a short face, with cheek (oculo-malar area) slightly shorter than broad.
B. affinis phenology in each region will determine when queens (or gynes), workers, or males will be observed in flight. For example, in southern Wisconsin, *B. affinis* gynes and queens, distinguished by larger size and other characteristics described above, are in flight in spring (roughly mid March - May) and then again in late summer and fall. Workers can be seen in the field several weeks after nest establishment, throughout the summer, into early fall (late June-September). Males are in flight in late summer and fall (August-September).

More difficult to observe, nesting occurs mid - March, April or May through September, and gynes overwinter from August until mid- March, April or May. If you happen to observed activity of *B. affinis* gynes and queens, take notes regarding behavior, habitat use, etc., as nesting and overwintering are little known. Notify FWS as soon as reasonably possible.
B. affinis can be confused with *B. citrinus, B. griseocollis* (Fig. C.3), *B. perplexus,* and *B. vagans*.

Figure C.1. Illustrations of a *B. affinis* queen (left), worker (center), and male (right) by Elaine Evans, University of Minnesota.

Figure C.2. Photographs of *B. affinis* (a) top view, (b) side view and (c) side/top view. Photographs were taken by Dan Mullen (Creative Commons) (a,b) and USGS Bee Monitoring Laboratory (c).

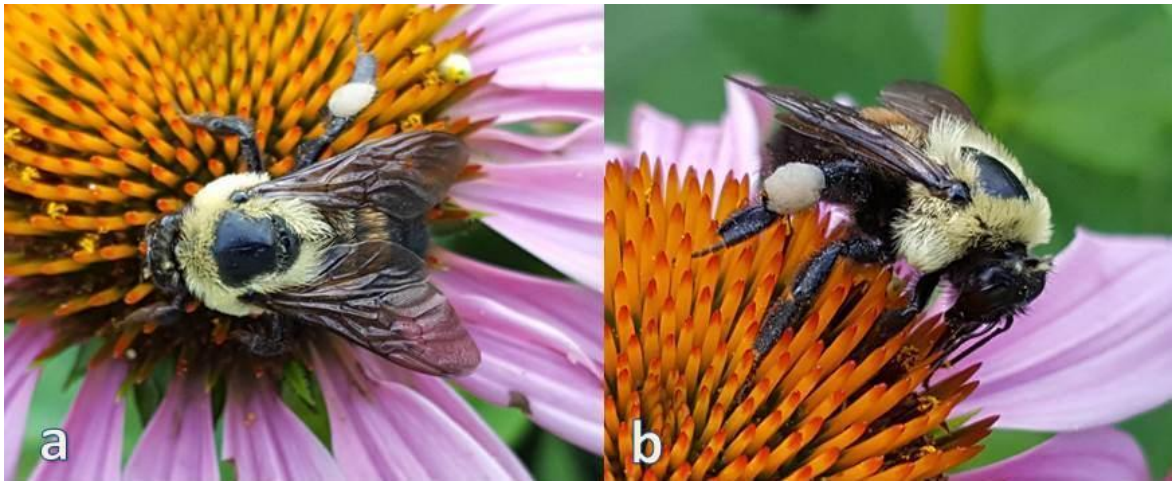


Figure C.3. Photographs of *B. griseocollis* (a) top view and (b) side view, which can be confused with *B. affinis*. Photographs were taken by Tamara Smith, USFWS.

Appendix D - How to Verify Records

- Self verification of species is encouraged and **Appendix C – Bee Identification** (above) provides useful information to help with identification.
- If verification/assistance with identification of potential *B. affinis* observations are requested, the surveyor acknowledges that data may be shared with third parties in order to accomplish this. The USFWS may submit by email the images and county level locations to a qualified expert for identification assistance, or if project information or locations are non-sensitive, the USFWS may submit the necessary information (including photos and locations) to other qualified experts (*e.g.*, BumbleBeeWatch.org). Once species identification has been made, the surveyor will be informed by USFWS of the results. If these requests require a significant amount of time and resources, changes to the protocol may be made.
- Proper documentation - verification requests to the lead field office should include geographic coordinates (decimal degrees) and photos that meet the standards in **Appendix A - Standardized Bee Photography**.

Appendix E - Further Information regarding Survey Effort

Based on a historical data set (Macfarlane 1974, in Colla and Packer 2008), if 150 *Bombus* were collected, the probability of missing *B. affinis* if it were present at historical abundance levels was 5%. In other words, if *B. affinis* is present at historical abundance levels, 150 bumble bees would need to be collected in order to detect the species with 95% confidence (Colla and Packer 2008, p. 1382). Recognizing the declines in abundance, capturing more individuals may be needed to reach this confidence level. We are unaware of similar detection probabilities for timed search surveys for bumble bees, however, based on expert input, we think it is reasonable that at least 1-person-hour of active sampling of 3 acres of high quality habitat, surveyed four times over the sampling season, will be sufficient effort to be reasonably certain that we would detect *B. affinis* if it were present. Other streamlined monitoring protocols recommend using timed transect searches (*e.g.*, Ward et al. 2014), similar to Pollard walks designed for butterfly monitoring (Pollard et al. 1993, entire) to estimate bee diversity and abundance, so we have suggested modified timed-area transect methods as one option for long-term monitoring. Whichever method is chosen, repeated sampling over multiple years will strengthen our confidence in species detections and non-detections. We hope the data collected through repeated surveys will help us develop detection probabilities of *B. affinis* and refine our survey recommendations to maximize efficiency and minimize uncertainty.

Appendix F - About Surveys for Proposed or Ongoing Actions that May Impact *B. affinis*

As a reminder, for those interested in seeking incidental take coverage through Section 7 or Section 10(a)(1)(B) of the Endangered Species Act, it is important to first review the Section 7 or 10 guidance (http://www.fws.gov/midwest/endangered/insects/rpbb/projectproponentsguidance.html) to determine if the rusty patched bumble bee is likely to be present and surveys are recommended for such purposes. The Service considers the rusty patched bumble bee likely to be present only in "**high potential" zones**" as described online indicated in the Section 7 and 10(a)(1)(B) guidance (https://www.fws.gov/midwest/Endangered/insects/rpbb/rpbbmap.html). This survey protocol document includes different voluntary survey protocols for a variety of purposes in high potential, low potential, and unoccupied zones (defined on our website https://www.fws.gov/midwest/Endangered/insects/rpbb/rpbbmap.html).

To determine if *B. affinis* may be in an action area, action agencies or project proponents may screen projects online via the USFWS's Information for Planning and Conservation website (IPaC, https://ecos.fws.gov/ipac/), or contact the USFWS Ecological Services Field Office for their area. If this screening indicates that a project is within an area where the rusty patched bumble bee is likely present (*i.e.*, the High Potential Zone), action agencies and others should coordinate with their state's USFWS Ecological Services Field Office (FO). An online directory of USFWS FO(s) is available at http://www.fws.gov/offices/.

If a project action area is within an area where *B. affinis* is likely present ("High Potential Zones", defined below, https://www.fws.gov/midwest/Endangered/insects/rpbb/rpbbmap.html), an action agency or project proponent may choose to conduct a survey to verify presence (note that negative surveys cannot verify absence with 100% confidence, but can at best predict likelihood of occupancy). The results of a survey, if they are negative and are carried out in accordance with FWS-recommended survey protocol (*i.e.*, Project Review Protocol), would indicate that the species would not be exposed to stressors associated with the action area. Project Review Protocol recommends one sampling season of surveys with sufficient effort[9] to support a determination that the species is not likely present in the portion of the action area surveyed. Although not required for project review, repeat sampling events in the same areas (if still suitable) for at least 3 consecutive years are advisable if you are trying to be reasonably certain that the species no longer occupies the area.

