WASHINGTON STATE UNIVERSITY EXTENSION

A CITIZEN SCIENCE GUIDE TO WILD BEES AND FLORAL VISITORS IN WESTERN WASHINGTON

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A CITIZEN SCIENCE GUIDE TO WILD BEES AND FLORAL VISITORS IN WESTERN WASHINGTON

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Abstract

Since wild bees are difficult to monitor and identify, this guide acts as an introductory document for those who would like to understand wild bee biodiversity and contribute to conservation through monitoring. This field guide is part of our citizen science program, the Citizen Science Initiative for Bees (CSI Bees), which seeks to deliver locally specific, data-driven education on wild bees of the Puget Sound Region.

A Citizen Science Guide to Wild Bees and Floral Visitors in Western Washington

Abstract

Wild bees and other pollinators are critical for the sustainability of natural and managed ecosystems. Identifying the diversity and species composition of pollinator communities can aid in developing conservation plans and determining if pollination needs are being met. This guide is intended to provide the tools to identify and monitor wild bees and other floral visitors in the Puget Sound Region. Within the guide are labeled diagrams showing the morphological features, size and shape, pollen-carrying device, flowers frequently visited, and flight pattern for each wild bee group. Moreover, we provide a dichotomous key to aid in identification. This field guide is part of our citizen science program, the Citizen Science Initiative for Bees (CSI Bees), which seeks to deliver locally specific, data-driven education on wild bees of the Puget Sound Region. Therefore, the guide also contains instructions on how to submit observations of wild bees to our website, www.nwpollinators.org. This guide is not intended for taxonomic identification, but rather a means for citizen scientists to become familiar with and monitor wild bees in western Washington urban gardens, farms, and landscapes. Since wild bees are difficult to monitor and identify, this guide acts an introductory document for those who would like to understand wild bee biodiversity and contribute to conservation through monitoring.

Introduction

Concerns about pollinator declines have grown in recent years. This is problematic because pollinators, including wild, native, and domesticated bee species are critical for the production of a diverse mixture of fruit and vegetable crops in the Puget Sound Region. However, we currently have a limited understanding of the diversity of pollinators in the Puget Sound Region. In response to this, we conducted dozens of floral visitor surveys in the Puget Sound Region from 2014 to 2015 on more than 30 urban gardens and small-scale diversified farms. Our results indicate that there are hundreds of different invertebrate floral visitor species in the Puget Sound Region, many of which are wild bees. This guide characterizes the major bee and non-bee species that inhabit farms in the Puget Sound Region. The goal of the guide is to inform people interested in pollinators about how to make observations of floral visitors on their home gardens and farms.

Citizen Science for Bee Monitoring

While this guide is intended for any individual interested in pollinators, it is also intended for those who wish to participate in our citizen science initiative on cataloguing wild bee diversity in the Puget Sound Region. Citizen science, the involvement of volunteers in research, is another means to gather ecological data on pollinators over large temporal and spatial scales (Devictor 2010; Kaartinen et al. 2013). To address the lack of long-term pollinator data in Washington State, and reinforce Washington State University's continuing commitment to information on beneficial insect protection (James 2014; Lawrence 2015), we established a citizen science program that connects community members in an information-sharing network, known as the Citizen Science Initiative for Bees (CSI Bees). All users of this guide are invited to contribute surveys of floral visitors to the CSI Bees project. Surveys can be submitted at our website, www.nwpollinators.org, and step-by-step instructions can be found in Section III. We also offer training classes on wild bee and floral visitor identification. A full list of classes can be found at our website. The premise of CSI Bees is to encourage wild bee conservation through short courses and collaborative bee monitoring.

How to Use the Guide

Tools useful for identification and descriptions of wild bees are found in Section I and II, respectively.

Details on how to observe and monitor floral visitors can be found in Section III. A data sheet for tracking your observations can be found in Appendix I.

