



# Making and Managing Wild Bee Hotels

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## Quick Facts

- Bee hotels are popular additions to Utah backyards and commercial agriculture.
- About 30% of Utah's roughly 1,100 native bee species are solitary, aboveground cavity nesters, and hotels can provide additional nesting sites.
- Mason bees and leafcutter bees are common hotel guests that are important pollinators of many orchard and vegetable crops.
- The vast majority of native bees are nonaggressive to humans, including hotel nesters.
- Use non-treated wood and natural materials in your bee hotel, and frequently replace nesting materials to limit the buildup of bee pests and diseases.
- Regularly observe hotel visitors to learn whether it is helping or harming its intended bee guests.



**Fig. 1.** Bee Hotels Can Be Creative, but All Require Regular Maintenance



**Fig. 2.** Common Hotel Residents Include Leafcutter Bees (e.g., *Megachile*, left) and Mason Bees (e.g., *Osmia*, right)

## INTRODUCTION

Bee hotels (also called “bee boxes” and “bee blocks”) (Fig. 1) are popular additions to Utah backyards and commercial agriculture alike, adding nesting habitat to aid local pollination efforts and address native pollinator declines. Common hotel residents include various species of mason bees (predominantly *Osmia*) and leafcutter bees (mainly *Megachile*) (Fig. 2). Mason bees are among the earliest spring pollinators and include the blue orchard bee (*O. lignaria*), which is prized for its superior pollination of many orchard crops, while leafcutter bees are active in summer and include the commercially managed alfalfa leafcutter bee (*M. rotundata*) and many native species that are important crop and garden pollinators. Hotels can contain other bee species such as small carpenter bees (*Ceratina*), wool-carder bees (*Anthidium*), and resin bees (*Heriades*, *Dianthidium*). Beneficial solitary wasps (e.g., *Isodontia* grass-carrying wasps) that are enemies of garden pests can be additional hotel nesters. Hotels can also attract bee enemies, including parasites, predators, and pathogens, and problems can arise when these and other unwelcome guests take up residence or exploit nest resources. Fortunately, many simple

and effective ways exist to make and manage healthy bee-nesting habitat. Strive to provide a 5-star experience for your targeted guests by regularly maintaining your hotel, and in return, reap outsized rewards from these small but mighty pollinators.

## CONSTRUCTION

### Exterior

The exterior of your bee hotel can be made from various materials such as untreated wood, cinder blocks, plastic buckets, or cut PVC pipe. Include an overhanging roof to protect nest materials from rain, or place it under the protection of a preexisting structure. Only use wire when a predator problem exists, as wire can injure bee wings.

### Nesting Tubes

Tubes should be breathable, removable, thick-walled, and have one closed end. They can be made from various materials that are scavenged locally, purchased, or handmade. Consider the preferred

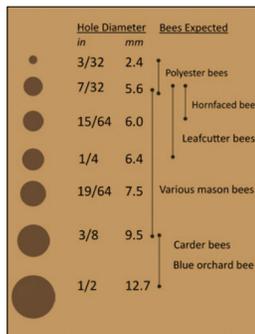
nesting material of the bees you are trying to attract, and offer the same. Avoid using glass or plastic (including straws and PVC) for nesting tubes, as plastic holds moisture and encourages fungal growth which can cause bee mortality.



**Fig. 3.** Nesting Tubes With Staggered Entrances and Added Color

Tightly pack tubes and nesting blocks into the hotel frame, and avoid fillers such as pine cones, moss, bark, and pine needles which bees will not use but can attract spiders, pollen mites, earwigs, and other harmful opportunists. Since bees use visual cues to locate their nests, stagger tube entrances and vary their sizes, or add a bit of color among the tube faces (Fig. 3) to help bees locate nests more quickly and to decrease unoccupied nest attacks. Note, however, that excess patterning can confuse bees. Allow ample time for paint or stain to dry before placing your hotel, as the odors can repel bees.

**Sizes:** Adequate tube lengths will better ensure a mixed ratio of female and male bees, as too-short tubes produce predominantly male bees. As a general rule, the wider the entrance, the longer the tube should be. Tube entrances less than 1/4-inch diameter should be 3 to 4 inches deep, and entrances 1/4 inch and larger should be 5 to 6 inches deep.