[9] Sufficient effort would consist of four approximately equally spaced sampling periods during the sampling season (early June to mid-August); one-person hour of search time per three acres of suitable high quality habitat (defined below) using non-lethal netting techniques. This document provides further details on methods, techniques, and best practices and is subject to continual improvement and modification.

Note that surveys should be conducted within a year before the project is initiated for negative survey results to remain valid throughout the duration of the project 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 FWS field office (https://www.fws.gov/offices/) should work together to ensure that the best available information is considered.

If an action agency or project proponent chooses to conduct a survey to verify presence or absence, we recommend that they and their surveyors develop a proposed survey strategy in coordination with the USFWS FO(s) so that all parties fully understand which methods will be deployed, what assumptions will be made, and what the various outcomes would be based on the survey results. If not already required by federal permit, we recommend that survey results are submitted (negative or positive) to the USFWS FO(s) in the state(s) where the surveys took place. We strongly encourage this coordination as it improves the USFWS' understanding of (1) the level of survey effort underway and (2) the distribution of the species.

CALIFORNIA BUMBLE BEE ATLAS

Participant Handbook- 2022

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Introduction

Bumble bees are charismatic and easily recognizable insects due to their large size and distinctive hair color patterns, usually featuring contrasting yellow, black, red, and white stripes. As plant pollinators, they play an important role in maintaining ecosystem function and crop production.

*Figure 1. Black tail bumble bee (*Bombus melanopygus*) queen nectaring at buttonbush (*Cephalanthus occidentalis*). Photo: L. Richardson.*

In recent years, the importance of pollinators and their contribution to the agricultural economy has been recognized, as has their vulnerability, in large part because of widespread losses of bees. Declines of both managed and wild bee populations are alarming, yet until recently, reports of declines in managed hives of the introduced western honey bee due to pathogens, pesticide exposure, and other stressors has dominated news coverage. Equally important, but less well understood or publicized, is the parallel decline of native bee populations, particularly bumble bees. A recent study led by the IUCN Bumble Bee Specialist Group, supported by studies led by Dr. Sydney Cameron, and a status review by Dr. Robbin Thorp and the Xerces Society, demonstrate that around ¼ of North America's approximately 50 species of bumble bees are undergoing worrying population declines. Some of these species, including Franklin's bumble bee (*Bombus franklini*) and the rusty-patched bumble bee (*B. affinis*), may already be on the brink of extinction.

The causes of these declines are not fully understood, but the following likely play a role: loss and fragmentation of habitat, pesticide exposure, climate change, overgrazing, competition with honey bees, low genetic diversity, and perhaps most significant, the introduction and distribution of bee pathogens into the environment from commercial pollinators. Regardless of the ultimate cause of bumble bee declines, protecting existing habitat and creating and maintaining new habitat are some of the most immediate and productive steps that can be taken to conserve these important pollinators. This will require widespread participation and collaboration by landowners, agencies, and scientists. The Xerces Society and others have already begun this effort, but more work is needed.

In addition to habitat, we need a better understanding of where these animals are living in order to conserve them, and to protect habitat in the best places. While there is a gross understanding of bumble bee distributions in California, more detailed and current information will generate better conservation recommendations. The state is home to around 25 species of bumble bees, and several of them face an uncertain future. The western bumble bee (*B. occidentalis*) has declined dramatically, especially in the western portion of its range, and species like Morrison's bumble bee (*B. morrisoni*) and Suckley cuckoobumble bee (*B. suckleyi*) appear to be in decline.

The California Department of Fish and Wildlife and the Xerces Society have partnered to support bumble bee conservation through a statewide community science project to collect

information on the distribution of the state's native bumble bees. This project builds on successes of the ongoing Pacific Northwest Bumble Bee Atlas undertaken by the Xerces Society and its partners in Washington, Oregon, and Idaho, which has provided important baseline information on the status of bumble bee populations. The missing partner is you—become a community scientist and join us! California is a large state with a diversity of bumble bee habitats, so we need many trained community scientists equipped with cameras and nets to survey its bees, collecting high-quality data about their occurrence and releasing them unharmed.

We invite citizen scientists to join in the project:

1. Register for the California Bumble Bee Atlas at our website and sign up for a Bumble Bee Watch account.
2. Familiarize yourself with our protocols. The best way to do this is by attending a training.
3. Pass a short quiz to be added to The Xerces Society's Scientific Collecting Permit.
4. Adopt a grid cell - you can do this alone, or with a group of friends or family (bumblebee watching is more fun with friends!).
5. Survey for bumble bees in your grid cell. Please visit your adopted grid cell twice (or more if you are willing!) per summer and use our standardized protocol (see pp. 15-19) to collect data about bees and their habitats.
6. Submit your data online using our website and Bumble Bee Watch.

What you will need to participate:

1. Transportation to your grid cell (or choose an area in which you live or work).
2. Insect net, collection vials, and a chilled cooler.
3. A smartphone or camera to take high quality pictures.
4. Access to a computer or smart phone where you can upload photos to Bumble Bee Watch and track your progress.

What is helpful to participate:

1. Basic knowledge of wildflowers and where to find them!
2. Local plant identification field guides.
3. Bumble bee field guides (Bumble Bees of North America)

Bumble Bee Biology

Bumble bees are social insects that live in family groups with a division of labor, where most bees do not produce their own offspring, instead benefiting when related individuals—mainly the queen—successfully reproduce. Bumble bee colonies are similar to those of honey bees, except that they are usually much smaller (50-500 individuals as compared to 10,000+) and lack highly developed "eusocial" behavior such as ability to communicate direction and distance to food sources outside the nest. Bumble bees have an annual rather than perennial colony cycle, persisting through just one growing season and not needing to store honey and pollen for consumption during winter, as is the rule with honey bees. The only bumble bees that survive into winter are queens produced the previous growing season and who have mated and stored sperm through hibernation. These bees emerge from hibernation in spring, foraging for pollen and nectar while searching for nest sites. Nests are often located underground in abandoned rodent nests, or above the ground in tufts of grass, old bird nests,

cavities in dead trees, and under rock piles.

After the queen finds a nest site, she builds irregular cells known as “pots” from wax secreted from glands on her abdomen. After provisioning these structures with nectar and pollen, she lays eggs on a pollen mass and begins to incubate eggs and the larvae that grow from them. The queen divides her time between foraging trips, incubation, and egg laying over the next 4-5 weeks, until emergence of the first adult offspring. These newly emerged adult females, known as workers, become the colony’s workforce to gather nectar and pollen. The queen now stays in the nest, where workers care for her as she attends to her sole responsibility, laying eggs.

*Figure 2. A captive common eastern bumble bee (*Bombus impatiens*) nest, with queen and worker-caste bees tending larvae and pupae. Photo: L. Richardson.*

At some point, depending on the species and habitat conditions, the colony switches from producing non-reproductive workers to rearing reproductive members of the colony, the new queens (also known as ‘gynes’) and males. After leaving the nest, newly emerged queens usually mate with one male, then consume nectar and pollen in preparation for winter. Following environmental cues, the mated queens create shallow hibernacula belowground in which to spend a period of dormancy. The remainder of the bees in the natal colony, including the foundress queen, die before winter.

In general, bumble bees forage on a diverse group of plants, although individual species may show preferences for certain plants due to floral architecture or other factors. For example, some bumble bees have long tongues and preferentially forage on plants such as penstemon and monkshood that have longer corolla tubes. By contrast, species with short tongues tend to forage on smaller flowers with an open structure, such as sunflower and asters. In addition, short-tongued bumble bees will engage in “nectar robbing” from flowers with a long corolla tube by biting holes at the base of the corolla and drinking the nectar from the outside of the flower. While this behavior causes damage to flowers and appears to be antagonistic, outcomes for plants are variable, and some bumble bees are pollinators of the plants they “rob” of nectar in this way.

