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Megachilid Bees in the Pacific Northwest: An Introduction

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Figure 1. An alfalfa leafcutting bee (*Megachile roduntata*) foraging on alfalfa
Photo: USDA Agricultural Research Service Bee Biology and Systematic Laboratory

Although the European honey bee (*Apis mellifera*) is perhaps the most well-known pollinator of home gardens and commercial farms, over 4,000 other species of bees are also found in North America. The Pacific Northwest boasts a wide diversity of these lesser-known bees, including bumble bees, sweat bees, mason bees, and leafcutting bees. These other species can be more efficient than honey bees at pollinating certain flowers, such as alfalfa (Figure 1) or red clover, and are estimated to pollinate approximately $3 billion worth of fruits and vegetables in the United States. This publication describes the Megachilidae family of bees, a large and diverse group of bees found in the Pacific Northwest, and highlights two important members of the family: leafcutting bees (genus *Megachile*) and mason bees (genus *Osmia*). Because these bees play a major role in pollinating both common garden plants and economically important crops, knowing more about them and how to protect and encourage them can benefit gardeners and farmers alike.

The Megachilidae family

Species in the Megachilidae family are found throughout the world. There are over 200 different species in the Pacific Northwest alone. Megachilid bees are solitary, meaning they do not share nests, and there is no social hierarchy or division of labor among individuals. Rather, each female mates, builds her own nest, and is in charge of providing food for her larvae. While females of some megachilid species

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Figure 2. All megachilid bees are solitary, but not all are "loners"—some like close neighbors and feel right at home in human constructed nests, like this orchard bee nest (A) or leafcutting bee nest (B). Many megachilids are opportunists that may also use natural holes, such as this *Megachile mendica* female provisioning her nest in a dead maple snag (C). Photos: (A) Dale Calder, CC BY-NC-SA 2.0, (B) Sandra DeBano, © Oregon State University , and (C) Randy Tindall

Figure 3. In contrast to megachilids, most bees, like this *Stenotritus pubescens*, collect pollen on their legs.

Photo: USGS Bee Inventory and Montoring Lab

dislike having close neighbors, females of other species may nest near each other or share the same nest entrance (Figure 2). However, regardless of the proximity of their nest to neighbors, all females build and provide food for their own nest cells.

The way the megachilid female builds her nest depends on the species. Unlike many other solitary bees that dig nesting tunnels underground, megachilid bees find existing cavities in wood, plant stems, or human-made structures, such as walls or pipes, to lay their eggs. Some also build their own nests above ground. The female builds the cell walls of the nest using materials found in the environment. Depending on the species, she may use dirt, pebbles, leaves, petals, or resin. This practice is different from other families of bees that secrete their own substances to build their cells. The female megachilid lays a single egg in its own cell. Inside each cell, she adds a loaf of pollen and nectar collected from flowers to feed the larva.

Another characteristic that separates the family Megachilidae from other bees is that females do not collect pollen on their legs (Figure 3). Instead, pollen is collected in long hairs, called scopa, on the underside of their abdomen (Figure 4, page 3). There are a few megachilid species that do not have scopa, but this is because they parasitize other bees' nests and do not need to collect pollen for their own larvae. These females lay their eggs in the nesting cells of a different bee species. The parasitic larvae develop faster than the larvae of the host species and eat the food intended for the host species.

Leafcutting bees

Leafcutting bees (genus *Megachile*) get their name because females of many leafcutting bee species line their nests with leaf circles that they cut from plants (Figure 5, page 3) using their sharp,