Glossary

The terminology found below may be helpful to better understand this guide. Terms have been adapted from: Triplehorn and Johnson (2005), Michener (2007), Gullan and Cranston (2010); and Droege (2015).

abdomen. A relatively simple structure typically made up of multiple segments. Bands of coloration and pollen-carrying devices located on this region may be particularly useful for bee identification.

antennae. These are paired, segmented appendages found on the head of the insect. These appendages are used primarily to sense the environment. These sensations can include tactile, smell, and hearing.

bilateral symmetry. Most insects are divisible into symmetrical halves, therefore having the same features (e.g., legs and wings) on both sides of their body.

clypeus. A section of the face below the antennae. This area often has microscopic features that are useful for bee identification.

compound eye. A complex light receptor, this organ is used in the perception of focused images. Some insects are color blind, while others can have the ability to distinguish color. For example, honey bees can distinguish blue and yellow, but not red.

corbicula. A flattened, plate-like area that is hairless and surrounded by longer hairs used to hold pollen while in transport to the nest.

fore leg. Attached to the thorax and multi-segmented, this appendage can be used for locomotion or can be modified. One example of a modification is bright coloration on male bees, which is used to attract mates.

fore wing. Typically transparent and membranous, but can also be hardened or leathery. This morphological feature is located on the middle thoracic segment. All bees have two fore wings.

head. This region is specialized for the collection and manipulation of food, sensory perception, and the integration of neural processes.

hind leg. Attached to the thorax and multi-segmented, this appendage can be used for locomotion or can be modified. One modification is the pollen basket, an area where pollen is attached for transport back to the nest.

hind wing. Typically transparent and membranous, this morphological feature is located on the last of three thoracic segments. All bees have two hind wings.

mid leg. Attached to the thorax and multi-segmented, this appendage is mainly used for locomotion. This is the second of three pairs of legs found on bees.

ocelli. These are light-sensitive simple eyes. Insects typically have three of these in a triangular arrangement on the top of the head. These do not form focused images, but rather sense differences in light intensity.

pygidial area. The area of the abdomen where the stinger and anus can be found. Externally, this area may be important in the identification of some bees.

scopa. These are long dense hairs which have evolved to hold pollen. These are typically found on the hind legs or the bottom of the abdomen.

terga. The upward-facing part of the abdominal segment. This region is often covered in useful identification features.

thorax. The center of locomotion. This region bears the three pairs of legs and two pairs of wings common to all bees.

Section I: Tools Useful for Identification

Classification

To simplify classification in this guide, we use five groups of bees (Winfree et al. 2007; Bloom 2014) and six groups of non-bee invertebrate floral visitors. The dichotomous key (Figure 1) can be used to begin the identification process. Each group in the key is paired with a symbol index and page number for quick reference.

Parts of the Bee:

Insects have three body segments, the head, thorax, and abdomen (Figure 2). The head houses the sensory appendages and organs including the eyes, antennae, and mouth parts. Insects are bilaterally symmetrical, meaning they have the same appendages on both sides of the body. Bees have two sets of wings, a hind wing and fore wing, and three pairs of legs. The thorax is the center of locomotion. You will find that the legs and wings are attached to the thorax.

Couplet	Key to Group Descriptions	Symbol	
1.a.	Body triangular in shape……Bugs (BG), p. 12		Other Floral Visitors
1.b.	Body not triangular in shape……go to 2		
2.a.	Four pairs of legs……Spiders (S), p. 12		
2.b.	Three pairs of legs……go to 3		
3.a.	One pair of wings……Flies (F), p. 12		
3.b.	Two pairs of wings……go to 4		
4.a.	Hardened shell-like front wings……Beetles (BTL), p. 12		
4.b.	Front wings not hardened……go to 5		
5.a.	Patterned wings……Butterflies (BTF), p. 12		
5.b.	Wings not patterned……go to 6		
6.a.	Pollen carrying device……go to 7		
6.b.	No pollen carrying device……Wasps (W)*, p. 12		
7.a.	Flattened plate on hind leg……go to 8		Bee Groups
7.b.	No flattened plate on hind leg……go to 9		
8.a.	Thorax and abdomen covered with thick fuzzy hair……Bumble bees (BB), p. 8		
8.b.	Thorax and abdomen not covered with thick fuzzy hair……Honey bees (HB), p. 7		
9.a.	Body with bright green segments……Green bees (GB), p. 10		
9.b.	Body without bright green segments……go to 10		
10.a.	Body small in size……Small bees (SB), p. 11		
10.b.	Body not small in size……Other large bees (OLB), p. 9		

*Some bees do not have pollen carrying devices. See page 6 for additional details.