Studies of flight distance show that bumble bee species vary in how far they typically forage from the nest, with estimates ranging from 275m (900ft) to 750m (2,460ft, nearly 1/2mi.), considerably further than most other native bees. Some bumble bees have been shown to fly as far as 10km when displaced from the nest, but such foraging distances are probably unusual. Body size has been shown to be positively correlated with bee flight distance, so larger bees tend to be able to forage further from the nest than smaller. Presence of high quality foraging habitat near the nest may reduce the distance bees must fly to forage, but numerous studies have shown that bumble bees may avoid foraging on resources close to the nest, perhaps in an effort to avoid nest detection by predators. Overall, theory predicts that

bumble bees should seek to minimize the costs associated with foraging while maximizing the return of calories.

Bumble bees evolved in cold, montane areas of central Asia, and many species' current distributions reflect this climate affinity, as they occupy higher latitudes and elevations compared to other bees. Their large body size and tendency to be densely hairy allow bumble bees to forage at cooler temperatures than many other bees can tolerate. In addition, they are warm-blooded, and can raise their body temperature well above ambient conditions, allowing foraging, brood care, and other behaviors below the thresholds at which other bees may be active. These adaptations allow certain California bumble bee species (e.g., high country bumble bee; *Bombus kirbiellus*) to tolerate the extreme cold found at high elevation in the Sierra Nevadas and other mountains. By contrast, other bumble bees have adapted to life in warmer, drier environments, and some of these are typical in low elevation California ecosystems. Taken together, this diversity of life history contributes to high species diversity in California, where 25 bumble bee species are native. The purpose of this project is to collect information on all of the state's varied bumble bees to produce a better understanding of their habitat and conservation needs.

Project Design

To conduct the California Bumble Bee Atlas we divided the state into approximately 250 grid cells of equal size (50 km x 50 km or 2,500 km^2). We used a stratified random sampling process to select 200 of these grid cells as priorities for survey in the first year of the Atlas. To do this, we first made a random sample from the map, then, for some cells, either removed or retained them due to patterns of historical bee collection activity, land ownership, or other factors. We are asking volunteers to adopt one of these grid cells, then visit it to conduct two or more surveys for bumble bees over the growing season (March-September, depending on location). We may adjust the grid cell map after the first year of the project in order to guide volunteers to surveying in areas of outstanding need. In addition, we provide volunteers the flexibility to instead survey along road transects or haphazardly in any area when they see and photograph bees.

Tracking Your Efforts

First, thank you so much for participating in this project. We are thrilled to have you on board and could not do this important work without your help. Because community scientists are such an integral part of this project, we would like to know all about your efforts—what does it really take to gather this information? We're working hard behind the scenes to provide you with the resources you need to make this project successful, but also want to be able to talk about the amazing efforts of our volunteers as they travel throughout the region capturing and identifying bumble bees. Because of this, we ask that you track your efforts and share them with us when you submit your data—thanks!

How to Participate

Step 1: Register

1. You will need a Bumble Bee Watch account to participate. If you do not yet have one, please create an account. It takes about five minutes. When registering for an account, please be sure to select California Bumble Bee Atlas as your project at the bottom of the page. This will help us keep track of user participation and data for the project.
2. If you already have one, head over to Bumble Bee Watch (www.BumbleBeeWatch.org) and register for the California Atlas Project. Once you've logged in, click on your username at the top of the page "Welcome, username". This will take you to your profile page. In the upper left of that page, click "edit". Here you can edit your contact information, email address and other details. At the bottom of the page you can also select a project. In that box, select **California Bumble Bee Atlas**, and then click " save." You are all set!
3. **In either case, please make a note of your Bumble Bee Watch username and password. You will use these credentials throughout the project.**

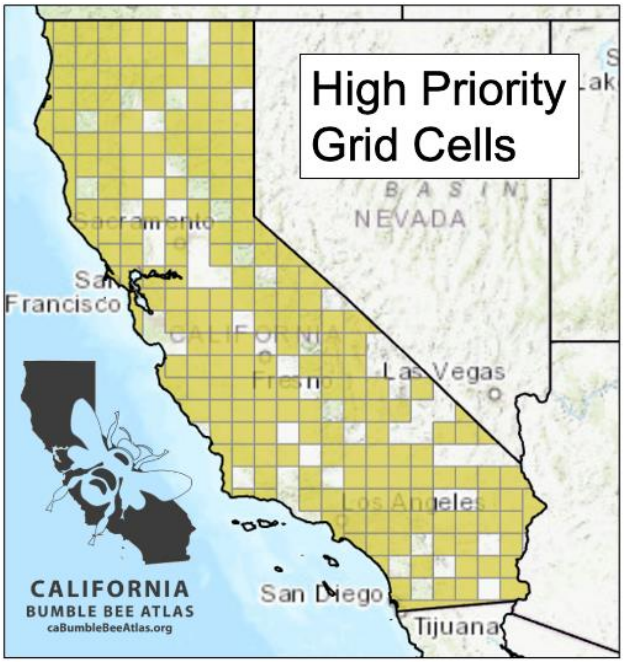

Figure 3. Map of California Bumble Bee Atlas priority grid cells.

Step 2: Training

Before beginning your work, you must attend a training with project staff. In spring 2022, we are offering a number of these training opportunities via remote webinar, and we will hopefully be able to present in-person trainings later in the project. You can find more information and register to attend a training on our website: https://www.cabumblebeeatlas.org/events.html.

We strongly encourage participants to attend a live training. However, if you cannot attend one of our scheduled webinars, you can watch a prerecorded version (links found here: https://www.cabumblebeeatlas.org/training-modules.html) at your own pace. And, much of the information presented in the training may be found on the project website or in this manual.

Step 3: Scientific Collecting Permit

The California Department of Fish and Wildlife (CDFW) requires a Scientific Collecting Permit (SCP) for handling of species on their list of Terrestrial Invertebrates of Conservation Priority, which includes six bumble bee species. This regulation helps ensure that research activities like ours are conducted in a manner that reduces impacts to these sensitive invertebrates while providing information that can aid their conservation. The Department issued The Xerces Society an SCP which allows trained volunteers to handle bumble bees as part of the California Bee Atlas. All you need to do is to review information about the permit conditions (e.g., by attending or watching prerecorded training workshops: https://www.cabumblebeeatlas.org/training-modules.html), then take a short quiz which demonstrates that you understand the environmental compliance concerns we have for handling of sensitive bumble bee species, as well as working around other sensitive wildlife species and their habitats (https://docs.google.com/forms/d/e/1FAIpQLSfZH9Mlz8rzIqwuUjGn19wyXOFXo7qwMMwHd_NnNMrjHdLrMw/viewform). Once you have passed the quiz, Xerces will send your information to CDFW. Once approved, Xerces will notify you and provide a copy of the permit. Please read through the permit upon receipt. You will also need to keep a digital or paper copy of the permit with you while you survey.

Step 4: Adopt a Grid Cell

Before you start work, you'll need to "adopt" one or more grid cells in which you agree to collect bumble bee data for the project. Adopting a grid cell means that you have agreed to conduct at least two surveys each year in that cell for bumble bees using our standardized protocols. To meet this requirement, you can visit two different locations within your cell on the same day, or revisit the same location on two different days. It's okay if two or more volunteers adopt the same cell.