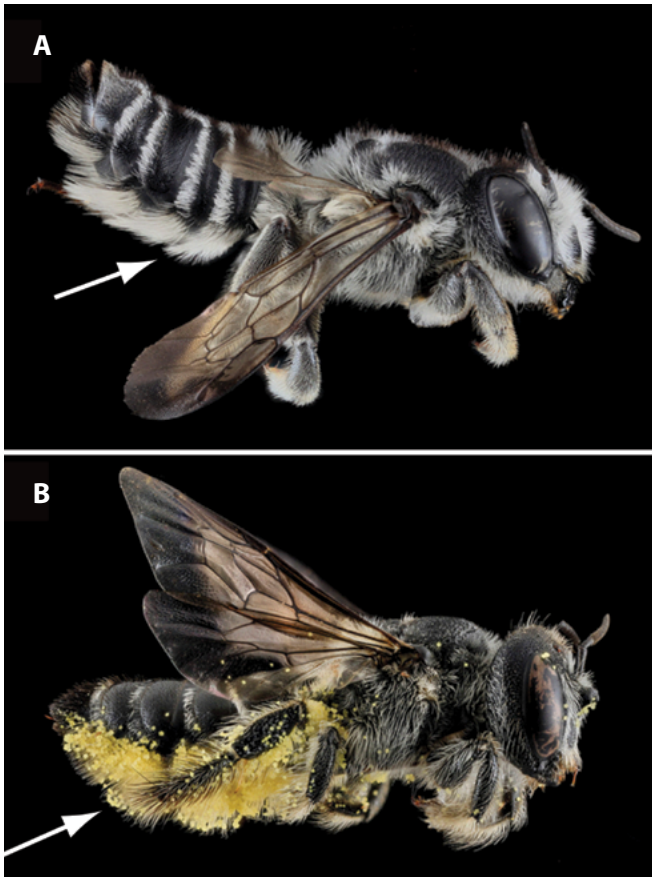

Figure 4. Many species in the Megachilidae family have long hairs on the underside of their abdomen called scopa (A) which they use to collect pollen (B).

Photos: USGS Bee Inventory and Monitoring Lab

toothed mandibles (Figure 6, page 4). There are approximately 1,100 species of leafcutting bees, and they are found all around the world in both temperate and tropical regions. Approximately 40 species are found in the Pacific Northwest.

Life cycle

Although the life cycles of leafcutting bees vary depending on the species, many share a similar pattern. As soon as they emerge as an adult, male leafcutting bees often patrol flowers or nesting sites in search of a mate. After mating, the female finds a convenient hole that can be used as a nesting site. Once she chooses her nest, she begins collecting the bits of leaves necessary to make her nest cells. She is rather picky, choosing thick leaves that are hairless on at least one side. When she finds a suitable leaf, she cuts a circular piece out with her strong jaws (Figures 7 and 8, page 4), and carries it back to her nest. If her leaf source is nearby, this might take no more than a minute. She will keep making trips back and forth until there are enough leaf pieces to cover the walls, floor, and ceiling of the hole. Different shapes are required to completely cover the entire area, but the female keeps track of where she is in the building process and cuts each leaf piece accordingly. She glues the pieces together by smashing the edges so the plant juice comes out. If the leaves are hairy, she places them so the smooth side faces inwards.

Next, in each cell, the female makes a loaf of pollen and nectar, and lays a single egg on top of it. Then, she closes the cell with a few more leaf pieces

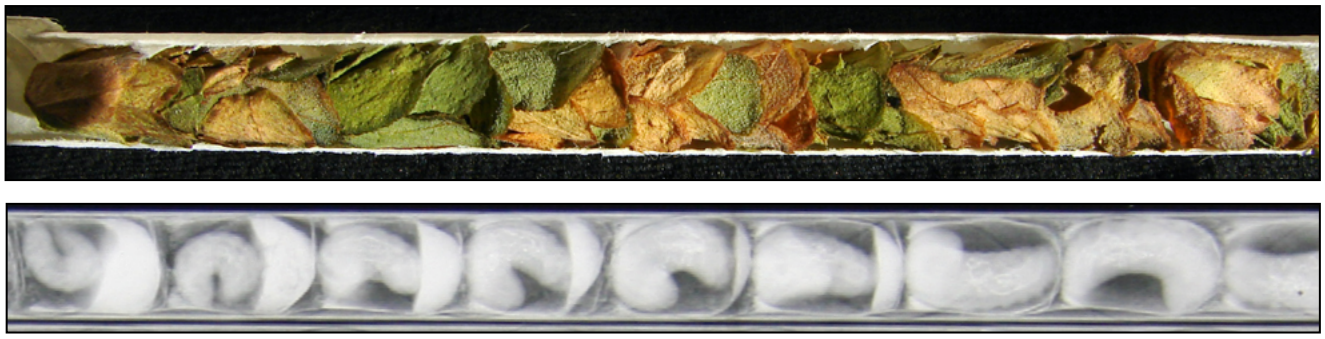

Figure 5. The nest of an alfalfa leafcutting bee showing the leaf wall exposed (top). By using an X-ray, the larvae can be seen inside (bottom).