Figure 1. Use this dichotomous key to aid you in the classification of bees and other floral visitors. Each couplet uses distinct characteristics that are unique to each group.

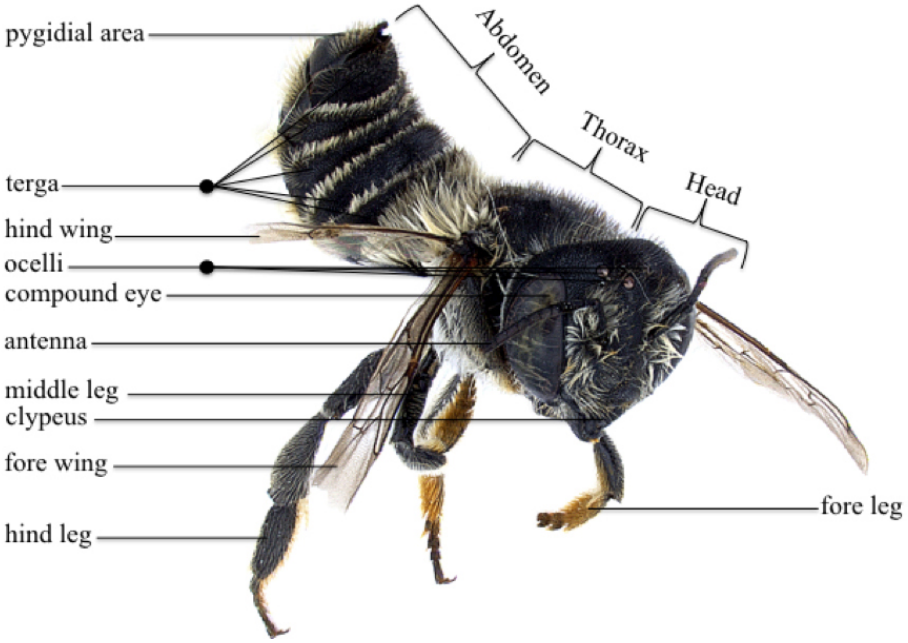

Figure 2. Bees are multi-segmented. Each segment has specific appendages that are labeled here. Familiarity with bee morphology is important for identification.

Color Images:

For this guide, we included the most common bees you may see. There are likely hundreds of species in the Puget Sound Region. It is important to note that each bee group in this guide represents many different species. The only exception is the honey bee. The color images in this guide are not intended for taxonomic identification, but rather a means to become familiar with wild bees. Common names for the groups are given.

Group Descriptions:

All color images come with a description of the key identification characteristics. Those characteristics are described in Figure 2. Particular emphasis has been placed on the traits that differentiate bees from other invertebrate floral visitors.

Sizing and Shape Guide:

Size and shape are often useful tools to identify bees (Figure 3). Each group description includes a sizing guide for your reference.

Seasonality:

In addition to size, all bees have a distribution that changes over time and space. Each group description includes details on the abundance of each bee group during the spring, summer, and fall seasons in farms, urban gardens, and landscapes near Seattle, WA. You may notice that a single bee species may vary in size. Seasonal change in body size can be normal, or can be driven by environmental stress.

Pollen-Carrying Device:

Most female bees collect pollen as a food source and inadvertently pollinate plants in the process. Male bees (Figure 14A) and cuckoo bees (Figure 17C) do not collect pollen and do not have a pollen-carrying device. Cuckoo bees parasitize other bee nests, and male bees are mainly useful for reproduction. Some bees carry pollen internally, as seen in the masked bee (Figure 17A), while other bees have depressions on their hind legs called the corbicula, or pollen basket (e.g., Figure 5). The corbicula is surrounded by hairs, which the pollen clings to. Some bees carry pollen on the underside of their abdomen in a hairy area called the scopa (e.g., Figure 11E). These scopal hairs can also be found on the hind legs of bees that lack the corbicula (e.g., Figure 11A).

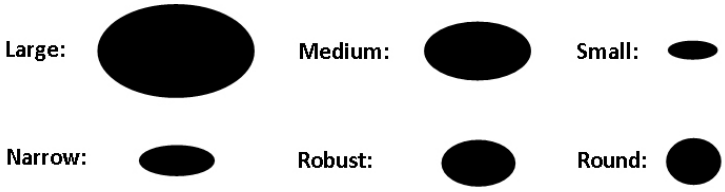

Figure 3. Size and shape guide for bee groups.