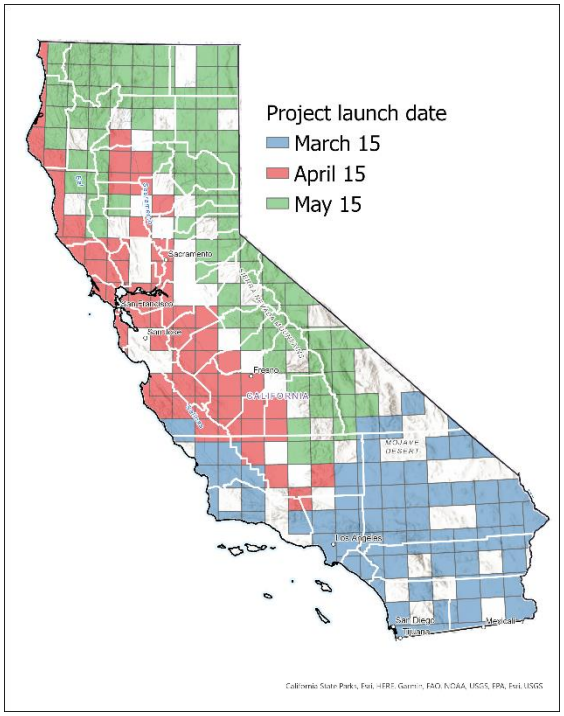

Figure 4. Launch dates for the Atlas vary by location, and are designed to maximize the abundance and diversity of bees in our surveys.

Please use the interactive map and sign-up form at the project website to find and adopt your grid cell: https://www.cabumblebeeatlas.org/adoptagrid.html. Also please note that due to the diversity of bumble bee habitats around the state, we are launching the project on three different dates, depending on latitude and elevation (Figure 4). Surveying on or after these dates will give you the best chance to document the full diversity of species present in your chosen grid cell, as well as protect queen-caste bees in early spring as they initiate nests.

Step 5: Conduct a Survey

Plan your visit

The best places to survey for bumble bees are areas that have an abundance and diversity of flowering plants. This can include grasslands, roadsides, developed parks, open forests, and coastal vegetation. Please note that availability of floral resources for bumble bees varies across the growing season, so you'll need to consider seasonality, ongoing drought, and other factors as your plan your field work. High quality bumble bee habitat may be found on both public and private lands. When selecting a site to survey, ensure that you have permission to conduct your activities. Unless you have explicit permission from a private landowner, stay on public lands and public rights-of-way (roadsides). Note that some public lands require a permit for research activities; this includes National Parks and National Monuments as well as California State Parks. Other public lands require a letter of access, such as regional park districts as well as ecological reserves or wildlife areas owned by the California Department of Fish and Wildlife. If you lack a permit, you are allowed to photograph a bee on a flower, but you cannot net or handle them. If you find yourself in this situation, you may want to consider submitting "incidental" survey data, which requires only photos of the bees, which do not need to be captured.

This list includes areas where permits may not be needed (though be sure to check with the appropriate authorities before surveying):

- Your backyard
- U.S. Forest Service land
- BLM land
- Local parks
- Natural Areas or open spaces
- Public beaches
- Roadsides (please practice safety along roads)

If you don't already have a location in mind when you adopt your grid cell, we encourage you to take some time to investigate the different areas contained within it. Grid cells are large with varied habitat, terrain, and land ownership. Although you can survey anywhere in the grid cell for bumble bees, taking time to select potential locations and access routes will help decrease travel time while maximizing the time you can dedicate to bumble bee surveys. We suggest you start with the project map, Google Maps, Apple Maps, Google Earth, or other maps that utilize aerial photography to flag potential sites and plan travel routes. Getting familiar with your sites using maps will also help you when it comes time to submit your data; accurate locations are important!

Here are a few mapping resources to help you plan your trip (**Note:** we do not guarantee the accuracy of any of these resources):

- Project map (created using Google My Map): https://www.google.com/maps/d/u/0/edit?mid=1F16oY52iNJWptb9UmeX0AGGn4yii0gaf&usp=sharing
- Google Earth: https://earth.google.com/web/
- Apple Maps: https://www.apple.com/maps/
- Open Street Map: https://www.openstreetmap.org/#map=5/39.309/-124.893&layers=Y
- Gaia GPS: https://www.gaiagps.com/map/?loc=5.0/-119.5751/37.3685&layer=GaiaTopoRasterFeet

- USGS Topo Maps – available from outdoor retailers and as digital downloads
- DeLorme State Atlas & Gazetteer Paper Maps

Check road conditions! Be sure to consult with locals about road surfaces and do not always rely on GPS or Google/Apple Maps for travel planning. For example, many roads on Forest Service lands are narrow dirt single tracks with limited turn-around space. They may also require high clearance vehicles. They are sometimes trafficked by logging trucks. Due to these conditions, they may increase the time needed to reach locations. Please use care and caution when driving on roadways that are new to you.

Environmental Compliance

As a California Bumble Bee Atlas volunteer it is important that you collect your data without impacting sensitive natural resources, including both bumble bees and other organisms that may be protected by state or federal law. As described above, Xerces has been issued a Scientific Collecting Permit by CDFW which will include the names of all trained volunteers. We will cover all of this material in the training workshop you attend, and you'll need to pass a short quiz about the safe survey methodology before CDFW can add your name to the permit. In general, we ask that you be aware while conducting field work of the potential for rare, threatened, or endangered species to occur in the area where you are working, and that you avoid potential impacts to them. There may also be sensitive or rare natural communities, such as vernal pool and certain types of wetlands, that we need to avoid impacts to. As a general rule, please tread lightly as you conduct your surveys. In addition, you will need to consider the following environmental compliance concerns.

Eagles—both bald and golden eagles are state and federally protected (Figure 5), therefore we want to ensure that our bumble bee surveys do not negatively impact them. Eagles incubate their eggs and fledge their young during the prime bumble bee surveying season. Loud noises or human presence can cause them to abandon their nests. If you encounter a nest during the courtship (December—January) or breeding season (April—August), move to a new site that is at least 1 mile from that location. If you encounter a nest during after the breeding season (Figure 6; September—November), you should move 0.5 miles away. Because it is hard to know whether an eagle might be present at a site, it is best practice to always select a back-up location or two when planning your survey visit just in case you happen to encounter an eagle nest. For details on specific sites or more information, please contact Dylan Winkler: Dylan.winkler@wildlife.ca.gov.

Figure 5. The golden eagle (left) is a large brown raptor whose range covers all of California. Adult bald eagles (right) have distinctive white heads, while juvenile bald eagles have a more mottled white and brown appearance. The bald eagle is present in most of California featuring bodies of water (ocean, rivers, and lakes). It is absent from swaths of the Central Valley and eastern desert regions (e.g., Mojave). Photo credits: USFWS; M. Thomson.

Figure 6. Eagle nests are often made of sticks or small branches. Golden eagle nests are most commonly found on cliffs but can also occur in trees or on human-made structures. Bald eagle nests are most often found in treetops high off the ground. Photo credits: NPS; USFWS.

Rabbit Hemorrhagic Disease—Rabbit Hemorrhagic Disease, Virus Serotype 2 (RHDV2) is a virulent and highly contagious disease of lagomorphs, the mammal group including rabbits and their relatives. RHDV2 is documented to afflict domestic and wild rabbits, jackrabbits, hares, and possibly pikas. Mortality rates of 5-80% of wild rabbit populations have been reported. To comply with our Scientific Collecting Permit, we must incorporate safety measures into our field work to slow the spread and help inform disease tracking and management actions.

RHDV2 can be transmitted through contact with an infected lagomorph or its blood, feces, or contact with contaminated objects. The virus is hardy, and can remain viable on meat, fur, clothing, or equipment for up to 15 weeks. **RDHV2 does not pose a health risk to humans** or non-lagomorph animals, however, humans and other animals can inadvertently spread the virus.