Photos: USDA Agricultural Research Service Bee Biology and Systematic Laboratory

Figure 6. The mandibles on this female *Megachile melanophaea* are enlarged and toothed to cut through leaves.

Photo: Colby Francoeur, USGS Bee Inventory and Monitoring Lab

Figure 7. A female leafcutting bee chewing off a leaf circle

Figure 8: Once cut, the leaves are carried back to her nest, leaving a distinctive cut pattern on the leaf.

Photos (Figures 7 and 8): Erica Siegel, ©2010

and begins work on the next cell. Interestingly, the female lays the eggs of her daughters in the cells farthest from the nest entrance. This way, males can emerge first and search out females to mate with immediately and, in the process, not disturb the slower-developing females. Most species make approximately 6 to 10 cells per nest. Once the last cell is sealed, the female moves on to make one or two more nests before she dies.

Alfalfa leafcutting bees

Although many different bee species are important for crop pollination, alfalfa leafcutting bees *(Megachile rotundata,* Figure 1, page 1) are one of the most important species of solitary bees to be bred commercially and used by growers to pollinate alfalfa grown for seed. This seed is the prime source of the 25 million acres of alfalfa planted in the United States every year. Though not native to North America, alfalfa leafcutting bees are commonly raised in Canada and then transferred to alfalfa seed fields in the United States because neither honey bee nor native bee populations are large enough to sustain the yields growers require to produce an economically viable crop. Alfalfa leafcutting bees that are used for agriculture are encouraged to nest in "domiciles" or "houses" that consist of wood or polystyrene boards drilled with appropriately sized holes (95 to 150 mm deep, 5 to 7 mm in diameter). The domiciles or houses are placed in blooming alfalfa fields (Figure 9, page 5). Managed populations of alfalfa leafcutting bees are estimated to increase alfalfa seed production by 50 percent.

How to identify leafcutting bees

Most leafcutting bees are about the size of a honey bee (Figure 10, page 5). A good hint that you are looking at a leafcutting bee is to check for the scopa on the bottom of the abdomen. Often, the hairs are very long and thick, and may be white, yellow, or reddish-brown (Figure 4, page 3). When the hairs are loaded with pollen, they are noticeable when the bee is visiting flowers; this aids greatly in identification (Figure 10, page 5). Another excellent feature

Figure 9. Domiciles or houses are placed in blooming alfalfa fields. Managed populations of alfalfa leafcutting bees are estimated to increase alfalfa seed production by 50 percent. Photos: Rusty Burlew

for identifying leafcutter bees is the size of their jaws (Figure 6, page 4). Because leafcutting bees need to chew through leaves, their mandibles are very large and sharply toothed. Some species also have slightly upturned abdomens in comparison with other bees, which helps them collect pollen on their scopa (Figure 4, page 3). Also, take a look around at the vegetation to see if there are any leaves with holes along their edges (Figure 8, page 4).

Mason bees

Another important group of megachilid bees are mason bees (genus *Osmia*). These bees get their name because many mason bee species build their nests with mud and pebbles. There are approximately 300 mason bee species in the Northern Hemisphere, with an estimated 75 species found in the Pacific Northwest. In the United States, native mason bee species are important pollinators of apples, cherries, almonds, raspberries, blackberries, blueberries, pears, and sweet clover.

Life cycle

Mason bees are similar to leafcutting bees in that they usually find existing holes for their nests instead of digging their own. Some species nest in wood or plant stems, while others may nest in human-made structures, empty snail shells, or even build their own nests of mud above ground. Instead of lining their cells with leaf pieces, females of most mason bee species use mud or chewed leaf pulp, sometimes mixed with mud. Like leafcutting bees, female mason bees have thick, strong jaws, which they use to scoop up mud, mold it into a cylindrical shape, and fly back with it to their nests. If they cannot find wet soil, they will often mix dirt with a little of their saliva.