Flight Pattern:

Bees and other insects can sometimes be identified by how they fly. You will notice that some bees are methodical, moving directly from one flower to the next and rarely going backwards. Other bees are smooth fliers, moving in looping, wide turns between flowers, or erratic, flying with darting movements (Figure 4). Observations of these flight patterns prior to or after the bee or floral visitor lands on the flower can lend additional confidence to your identification of the specimen.

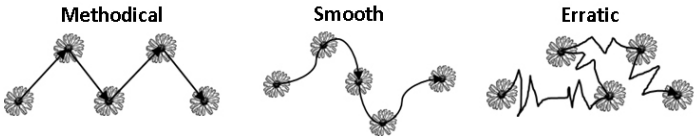

Figure 4: Flight patterns commonly observed in bees. The line represents the mode of travel to and between flowers.

Section II: Descriptions of Wild Bees and Other Floral Visitors

Honey Bees:

Group Description: Honey bees (Figure 5) are medium to large in size. Body colors include grey to black, orange to yellow, and brown. They have black stripes on their abdomen, and the thorax is often fuzzy. Honey bees are not native to the Americas. Many flies may be similar in coloration to bees. Flies that mimic honey bees will lack two pairs of wings (e.g., Figure 20C), a corbicula, and will generally have large eyes that nearly touch in the front of the head.

Shapes and Sizes: Medium in size, narrow in shape (Figure 6).

Pollen Carrying Device: Corbicula (e.g., Figure 5).

Flight Pattern: Methodical (Figure 7).

Figure 5. Lateral and frontal images of the honey bee.

Plants Visited: Our surveys suggest that honey bees may visit over 90 different garden plants. The most frequently visited include smartweed, sunflower, white clover, squash, borage, tomatillo, and oregano. Honey bees generally collect only one type of pollen on each foraging bout. Honey bees also collect nectar while visiting flowers; therefore, pollen may be absent from the corbicula.

Seasonality and Range: Honey bees have year-round colonies, which can be wild or kept by humans. These colonies begin small, and steadily build over the season. Our research indicates that honey bees may be most abundant in rural areas in the spring, becoming more evenly and widely abundant in summer. However, in the late summer honey bees may begin to decline in numbers. In the fall, honey bees remain highly abundant only in localized rural areas.

Figure 6. Range of sizes and shapes for honey bees.

Figure 7. Fight pattern of honey bees.

Bumble Bees:

Group Description: Bumble bees are generally covered in thick, fuzzy hair. This hair can be black, yellow, orange, white, or a mixture of colors (Figures 8A-C). Bumble bees are medium to large in size with a round or robust body shape. Three examples of common bumble bees in the Puget Sound Region are shown.