To avoid spread, follow these three safety measures when out in the field:

1. Report observations of unexplained mortality of wild lagomorphs here:
a. https://wildlife.ca.gov/Conservation/Laboratories/Wildlife-Health/Monitoring/Mortality-Report
2. Do not touch, move, or salvage live lagomorphs, their carcasses, or feces.
3. Disinfect boots and any gear that touched the ground using a fresh 10% bleach solution when moving from one field site to another, particularly if you work in an area of known RHDV2 occurrence or encounter sick or dead lagomorphs. This is always important as it also reduces the spread of soil-borne pathogens like the fungus responsible for sudden oak death. Look up recent reports before you go into the field:
a. https://usda-aphis.maps.arcgis.com/apps/webappviewer/index.html?id=37791da88ef04cd08404a5794aaf0be3

Useful links:
https://www.cdfa.ca.gov/AHFSS/Animal_Health/RHD.html
https://www.aphis.usda.gov/animal_health/downloads/rhdv-cleaning-guidance.pdf

Conduct your survey

Before you head out on your survey, let someone know your travel plans, including expected return time/date. When surveying, please follow all rules, regulations and posted signs; respect private property and take all necessary safety precautions. You can find some helpful videos for this process here: https://www.cabumblebeeatlas.org/training-modules.html.

Unfortunately, despite your best planning, it is possible that conditions when you arrive are not optimal. We encourage folks to be flexible and opportunistic while staying within their assigned grid cell. As such, bring resources with you to help with navigation, including printed maps as cell service is not available in many parts of the California.

What you need to bring:

- Paper maps
- Insect net
- Insect vials
- Small cooler with ice or ice packs
- Water, food, sunscreen, hat
- Timer (smart phone or watch)
- Camera with macro capacity (smart phone or dedicated camera)
- Data sheets and pencil/pen
- Water, food, sunscreen, hat

What you may want to bring:

- Field guides (bees and plants)
- Hand lens
- Field notebook
- Friends!

Step 5: Submit your data

In the field, for each point survey, you will complete separate forms to document 1) the sites and habitats where you collected; and 2) the bees you observed in them. Now, you'll transfer this information to our website for curation of project data, Bumble Bee Watch. The most efficient way to enter your data is through our website (https://www.bumblebeewatch.org/app/); you can also enter data for more simplistic "incidental" observations using Bumble Bee Watch mobile apps, available from the Android and Apple stores. The data entry process is summarized here, and you can find more detail on our website: https://www.cabumblebeeatlas.org/submit-data.html.

Figure 7. From the Bumble Bee Watch homepage, select "Record a sighting" to begin uploading your data.

1. Curate your photos and gather your data. Make sure you know which photos belong to each individual bee you recorded on your field forms. You may submit up to five photos for each bee record; please include a photo of the host plant if possible as one of these five!
2. Login to Bumble Bee Watch.
3. Choose Record a Sighting -> Bumble Bee Sighting. Choose "California Bumble Bee Atlas" as your project from the drop-down menu.
4. Enter site/habitat information from your Rapid Habitat Assessment Form (Figure 8). This information is referred to as a "checklist" in Bumble Bee Watch. Note that required fields are marked with an asterisk (*). Click "save."
5. When you are done with habitat information, for each bee you collected during this survey, upload up to 5 photos, provide a species identification, and specify the host plant (Figure 9). If you don't know how to identify bumble bees, use site tools and the field key at the end of this document to make your best guess (we'll verify this later). Click "add another" to add more bees. When you have added all bees from this survey, click "save."

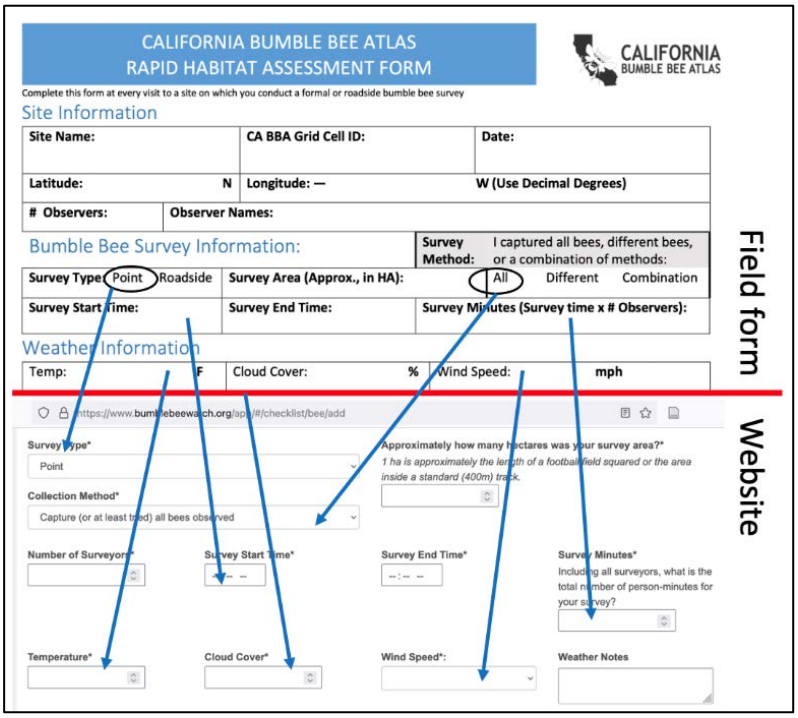

Figure 8. How to transcribe site or habitat information from your field form (top) to Bumble Bee Watch online (bottom). Arrows connect the same fields in both contexts. Additional fields not shown.

6. If you need to edit either your checklist (habitat information) or observed bees, you can do this by clicking "Welcome, <your name>" at the top of any page on Bumble Bee Watch, then scrolling to the list of checklists.

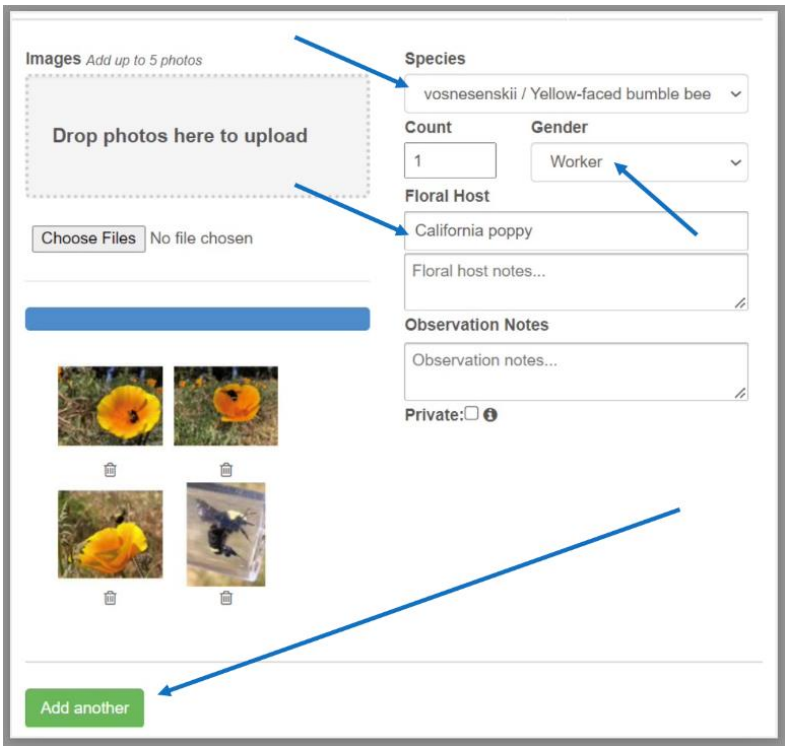

Figure 9. Upload photos of bees and their host plants. Blue arrows indicate some key fields you'll need to fill in.

7. Please don't forget to fill out the "survey effort" portion of this process! Your volunteer labor is a significant contribution you make to bumble bee conservation, and we'd like to be able to periodically report summaries of volunteer efforts to our funding agencies.
8. For incidental observations (photos of bees made outside of formal point or roadside surveys; see below), at #3 above, choose "Bumble Bee Watch" as your project name (*not* California Bumble Bee Atlas). Follow directions for data entry and photo upload. This is a simplified process and you won't need to have collected extensive field notes. Don't worry, we'll make sure this incidental data makes it into our project.