Figure 10. Most leafcutting bees are about the size of a honey bee (A). A way to check if it is a leafcutter is to examine the underside of the bee's abdomen for scopa, which may be covered by pollen (B). Photos: Rusty Burlew

A female mason bee will generally make between 4 to 12 cells per nest, depending on the species, and will lay a single egg in its own cell on a pollen loaf. Unlike leafcutting bees, mason bees will leave the cell closest to the nest entrance empty. This extra space helps to protect the nest from predators and parasites. The female seals the nest with a mud plug that the offspring chew through when they emerge

from pupation in spring. Females mate soon after leaving their nest, and then begin to search out a space for their own nests.

Blue orchard mason bees

One of the most well-known species of mason bees is the blue orchard mason bee (*Osmia lignaria*, Figure 11), which is often used for pollinating fruit crops such as apple, pear, and cherry. They are efficient pollinators of these fruit species, commonly transferring more pollen than honey bees. As with the alfalfa leafcutting bee, blue orchard mason bees often nest near each other and readily accept human-made nesting sites (Figure 9, page 5), making them ideal pollinators of commercial and home-garden crops.

How to identify mason bees

Mason bees are usually smaller than leafcutting bees and have shorter, rounded abdomens. In the United States, they are generally dark black and metallic looking, although some species can be iridescent shades of blue and green (Figure 12). Many do not have obvious bands of hair along the top side of their abdomen. Their exoskeleton is punctiform, meaning that it looks like it is covered with many small indentations (Figure 12).

Conserving and encouraging megachilid bees in the garden and farm

Pesticides and bees

The effect of pesticides on bees has been a long-standing concern. Most bee poisonings in the Pacific Northwest are caused by pesticides that are both highly toxic and remain toxic in the environment for more than 8 hours. These pesticides belong to a variety of chemical families including organophosphates, carbamates, neonicotinoids, and pyrethroids. Bees may be poisoned through direct exposure to pesticides (e.g., spray drift) or by visiting plants that have been treated with pesticides. Recent research suggests that systemic pesticides may pose a particular threat to bees. These pesticides are absorbed by the plant and circulate throughout the plant's tissue. Systemic pesticides are very effective in protecting plants from insect pests because the pest ingests the pesticide when feeding on any part of the plant. Unfortunately, these pesticides can also be found in the pollen and nectar on which bees feed. Some

Figure 11. The blue orchard mason bee (*Osmia lignaria)* is often used for pollinating fruit crops such as apple, pear, and cherry. They commonly transfer more pollen than honey bees.

Photo: USDA Forest Service

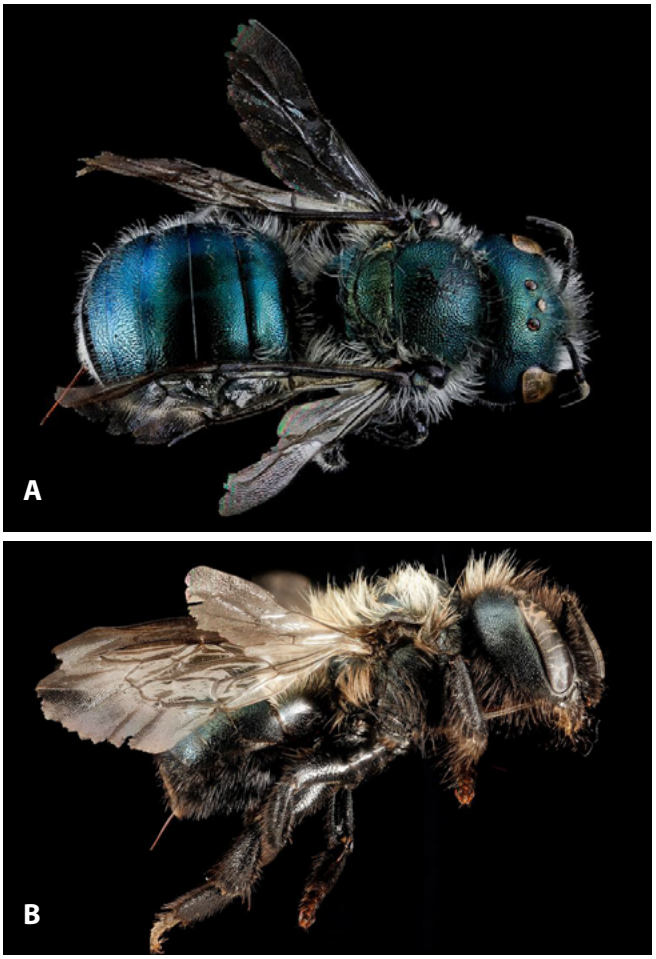

Figure 12. Osmia species may be iridescent blue-green such as this *Osmia atriventris* (A), or a darker metallic black, such as *Osmia paradisica* (B).