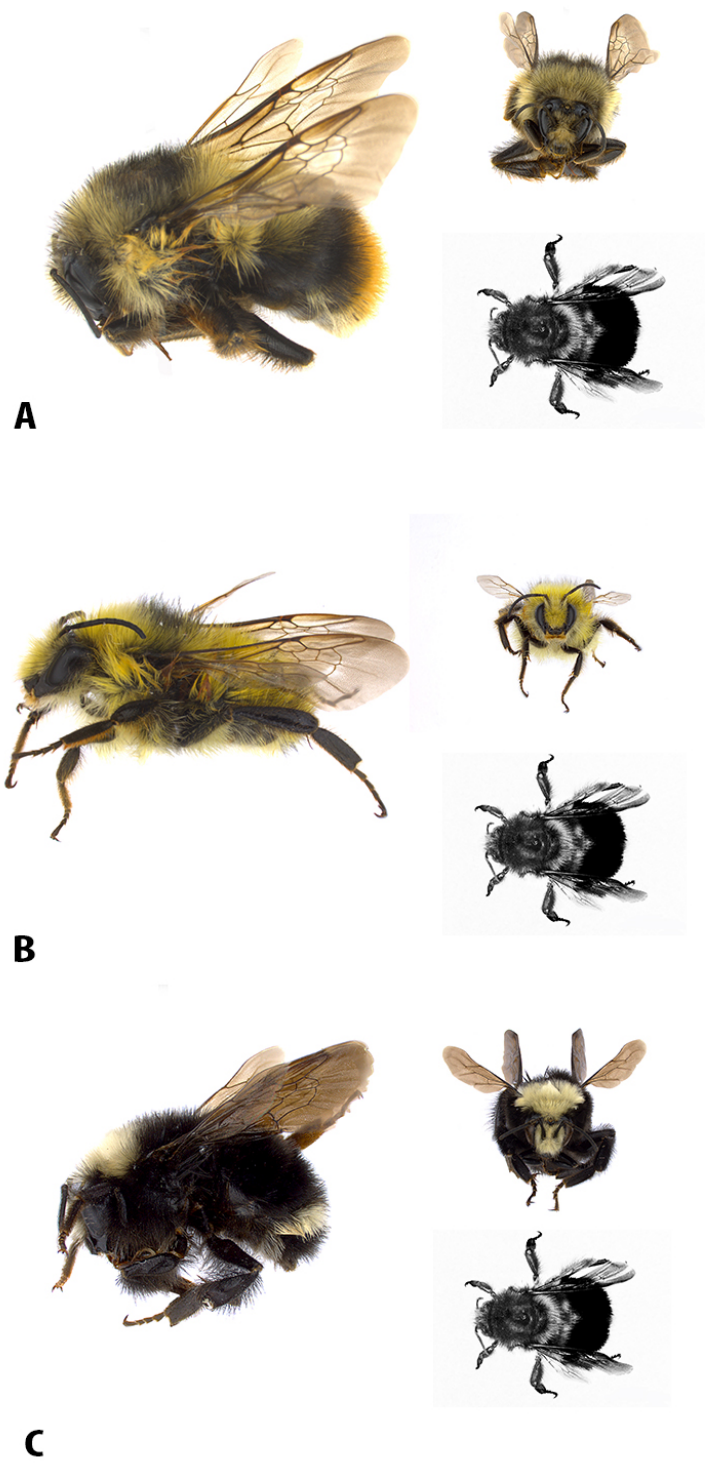

Figure 8. Lateral and frontal images of the: A) fuzzy-horned bumble bee; B) yellow bumble bee; and C) Vosnesensky bumble bee.

Shapes and Sizes: Medium to large in size, round to robust in shape (Figure 9).

Pollen Carrying Device: Corbicula (e.g., Figure 8B).

Flight Pattern: Smooth (Figure 10).

Plants Visited: In our study, bumble bees visited approximately 75 different plant species. The most commonly visited plants were lavender, tomato, phacelia, borage, comfrey, squash, tomatillo, flatweed, zinnia, pole bean, red cover, and sunflower.

Seasonality and Range: Bumble bee queens emerge in the spring, search for a new nest, and begin to forage for pollen. These queen bees can form colonies that reach several hundred individuals by mid-summer. The colony will slowly dwindle as new queens are produced for the following year. In our research, bumble bees begin the season most abundantly outside of urban areas in the early spring. By summer, this trend shifts and urban areas may have the most bumble bees. In the fall, bumble bee populations appear to be most abundant in rural areas, with moderate abundance in urban areas. These trends may be driven by regional biological and physical factors.

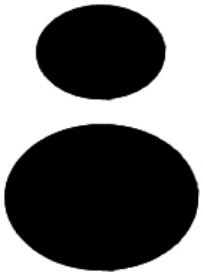

Figure 9. Range of sizes and shapes for bumble bees.

Figure 10. Fight pattern of bumble bees.