Survey Methods

Survey Timing and Conditions

Bumble bees are generally active from March through September depending on the habitat, species, and weather. Some species may be active earlier, and some may be active later. But, since the goal of this project is to get a better understanding of the distribution of all species in California, we're targeting the middle of the season for field surveys: **May, June, July, and August**. In some locations it may be appropriate to survey earlier or later than that, which is why we open grid cells starting in March. Nevertheless, in most places the best timing will be between May and August. Bumble bees prefer warm sunny days to forage, so please survey on sunny (or mostly sunny days) between 60°F and 90°F. Conditions much hotter, cooler, or cloudier will likely result in reduced bumble bee activity. Bumble bees will also avoid very strong winds, so focus surveys on days with low winds. The best sites to find bumble bees will be open (non-forested) areas with an abundance and diversity of flowering resources.

Point Surveys

Point surveys are our standard surveys and will provide high quality bumble bee data from any survey area. These surveys are 45 person-minutes and will need to take place in an area around the size of a hectare (2.5 acres). This means that if you are alone you will survey for

45 minutes. If you brought one friend, you will survey for 22.5 minutes, and if you brought two friends, you will survey for 15 minutes, etc. You will also need to plan for time to conduct a habitat assessment on each visit to gather habitat information about the site that you surveyed and the surrounding area at each site.

Phase 1: Plan your survey area

Surveys should cover approximately one hectare or 2.5 acres (100m x 100m or 328' x 328'). This does not have to be a square, but could be 20 m x 500 m along a roadside or any other similar area configuration. Mark the center of your location on a map (either paper or smartphone app). This will be very important later for data submission, please document the location of each survey accurately! See the videos on our website to help you get thelatitude and longitude information. These will need to be in decimal degrees.

Phase 2: Fill out the data sheet

This will include date, time, surveyors, location, and basic weather information (approximate temperature, cloud cover, wind, etc.). See the data sheets for more detail.

Phase 3: Begin your survey

Note the start time of your survey, start the timer and begin searching for bumble bees. While looking for bumble bees you should wander through the entire survey area, focusing on plants that are flowering. Focus on ALL flowering plants, not just those that are most abundant or showy. Because of many reasons different bumble bees are sometimes attracted to different species of flower. When you find a bumble bee, capture it into a vial (either directly or using an insect net), note the plant species that it was visiting, and place the vial in a chilled cooler. I like to put a petal of the flower into each vial to remind me which species of flower it was visiting when I record my data later. Alternatively, use a small piece of paper, a grease pencil etc. to document and connect each bee to its flowering plant. Be sure to keep bees from different flowers also separated in the cooler so you remember later. Take a picture of each plant (include flowers and leaves) for later confirmation or identification. There are several wildflower smartphone apps focused on the California flora that can help you in the field, and there are many other resources available (see https://www.cabumblebeeatlas.org/project-resources.html) Continue in this fashion for 45 person-minutes (count only time searching for bumble bees) or until you have run out of vials. If you run out of vials, stop the timer and continue to Phase 4, and then return to Phase 3 for the remaining amount of time. When your time is complete, note the end time of your survey.

Phase 4: Document each bumble bee

After bees are cooled for a period of time (several minutes) they will slow enough to allow you to photograph them. You can do this using the provided photo chamber, or directly on another surface (see Figure 10). Using a camera or smartphone take clear, in-focus pictures of the each bee's head, thorax, and top and bottom of the abdomen (maximum of 5 photos for each bee). We offer some photography advice on the project website: https://www.cabumblebeeatlas.org/photography-tips.html. Be sure to document how many photos you take of each bee, and note the file names on the Bumble Bee Data Sheet. Also, make note of the species of flower on which the bumble bee was captured if applicable, or note otherwise (e.g. nest searching, patrolling). After you photograph the bumble bee it may

still be a bit sluggish and may take some time to warm up.Place in the shade and it will slowly acclimate and be on its way. Continue in this fashion until you have documented each individual bumble bee. If you have time remaining on your survey, return to Phase 3, otherwise continue to Phase 5.

Figure 10: Different options for photo documenting bumble bees. The bee on the left has been in a chilledcooler, while the one on the right may have been collected directly from a flower.

Phase 5: Collect Habitat Information

Spend some time walking around your site collecting the data for the Rapid Habitat Assessment. Take photos of each plant, as well as an overview of the overall habitat.

Phase 6: Complete Documentation

Ensure that all data sheets are complete and that you have collected all necessary habitat information. While it might be tempting to leave some of this information for later, or when you get home, taking the time to do it while on site will reduce errors and increase the quality of the data you collect.

Phase 7: Submit your data

See steps 5-7 above (pp. 14-15) for assistance. You can find more advice on data submission on our website: https://www.cabumblebeeatlas.org/submit-data.html.

Roadside Surveys

Roadside surveys are a common way to document bumble bee abundance and species richness, and have been used in a standardized way in other regions on the country (MN, VT, ME). They are also a great way for most anyone to participate, as they often do not require walking long distances or over uneven terrain. However, roadside surveys are also not perfect (no method is) as each individual survey is significantly shorter, and our roadsides tend to get crowded with non-native plants. As one of the goals of this project is to better understand the needs of our SGCN bumble bees, finding which native plants they are using is a priority. Roadside surveys may not be a perfect format to learn that specific information, but will still contribute to our understanding of bumble bee distribution and habitat needs. Roadside surveys can be conducted en route (or in return) from a formal survey site, or on their own,

but should take place within a grid cell that has been adopted by someone in your party. Again, be sure to follow posted signs and regulations; please respect private property and if necessary obtain permission from the landowner.

Phase 1: Plan your route

Select a stretch of road that is at least 10 miles long. Ideally, the stretch of road would have several obvious open patches when looking at aerial photos/maps.

Phase 2: Begin survey

Once you arrive on your selected route stop at the first patch of available flowers that you observe (park carefully and follow local regulations and general safety precautions). Observe the flower patch – if you observe bee activity, begin the survey. If there is no bee activity, proceed to the next patch of flowers and repeat.

Before you begin the survey, fill out the top of the datasheet (site and weather information). Be sure to include the start and stop times. A roadside survey is 15 person-minutes long. Start your timer and capture bumble bees into vials. While looking for bumble bees you should wander from flower patch to flower patch in the roadside area. Focus on ALL flowering plants, not just those that are most abundant or showy. Because of many reasons, different bumble bees are sometimes attracted to different species of flower. Be sure to document the species of flowerthat each bumble bee was visiting (you can use a small label, a grease pencil, or a sample of the flower placed in the vial). Place each bee into a chilled cooler.

Phase 3: Record bumble bee data

Once the 15 minute period is over, record each individual bee on the Bumble Bee Survey data sheet and photo document each individual following the tips here: https://www.cabumblebeeatlas.org/photography-tips.html. Be sure to write the corresponding photo file names for each individual.

Phase 4: Collect habitat data

Fill out the Rapid Habitat Assessment Form for each roadside stop. Take a picture of each species of blooming plant, as well as the overall habitat surveyed.

Phase 5: Repeat

Drive at least 1 mile down the road and then find another patch of flowering plants at which to conduct a survey and go back to Phase 2. Each Roadside survey should consist of five fifteen minute surveys within a ~10 mile stretch of road.

Phase 6: Submit your data

See steps 5-7 above (pp. 14-15) for assistance. You can also see guidance on our website: https://www.cabumblebeeatlas.org/roadside-surveys.html.