**Fig. 4.** Tube Diameters for Common Nesting Bees

Mason bees prefer entrances from 1/4 to 3/8 inches in tunnels that are 5 to 6 inches deep, while leafcutter bees prefer slightly smaller holes, ranging from 1/8 to 1/4 inch. Providing interior diameters that range from 5/64 to 3/8 inches will attract a wider variety of bee species throughout the growing season (Fig. 4).

**Grooved trays and wooden blocks:** Wooden grooved boards or trays (Fig. 5) can be purchased or homemade and are recommended as they can be opened to inspect and sanitize and are reusable with annual maintenance. For wooden nesting blocks (Fig. 5), cut an 8-inch or longer piece from an untreated 4-by-4 block for tunnels 1/4 inch or smaller, and drill 3 to 5 inches into the face. Use a 4-by-6 or 4-by-8 block for tunnels greater than 1/4 inch, and drill 5 to 6 inches deep. Attach a secure backing if your tunnel



**Fig. 5.** Nested Wooden Grooved Trays With Liners (left) and Drilled Wooden Block (right)

goes through the back side, as bees will not nest in open-ended cavities. Avoid injuring fragile bee wings and bodies by drilling perpendicular to the wood grain, using a sharp bit at high speed, and smoothing entrances with sandpaper. Use liners in boards, blocks, and trays for a healthier bee habitat.

**Cardboard tubes, paper straws, and tube liners:** Cardboard tubes make good nesting habitat and can be purchased at garden centers or online. Inserting liners can extend their use. Consider using paraffin-coated paper straws or tubes made from parchment paper, as paper alone may wick moisture from the pollen stores. Securely close one end of each tube and tube edges with a small amount of foil tape, wax, hot glue, or something similar. When using liners, ensure a snug fit to deter enemies from entering the interspaces.

**From-Your-Landscape:** A seasoned, dry, short, and wide log can easily be made into a wooden nesting block. Hollow reeds or pithy stems and branches can be purchased or sourced from nature and made into tubes and stem-bundle hotels. Recommended sources include dead stems from large-stemmed asters (*Symphyotrichum*), sunflower (*Helianthus*), yucca (*Yucca*), bee balm (*Monarda fistulosa*), honeysuckle (*Lonicera*), raspberry (*Rubus*), sumac (*Rhus*), teasel (*Dipsacus*), forsythia (*Forsythia*), wild rose (*Rosa*), elderberry (*Sambucus*), and phragmites (*Phragmites*). Ensure tubes are free of cracks and holes, and securely plug one end of each stem or reed with clay, mud, or similar, or cut near a stem node (where a lateral branch or leaf stem juts off the main stem) for a natural plug. Include from 15 to 20 stems in each stem-bundle hotel. Consider planting hollow or pithy-stemmed plants in your landscape for a sustainable tube source, but avoid planting teasel and phragmites, which are largely invasive. Further, note that bamboo nesting tubes are controversial since bamboo's strength compromises safe access to bee cocoons for harvest or inspection. Also, bamboo tube diameters often exceed the recommended range, encouraging wasps and other nontarget species.

## PLACEMENT

Rather than having one large hotel, place multiple smaller hotels in bee-attractive locations. Place hotels off the ground at varying heights up to about 5 or 6 feet, space them widely near flowering plants and a mud source, and face them southeast or east to catch the morning sun. Trim any tall vegetation blocking hotel entrances. Posts, buildings, and isolated trees are good mounting options, but ensure the hotel is secured to the surface and not hanging, and that it is protected from wind, rain, and sprinkler systems. Also protect your hotel's location from drifting pesticide sprays.

## MONITORING

Regularly observe your hotel during various times of day throughout the growing season to determine its beneficiaries. Look for your targeted bee guests and their signature cavity plugs of mud, leaves, or other materials (Fig. 6). Also look for bee enemies



**Fig. 6.** Mason Bees' Mud-like Caps (left) and Leafcutter Bees' Vegetative Caps (right)

(Figs. 7 and 8), including:

- Predatory and parasitic wasps;
- Food or brood thieves (“kleptoparasites”) such as pollen mites, Sapygid wasps, and “cuckoo” bees;
- Predators such as birds, rodents, spiders, beetles, ants, and earwigs; and
- Molds, bacteria, viruses, and fungi, including chalkbrood, a common and fatal fungal pathogen resulting in white, chalky brood.