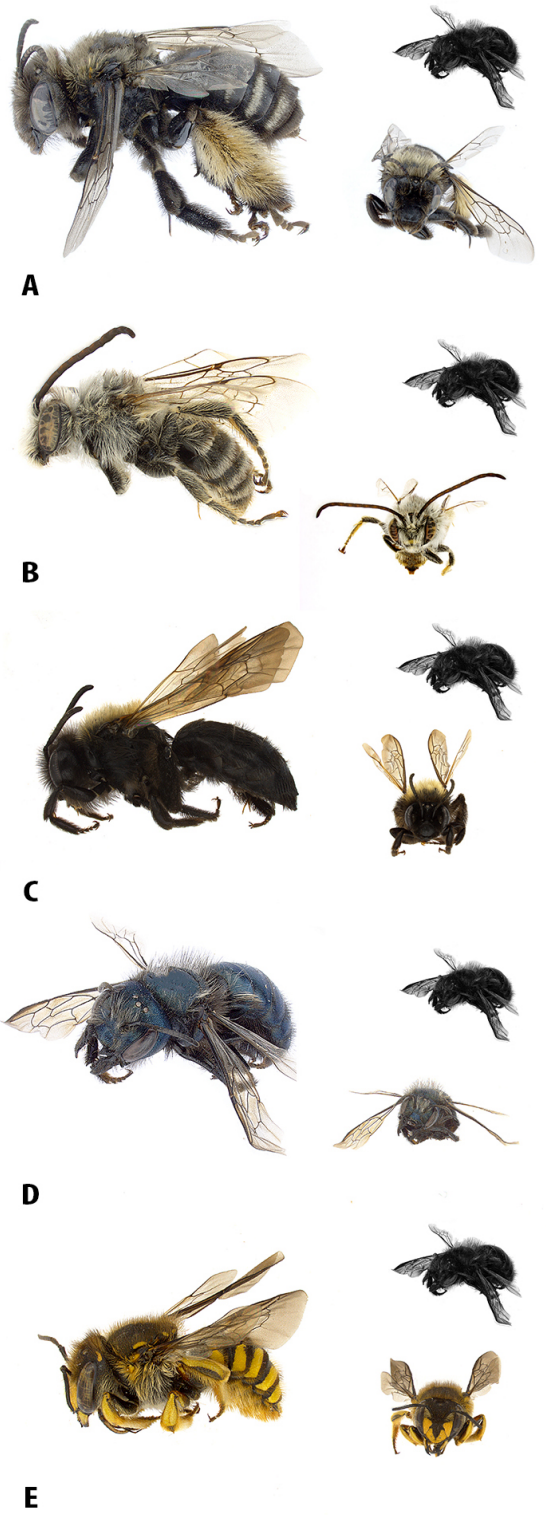

Figure 11. Lateral and frontal images of a: A) long-horned bee; B) digger bee; C) sand/mining bee; D) mason bee; and E) carder bee.

Other Large Bees:

Group Description: Other large bees (OLBs) are a cosmopolitan group of many bee species (Figures 11A-E). This group encompasses bees that are approximately the size of a honey bee (e.g., Figure 5). Body coloration will range from metallic blue (Figure 11D) to striped (Figure 11E), or very dark (Figure 11C). Some OLBs may have long antennae (Figure 11B). Five examples of OLBs are shown.

Shapes and Sizes: Medium in size, narrow to robust in shape (Figure 12).

Pollen-Carrying Device: All bees with abdominal scopa are OLBs (e.g., Figure 11E). Some OLBs will collect pollen in hair on their hind legs (e.g., Figure 11A).

Flight Pattern: Erratic (Figure 13).

Plants Visited: Other large bees visited 35 different plant groups in our study. The most commonly visited were sunflower, calendula, cosmos, fringed quickweed, common oregano, cilantro, zinnia, and mayweed. Some OLBs may visit early season fruit trees.

Seasonality and Range: Other large bees may be much less abundant than honey bees or bumble bees. Most OLBs are solitary and do not establish large colonies. In the spring, some rural areas may have OLBs in high abundance. Other large bees may be most abundant in urban areas during the summer months. By fall, these bees may not be present in urban gardens, farms, and landscapes in the Puget Sound Region.

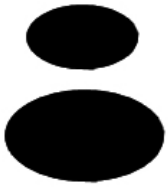

Figure 12. Range of sizes and shapes for other large bees.

Figure 13. Fight pattern of other large bees.

Green Bees:

Group Description: Green bees have a metallic green body (Figure 14B), and sometimes a striped abdomen (Figure 14A). They are narrow in shape and much smaller than a honey bee (e.g., Figure 5). Some wasps can look like green bees. Two examples of green bees are shown.

Shapes and Sizes: Small to medium in size, narrow in shape (Figure 15).