Photos: Brooke Alexander, USGS Bee Inventory and Monitoring Lab

systemic pesticides, such as neonicotinoids, may be particularly dangerous to bees because of their long residual times; neonicotinoids can persist in plants and soil for months or sometimes years. Commonly used by both homeowners and agricultural producers in the United States, these pesticides are applied to seeds and soils, and directly on plants. Plants purchased at retail garden centers and local nurseries may have been treated with neonicotinoids. Specific types of neonicotinoids (e.g., clothianidin and imidacloprid) have been found to be toxic to megachilid bees such as blue orchard and alfalfa leafcutting bees.

Because they do not have a central hive, it is more difficult to detect pesticide poisoning in megachilid bees than in honey bees. Signs of poisoning include the presence of a large number of dead, dying, or lethargic bees. For alfalfa leafcutting bees, a distinctive sign of poisoning is the presence of large numbers of dead males on the ground in front of the field domiciles or a lack of nesting by females. Females usually forage near their field domicile, so shelters closest to areas of pesticide applications are most likely to be affected.

Fortunately, there are several ways to reduce the threat of bee poisoning. First, don't use pesticides if you don't need to, especially around flowers. If you do need to use pesticides, select the right product. A number of excellent resources are now available to guide you in selecting effective pest control products that pose the least threat to pollinators, including *How to Reduce Bee Poisoning from Pesticides* (PNW 591) and its companion app for your mobile device (available at https://catalog.extension.oregonstate.edu/pnw591). This publication and app allow you to quickly determine whether a pesticide is known to be toxic to bees. Remember though, pesticide applications of any type should be applied according to the label. Apply pesticides at times when bees are not active (e.g., evening) and in proper weather conditions. For example, do not apply pesticides during windy conditions, which increase spray drift, or when dew or unusually low temperatures are forecast, since these conditions usually double the time during which pesticide residues remain toxic to bees. In addition, avoid purchasing seeds or other plant material for your garden or farm that have been treated with neonicotinoids. Some larger retailers are now labeling plants that have been treated with neonicotinoid pesticides and others are planning to eliminate the use of these pesticides on plants that are attractive to bees. If in doubt, ask your supplier for information on whether plant material has been treated with systemic pesticides.

Protecting and enhancing megachilid habitat

Bees, in general, have two basic needs: food and a place to lay their eggs. Food, in the form of nectar and pollen, is provided by flowering plants. To encourage a diverse group of megachilid bees on your property, provide abundant and diverse flowering plants throughout the growing season. Different species of bees are active at different times of the growing season, so it is important that pollen and nectar are available not only at peak production periods but also early and late in the season. On farms, non-cultivated areas (such as field margins, hedgerows, and riparian areas) can be planted with flowers that will bloom at different times of the season to feed bees when crops are not in bloom. Some crops and flowers appear to be particularly attractive to certain types of bees (Figure 13, page 8). For a list of crop and garden plants that may be particularly attractive to leafcutting and mason bees, see Table 1 on page 8. Below is a list of resources that include information on "bee-friendly" plants that grow in the Pacific Northwest. These resources include information on color, bloom time, and growing requirements, and can guide your choice of plant material.

Plants for Pollinators in the Inland Northwest. 2011. USDA Natural Resources Conservation Service. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmstn10799.pdf

Plants for Pollinators in the Intermountain West. 2011. USDA Natural Resources Conservation Service. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmstn10798.pdf

Plants for Pollinators in Oregon. 2008. USDA Natural Resources Conservation Service. https://plants.usda.gov/pollinators/Plants_for_Pollinators_in_Oregon_PM%2013.pdf

Selecting Plants for Pollinators: A Regional Guide for Farmers, Land Managers, and Gardeners in the Intermountain Semidesert Province including the States of Washington, Oregon, Idaho, Wyoming and Parts of California, Nevada, Utah, Montana, and Colorado. Pollinator Partnership. http://www.pollinator.org/PDFs/Guides/IntermtSemidesrt342rx2.pdf