Rapid Habitat Surveys

At each location that you conduct a bumble bee survey (point or roadside) you will need to conduct a habitat survey. This information will help us to understand what kinds of landscape features are important for bumble bees. The habitat survey should take between10 and 30 minutes to complete. Habitat surveys will be longer for point surveys where eachindividual survey area is larger. Each roadside habitat survey will be a bit shorter. The Rapid Habitat Survey form appears at the end of this document, and may be downloaded from our website: https://www.cabumblebeeatlas.org/project-resources.html

Phase 1: Fill out the site and weather information

Use a GPS device and/or smartphone to gather weather information and locality. If you don't have access to weather in the field, you can gather weather from a nearby weather station later. See https://www.cabumblebeeatlas.org/project-resources.html for guidance.

Phase 2: Gather Habitat Information

1. Choose a primary habitat type of the survey area from the list provided, as well as the habitat types of the surrounding area.
2. Walk the entire survey area and estimate how much of the survey area has blooming plants.
3. Count the number of blooming species of plants (include trees and shrubs) you observe.
4. Look for habitat features noted on the datasheet – these are often associated withbumble bee nesting locations.
5. Do your best to assess the management activities in the area.

Phase 3: Document the species of plant in bloom.

Document each species of blooming plant. Remember that if possible, we'd like you to submit a photo of the host plant with each separate bumble bee observation you upload to Bumble Bee Watch.

Phase 4: Submit your data.

See steps 5-7 above (pp. 10-15) for assistance. You can also see guidance on our website: https://www.cabumblebeeatlas.org/help.html.

Alternative Survey Options

Incidental Observations

In addition to the formal surveys described above, incidental surveys or bumble bee observations can also help to our understanding of bumble bee distributions in California. They are more casual, and could occur anywhere, and at any time. These surveys are also appropriate for National Parks, and other areas where capturing bumble bees without a permit is prohibited—follow local regulations. You might be in your adopted grid cell, or 100 miles away from it. Nevertheless, and especially now that you have caught the bumble bee watching bug, you may observe bumble bees visiting flowers and decide to stop and take a picture. These observations will not take the place of formal surveys, but they will help fill in information gaps in California.

Incidental observations/photos can either be *in situ* (directly on a flower) or in a vial/photo chamber. Submit only photos that are in-focus with enough detail to determine the species in the photo (see https://www.cabumblebeeatlas.org/photography-tips.html). Please remember that all observations for the project need to be photo documented to count. Including information (and a photo if possible) about the plant on which you observed the bee is also

very helpful.

Considerations:

- With incidental observations, you do not need to submit an observation of every bee you take at each location. Include only the best photos of each species (but see bulletpoint below). If you are not sure if photos are different species or not, err on the side of including too many observations.
- Include observations of the same species of bee visiting different species of flowers –that is great information to have.
- Do your best to identify the species of flower that the bumble bee was visiting. See https://www.cabumblebeeatlas.org/project-resources.html for resources.
- If you have a smartphone you can enter these observations directly into Bumble Bee Watch using the app.

Resources

Books and Literature:

Droege, S. October 2015. The Very Handy Manual: How to Catch and Identify Bees and Manage a Collection. Available from: https://ecos.fws.gov/ServCat/DownloadFile/152039?Reference=101509.

Goulson, D. 2009. Bumblebees: Behaviour, Ecology, and Conservation. Oxford UniversityPress. 336 pp.

Hatfield R, Jepsen S, Mader E, Black SH, Shepherd M. 2012. Conserving Bumble Bees. Guidelines for Creating and Managing Habitat for America's Declining Pollinators. Available from https://www.xerces.org/publications/guidelines/conserving-bumble-bees (accessed March 14, 2022).

Koch JB, Strange JP, Williams PH. 2012. Bumble Bees of the Western United States. USDA Forest Service and the Pollinator Partnership.

Stephen WP. 1957. Bumble bees of western America (Hymenoptera: Apoidea). Corvallis: Agricultural Experiment Station, Oregon State College.

Thorp RW, Horning DS, Dunning LL. 1983. Bumble bees and cuckoo bumble bees of California (Hymenoptera, Apidae). University of California Press.

Williams, P.H., R.W. Thorp, L.L. Richardson, S.R. Colla. 2014. Bumble Bees of North America: An Identification Guide. (Princeton Field Guides). Princeton University Press. 208pp.

Project Websites:

California Bumble Bee Atlas: CABumbleBeeAtlas.org
Pacific Northwest Bumble Bee Atlas: PNWbumblebeeatlas.org
The Xerces Society for Invertebrate Conservation: xerces.org

Other websites:

- Google Maps with Overlaid Grid (you will be able to find the grid number of youradopted cell to help you plan a trip)

Social Media:

Join our Facebook Group: https://www.facebook.com/groups/cali.bumblebees

Follow us on Twitter: https://twitter.com/cabumblebees
Follow us on Instagram: https://instagram.com/cabumblebees/

CALIFORNIA BUMBLE BEE ATLAS
RAPID HABITAT ASSESSMENT FORM

CALIFORNIA BUMBLE BEE ATLAS

Complete this form at every visit to a site at which you conduct a POINT or ROADSIDE bumble bee survey

Site Information

Site Name:	**CABBA Grid Cell ID:**	**Date:**
Latitude: **N**	**Longitude: —**	**W (Use Decimal Degrees)**
# Observers:	**Observer Names:**	

Bumble Bee Survey Information:

Survey Method:	I captured all bees, different bees, or a combination of methods:

Survey Type: Point Roadside	**Survey Area (Approx., in HA):**	All Different Combination
Survey Start Time:	**Survey End Time:**	**Survey Minutes (Survey time x # Observers):**

Weather Information

Temp: **F**	Cloud Cover: **%**	Wind Speed: **mph**

Habitat Information

Survey Area Circle the most appropriate habitat type (**CHOOSE 1**).	**Habitat Types**	**Examples**	**Surrounding Area (Visible)** From the **Habitat Types**, list (up to) the top three habitat types visible from most to least abundant.
	Grassland / Meadow	*Meadow, open, grasses dominant*	
	Woodland / Forest	*Trees dominant, and in the over-story*	
	Shrub / Scrub	*Arid, shrubs present, and abundant*	
	Agricultural Lands	*Crops, pasture, orchard, etc.*	1
	Riparian Areas	*Along lake or stream*	2
	Developed / Roadside	*Sub/urban areas; parks/gardens; roadsides*	
	Wetland	*Bogs; marsh; saturated earth*	3

How much of the **survey area** has flowering resources available? (Circle one closest match)

0 10% 20% 30% 40% 50% 60% 70% 80% >=90%

Nesting Habitat

Choose which of the following features you see in or near the survey area:

- ☐ Bunch grasses
- ☐ Rodent holes/tunnels
- ☐ Brush piles
- ☐ Bare soil
- ☐ Leaf litter
- ☐ Pine needle duff layer
- ☐ Rock piles

Management

I see evidence of, or know that the following have occurred in or near the survey site:			
Mowing	Yes	No	Suspect
Livestock grazing (animals, cow pies, hoof prints)	Yes	No	Suspect
Native grazing (animals, deer/elk scat, hoof prints)	Yes	No	Suspect
Agriculture	Yes	No	Suspect
Insecticide use	Yes	No	Suspect
Herbicide use	Yes	No	Suspect
Fire (circle one: *controlled burn* or *wildfire* - circle)	Yes	No	Suspect
Honey bee hives (inc. number of hives _____)	Yes	No	Suspect

Notes:

CALIFORNIA BUMBLE BEE ATLAS
RAPID HABITAT ASSESSMENT FORM

Complete this form at every visit to a site at which you conduct a POINT or ROADSIDE bumble bee survey

Plant Species in Bloom

How many different species of flower (incl. trees and shrubs) are in bloom **in the survey area**? (Circle closest match)			
1-2	3-5	6-10	>10

Document each species of currently blooming plant that you see in the survey area – including trees and shrubs. Use plant identification field guides, and take pictures of the flowers and leaves of each species. If you are uncertain, give the plant a generic name, and be sure to photo document for later identification. Use second sheet if needed.