Pollen-Carrying Device: Look for hair and pollen on the hind legs (e.g., Figure 14B). These bees will not have abdominal scopa.

Flight Pattern: Erratic (Figure 16).

Plants Visited: Green bees may visit approximately 19 different plant groups. Examples of plants frequently visited by green bees include cosmos, sunflower, and calendula.

Seasonality and Range: Green bees may have equal abundance through each season; although, similar to other large bees, they may be less abundant than honey bees and bumble bees. These bees may also be more difficult to observe because of their erratic flight. In the spring and summer green bees appear to be most common in rural areas. Late in the season, this trend may shift and some urban gardens and landscapes may have more green bees than farms in the surrounding countryside. These trends are likely due to biological and physical factors, combined with the inherit life cycle of these bee groups.

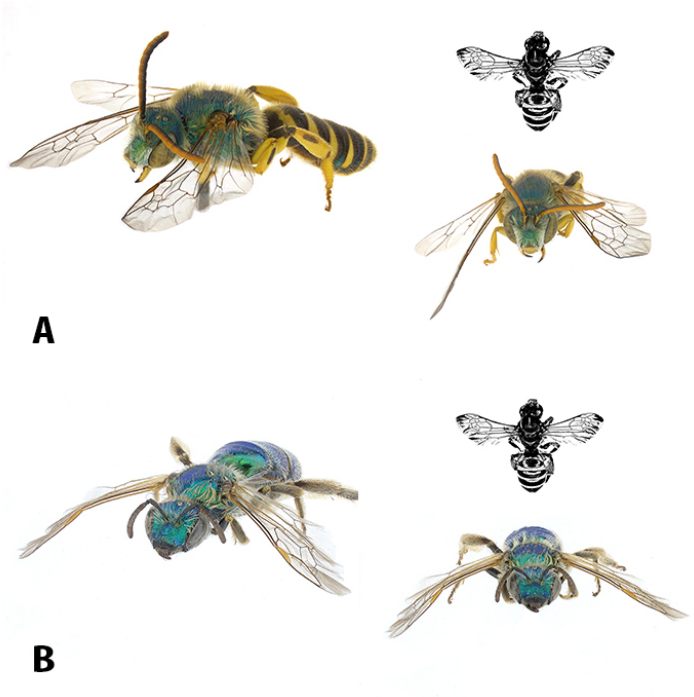

Figure 14. Lateral and frontal images of green sweat bees.

Figure 15. Range of sizes and shapes for green bees.

Figure 16. Fight pattern of green bees.

Small Bees:

Group Description: Small bees will typically appear to be black (Figure 17A), but may have a black abdomen with white stripes (Figure 17B). In some cases, the abdomen of small bees will be red and hairless (Figure 17C). These are the cuckoo bees. There are also very tiny bees within this group that can be identified by a pointy abdomen (Figure 17D). Four examples of small bees are shown.