If spiderwebs are present, check that your hotel receives morning sun and is not in a dark location, and relocate if necessary. If earwigs are a problem, consider placing sticky barriers around the hotel access areas, but use caution as bees can get blown onto the barriers. Also look for sharp-tailed bees (*Coelioxys*), common leafcutter bee parasites easily identified by their pointed abdomen.



**Fig. 7.** Hairy-Fingered Mite Infestation (white material) on Pollen Loaf (left), and Chalkbrood in a Nesting Tube (right)



**Fig. 8.** Hotel-Nesting Bee Enemies Include Species of Wasps (e.g., *Pteromalus venustus*, left) and Cuckoo Bees (*Coelioxys* sp., right)

## MAINTENANCE

### Overwintering

**Remove nesting material:** When bee activity ceases in late autumn or after the first frosts (or by early summer if you are exclusively raising mason bees), remove the nesting tubes and blocks from your hotel for inspection and overwintering. Moving the hotel later in autumn (November or December) allows bees to more fully develop and has been associated with producing heavier (thus healthier) adults in the summer-nesting alfalfa leafcutter bee, but a later move also increases exposure to enemies. Dislodged bees can starve when moved too early in their development, so move tubes gently with capped ends facing up.

**Inspect:** Inspect tubes for damage such as cracks and holes which can indicate the presence of bee enemies and necessitate opening for closer examination.

**Store:** Your hotel may overwinter in its outside location if it remains dry and protected from the elements, but it will be at greater risk for harm from predation, parasitism, and overheating. Note that a refrigerator should not be used to overwinter leafcutter bee nests, which are identified by leaf-capped tube ends.

- Place nesting materials in an unheated garage, shed, or similar area that is protected from moisture, wind, direct sun, and predators such as birds and rodents.
- Store tubes with the capped ends facing upwards to effectively position young bees atop their food source.
- Cover cardboard tubes with sawdust or vermiculite during storage for control of parasitic wasps and other enemies.

### Replacing Nesting Materials

Timing is important when cleaning or replacing nest structures, as acting too early in the spring risks disturbing viable cocoons and acting too late risks disturbing new eggs. Address this issue (and others) by phasing out nesting materials.

In early spring, secure the overwintered hotels and nesting materials inside a dark container (an “emergence box”) and cut a 3/8-inch (about 1 cm) hole near the bottom for the bees to crawl out. Move the box near the hotel’s original outdoor location, and place fresh nesting materials nearby. The emerging bees will crawl toward the hole’s light and escape, but the hole’s small size discourages reentry. Providing new nesting materials nearby gives bees ready access to clean nesting sites. If you are hosting many unknown bee species, keep the nest materials inside the emergence box for an entire year or two, as a second year may be warranted when nests are from species that take up to two winters to emerge (parsivoltine). In Utah, *O. coloradensis* and *O. montana* are common parsivoltine species.

- Discard and replace tubes, paper straws, tube liners, and all stems and reeds annually once bees have emerged.
- Discard and replace nesting blocks at least every two years, even when using inserts.
- Thoroughly disinfect grooved boards and trays annually before reinstating them for use (see “Cleaning” section).
- If you must reuse nesting tubes, have two sets: one for the overwintered bees in various stages of spring emergence and the second placed near the first set for the new nesting generation. Clean the first set with the bleach solution (see “Cleaning” section) and pipe cleaners once its bees have emerged (look for exit holes in the tube caps), and inspect each tube again when placing them the following spring.
- For mason bee nests in orchard crops, in early summer, place the newly sealed nesting tubes in a mesh bag in a sheltered

location to prevent parasite attacks. Tubes can remain outside in a protected location or unheated shelter above 36 °F.

## Cleaning

Cleaning can occur once bees have emerged (look for exit holes in tube caps), which can be from spring (mason bees) into summer (leafcutter bees). Most nesting tubes cannot be sufficiently cleaned and sanitized and should be discarded after bees emerge, but wooden blocks may be used for an additional year if sanitized. Grooved wooden boards and trays can be disassembled, scrubbed, and sanitized before being offered as new nesting sites each year. Also clean field shelters annually.