Continued on page 9

Table 1. Crops and garden plants that may be preferred by leafcutting and mason bees

Flowers (native to the Pacific Northwest)	Leafcutting Bees	Mason Bees
Crops and home orchards	Alfalfa and other legume crops	Fruit and berry crops (e.g., apple, apricots, raspberries, cherries) and legume crops
Astragalus—legumes that include milkvetches, e.g., woollypod milkvetch *(A. purshii),* basalt milkvetch *(A. filipes)*	x	x
Balsamorhiza—group of plants in the sunflower family that are commonly called balsamroots, e.g., arrowleaf balsamroot (*B. sagittata*), Carey's balsamroot (*B. careyana*), Hooker's balsamroot (*B. hookeri*)		x
Cleome—group of plants commonly called spider flowers or bee plants, e.g., Rocky Mountain beeplant *(C. serrulata),* yellow spiderflower *(C. lutea)*	x	
Crepis—in the aster family and commonly known as hawksbeard, e.g., largeflower hawksbeard (*C. occidentalis*), tapertip hawksbeard (*C. acuminata*)	x	x
Dalea—legumes that are commonly known as prairie clover or indigo bush, e.g., Blue Mountain prairie clover (*D. ornata*)	x	
Hedysarum—legumes commonly known as sweetvetches, e.g., Utah sweetvetch (*H. boreale*)	x	x
Helianthus—sunflowers, e.g., common sunflower (*H. annuus*)	x	
Penstemon—commonly known as beardtongues—a large and diverse group, e.g., scabland penstemon (*P. deustus*), royal penstemon (*P. speciosus*)		x
Phacelia—often called scorpionweed, e.g., threadleaf phacelia (*P. linearis*), silverleaf phacelia (*P. hastata*)		x
Rosa—roses, e.g., Nootka rose (*R. nutkana*), Woods' rose (*R. woodsii*)		x
Solidago—goldenrods, e.g., Missouri goldenrod (*S. missouriensis*), Canada goldenrod (*S. canadensis*)	x	

Adapted from *Plants for Pollinators in the Inland Northwest*

Figure 13. Some crops and flowers appear to be particularly attractive to certain types of bees. *Astragalus* (A) attracts both leafcutting and mason bees; *Cleome* (B) attracts leafcutting bees; *Penstemon* (C) attracts mason bees; and *Solidago* (D) attracts leafcutting bees.

Photos: (A) Cassondra Skinner, USDI Bureau of Land Management, (B) USDI Bureau of Land Management, (C) Sheri Hagwood, USDI Bureau of Land Management , (D) Samantha Roof, © Oregon State University (A, B, and C are hosted by the USDA-NRCS PLANTS Database.)

Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms. 2015. The Xerces Society http://www.xerces.org/wpcontent/uploads/2008/11/farming_for_bees_guidelines_xerces_society.pdf

Another way you can enhance megachilid habitat on your property is to provide nesting habitat. One of the simplest measures you can take is to protect existing nesting habitat. Cavities located in wood or plant stems, or in structures like sheds and other outdoor buildings, should be preserved. It's important to note that megachilid bees do not bore holes or otherwise damage structures; they simply take advantage of existing cavities. In addition, many species of mason bees need moist, clay soil to use in nest construction. To help meet this need, keep an area of bare, exposed soil in your garden or on your farm, or put out a small container of clay-rich mud. You can also increase nesting habitat by building your own nests or buying commercially made ones. Many guides are available that describe the best way to make nests for leafcutting and mason bees, including:

Nurturing Mason Bees in Your Backyard in Western Oregon (EM 9130). Oregon State University. https://catalog.extension.oregonstate.edu/em9130

Nests for Native Bees: Invertebrate Conservation Fact Sheet. The Xerces Society. http://www.xerces.org/wp-content/uploads/2008/11/nests_for_native_bees_fact_sheet_xerces_society.pdf

Tunnel Nests for Native Bees - Nest Construction and Management: Invertebrate Conservation Fact Sheet. The Xerces Society. http://www.xerces.org/wp-content/uploads/2009/11/tunnel-nest-management-xerces-society.pdf

For more information

OSU Extension publications

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Additional resources

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