Bumble Bee Visited?	Plant Common Name	Plant Scientific Name	Photo #/timestamp
☐			
☐			
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Volunteer Data

What time did you start and stop volunteering on the day of this survey? Include planning, taking photos, recording data, driving, etc.	Start time:	Stop time:
How many miles, round trip, did you drive to conduct your survey?		miles
How many hours did you spend organizing your data? Photo organization, entering data in Bumble Bee Watch, etc.		hours

CALIFORNIA BUMBLE BEE ATLAS BUMBLE BEE SURVEY DATA SHEET

Complete this form for every site that is surveyed

Date data entered:_____By:_____

CALIFORNIA BUMBLE BEE ATLAS

Survey/Weather Information

Site Name:	**CABBA Grid Cell ID:**	**Date:**	**Survey Type: Roadside Point** (Circle One)	**Temp: F**
Latitude: N	**Longitude: —**		**W (Use Decimal Degrees)**	**Wind Speed: mph**
Observers:			**Total # Observers _____**	**Cloud Cover: %**
Start Time:	**End Time:**	**Survey Minutes:**	**Total Person Minutes:** (# Obs. X Survey Min.)	
Primary Survey Method:	☐ Captured all observed bumble bees	☐ Focused on capturing bumble bees that looked different than those already caught		
Notes:				

Bumble Bee Observations

Entered in BBW	Bumble bee species	Host plant	Photo #s/timestamp
☐			
☐			
☐			
☐			
☐			
☐			
☐			
☐			
☐			
☐			

CALIFORNIA BUMBLE BEE ATLAS BUMBLE BEE SURVEY DATA SHEET

Complete this form for every site that is surveyed

Date data entered:_____By:_____

CALIFORNIA BUMBLE BEE ATLAS

Entered in BBW	Bumble bee species	Host plant	Photo #s/timestamp
☐			
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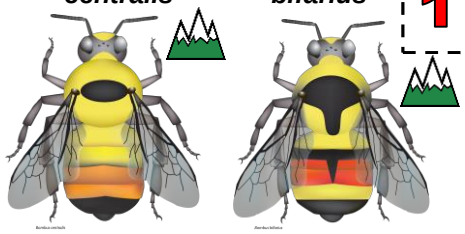
Use a second data sheet if you need to.

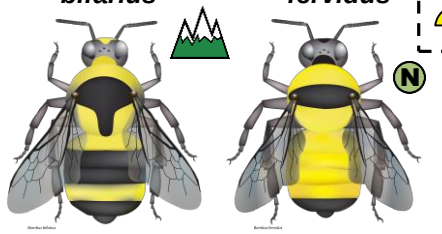
California Bumble Bee (*Bombus*) Females

XERCES SOCIETY for Invertebrate Conservation

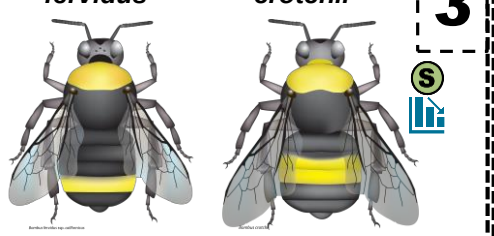
1



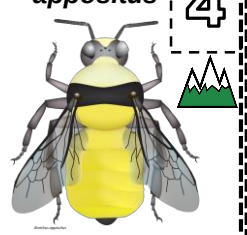
2



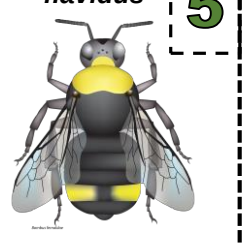
3



4



5



Color pattern groups

1. **Red** hair present
2. Stripes + **T1 yellow**
3. Stripes + **T1 black**
4. **White** hair present
5. Cuckoo bumble bees

Symbols used in key:

- Montane
- Pacific Coast
- N — Northern CA
- S — Southern CA
- Declining

CALIFORNIA BUMBLE BEE ATLAS
caBumbleBeeAtlas.org

V.1, July 2021

Identifying the Bumble Bees of California

1. Determine whether you are looking at a male or female bumble bee (see **Figure 1**).
2. Next, determine whether your bee is a “true” or a “cuckoo” bumble bee. Most bumble bee females have a concave, hairless pollen-carrying area (corbicula) on the hind leg (**Figure 2**, left panel), while in cuckoo species this area is convex and hairy (right panel). Legs of males are more difficult to tell apart, but generally, cuckoo male legs are hairier than true male bumble bee legs.
3. Hair color patterns: Page 1 of this guide shows typical color patterns for female bumble bees found in California. Examine the hair color on the front and top of the face, the thorax, and the six abdominal segments (‘Terga,’ abbreviated as ‘T’ on the first page). Caution, many species have variable color patterns, and males are not depicted here! Make sure to consult a field guide too!
4. Beyond color patterns, useful identification marks are: cheek length (relative to width; **Figure 3**), wing color, placement of simple eyes on the head, and presence of sternal hairs (**Figure 4**).
5. Symbols indicate *recent* distribution of species and/or individual color morphs with strong affinities for particular habitats/regions, as well as *known* patterns of decline. Expect to also find bees outside of the areas indicated!

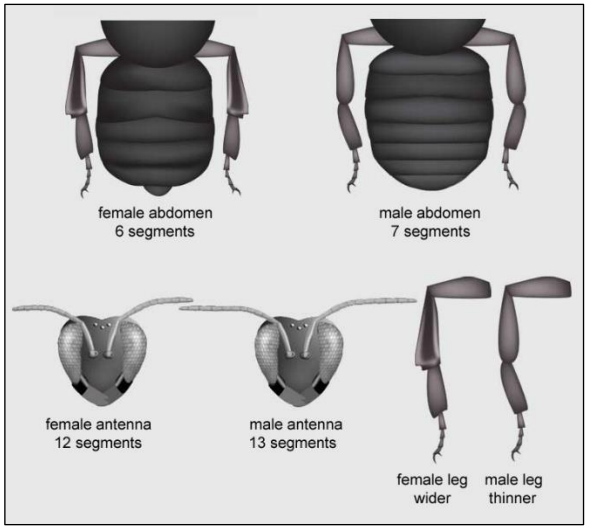


***Figure 1**: Characteristics of male vs. female bumble bees. Illustrations by Elaine Evans, the Xerces Society*

***Figure 2**: Hind legs tibial segment of true (left) vs. cuckoo (right) bumble bees. Photos Sam Droege:, USGS Bee Inventory and Monitoring Lab.*

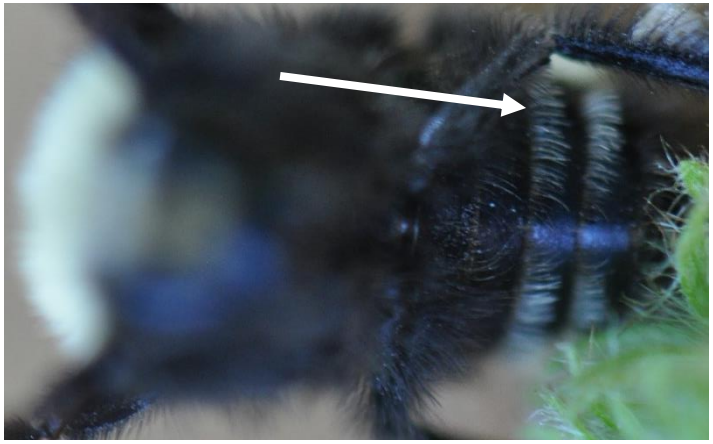


***Figure 4**: Note the yellow hairs on the sternal (underside of the abdomen) segments. Similar species have black hairs in that location. Photo by Rich Hatfield, the Xerces Society.*

***Figure 3**: Cheek Length. The bee on the left has a long cheek and the bee on the right has a short cheek. Photos: Rich Hatfield, the Xerces Society.*

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