- Clean tunnels in wooden nesting structures by re-drilling to loosen debris, then soaking in a bleach solution of 1 part bleach to 2 parts water for 5 minutes. Small lumber kilns can also be used for sanitizing.
- If chalkbrood is present, dispose of the old nests, as the viable fungal spores are difficult to remove. Minimize bee stressors, second-generation nesters, nest crowding, high moisture levels, and cool temperatures, all of which can exacerbate chalkbrood's occurrence.

Become familiar with the various types of bees in Utah by reading the Zesiger et al. (2021) and Wilson & Carrill (2019) publications (see "References" section) and learn who benefits from your hotel. Throughout spring and summer, check your hotel often for signs of moisture and bee predators and parasites. When next fall arrives, repeat your maintenance routine, once again striving for that perfect guest experience.

## REFERENCES AND FURTHER READING

Arapahoe County Extension. (n.d.). *Bee hotel resources*. Colorado State University.

Baker, A. M., & Potter, D. A. (2020). Invasive paper wasp turns urban pollinator gardens into ecological traps for monarch butterfly larvae. *Scientific Reports* 10, 9553.

Barthell, J., Frankie, G., & Thorp, R. (1998). Invader effects in a community of cavity nesting megachilid bees (Hymenoptera: Megachilidae). *Environmental Entomology* 27, 240-247.

Brokaw, J. & Isaacs, R. (2017). *Building and managing bee hotels for wild bees* [Bulletin E-3337]. Michigan State University Extension.

Cane, J. H. (2015). *Gardening and landscaping practices for nesting native bees* [Fact sheet ENT-175-15]. Utah State University Extension and Utah Plant Pest and Diagnostic Laboratory.

Crown Bees. (n.d.). DIY – *How to make a solitary bee house*. <https://crownbees.com/blog/diy-how-to-make-a-solitary-bee->

house/#:~:text=Types%20of%20Nesting%20Materials,-The%20solitary%20bees%20and%20wasps

Crown Bees. (n.d.). *Capped-end guide for cavity-nesting bees*. <https://crownbees.com/capped-end-guide-for-cavity-nesting-bees/>

MacIvor, J. S. (2017). Cavity-nest boxes for solitary bees: A century of design and research. *Apidologie* 48, 311-327.

MacIvor, J. S., & Packer, L. (2015). 'Bee hotels' as tools for native pollinator conservation: A premature verdict? *PLoS ONE* 10: e0122126.

Mader, E., Spivak, M., & Evans, E. (2010). *Managing alternative pollinators: A handbook for beekeepers, growers, and conservationists*. SARE Handbook 11.

Mader, E., Shepherd, M., Vaughan, M., & Guisse, J. (2013). *Tunnel nests for native bees: Nest construction and management*. The Xerces Society for Invertebrate Conservation.

Mason, L., Sayre-Chavez, B., O'Brien, C. O., & Seshadri, A. (2022). *A beginner's field guide to identifying bees*. Colorado State University Extension.

Mull, A., Gunnell, J., Hansen, S., Ramirez, R., Walker, A., Zesiger, C., & Spears, L. (2022). *Factors contributing to bee decline* [Fact sheet ENT-235-22-PR]. Utah State University Extension.

Project Eleven Hundred. (2021). *Protecting native bees*. Retrieved August 2, 2022 from <https://www.projectelevenhundred.org/>

Shepherd, M. (2018). *Nests for native bees*. The Xerces Society for Invertebrate Conservation.

Tepedino, V. J., Parker, F. D., & Durham, S. L. (2022). Mixed diapause duration in cohorts of four species of *Osmia* bees (Megachilidae) along an elevation and temperature gradient in Northern Utah (USA). *Journal of Apicultural Research* 61, 4.

Utah State University Extension. (n.d.). *Bees and other pollinators*. <https://extension.usu.edu/pests/bees/>

Wilson, J. S. & Carrill, O. M. (2019). *The bees in your backyard: A guide to North America's bees*. Princeton University Press.

Xerces Society for Invertebrate Conservation. (n.d.). *Wild bee conservation*. Xerces.org.

Zesiger, C., Cohen, E., Jarvis, H., Spears, L., & Ramirez, R. (2021). *Beginner's guide to common native bees*. Utah State University Extension.

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