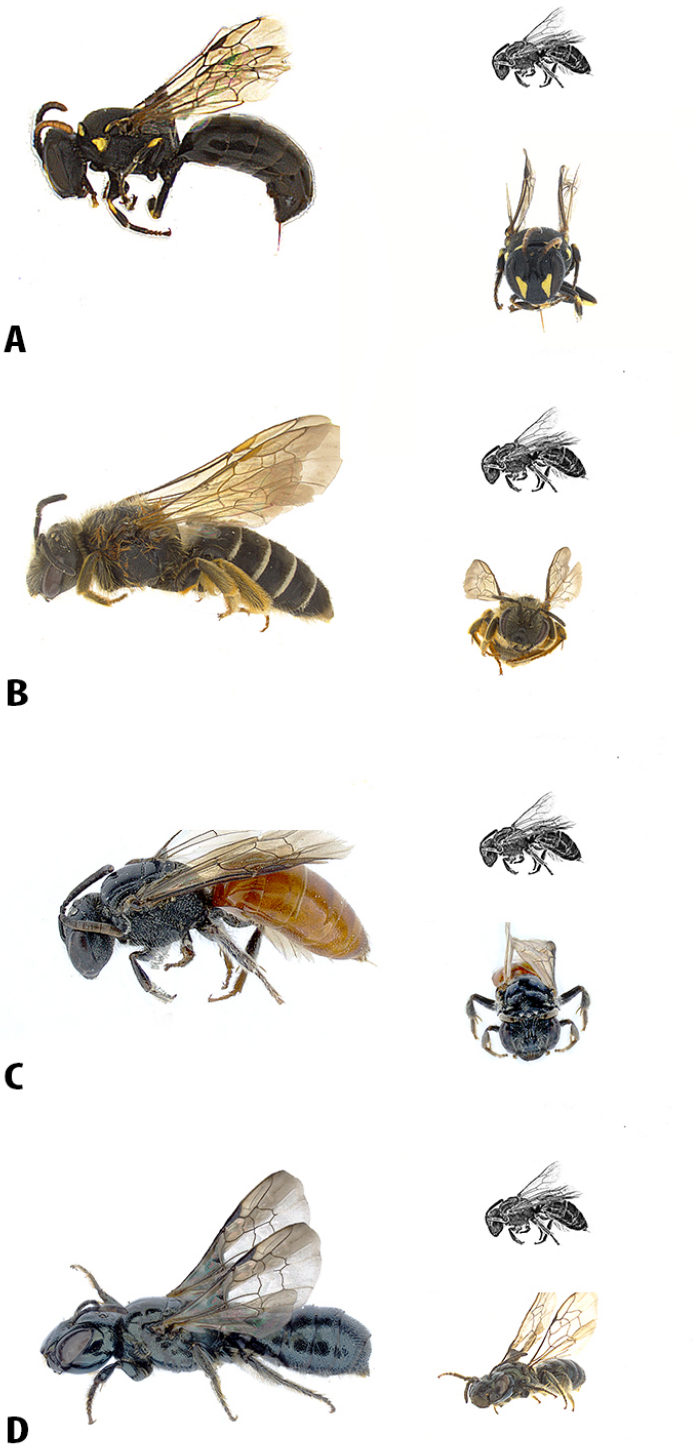

Figure 17. Lateral and frontal images of a: A) masked bee; B) sweat bee; C) cuckoo bee; and D) small carpenter bee.

Shapes and Sizes: Small in size, typically narrow in shape (Figure 18).

Pollen Carrying Device: All small bees carry pollen on their hind legs (e.g., Figure 17B) or internally (e.g., Figure 17A). Cuckoo bees will not have a pollen-carrying device (e.g., Figure 17C).

Flight Pattern: Erratic (Figure 19).

Plants Visited: Small bees (SBs) visited 41 garden plants during our study. Examples of these plants include flatweed, cilantro, buckwheat, calendula, borage, dill, and sow thistle.

Seasonality and Range: Small bees may be more commonly found in the spring and summer. These bees are difficult to observe because they move very quickly and fly in an erratic manner. In the spring, small bees appear to be most abundant in the urban gardens and landscapes of the Seattle, WA, area and rural areas south of Olympia, WA. In summer, small bees may be locally abundant on farms east of Seattle, WA. By fall, small bees may not be present throughout gardens, farms, and landscapes of the Puget Sound Region.

Figure 18. Range of sizes and shapes for small bees.

Figure 19. Fight pattern of small bees.

Other Floral Visitors:

Group Description: While wild bees are the focus of this field guide, it is important to note the diversity of other floral visitors (Figures 20A-F). These visitors can vary in morphology and behavior. While many of these visitors are easily distinguished from bees, flies, and wasps may be difficult to differentiate. With close inspection you will find that all flies have short antennae and only one pair of wings. Wasps are closely related to bees, but will lack a pollen-carrying device. Refer to the dichotomous key in Section I for more identification traits of non-bee floral visitors.

Shapes and Sizes: Small (Figure 20C) to large (Figure 20A); narrow (Figure 20B), robust (Figure 20E), or round (Figure 20F).

Pollen-Carrying Device: Other floral visitors will not have a pollen-carrying device (i.e., corbicula or scopa). These floral visitors may feed on pollen or nectar at the flower, but usually do not harvest pollen to provision nests. One exception is the pollen wasps.

Flight Pattern: Methodical (Figure 20B), smooth (Figure 20E), or erratic (Figure 20C).

Plants Visited: In our study, other floral visitors were found on 124 garden plants. Examples of these plants include clover, smartweed, lavender, dandelion, and buckwheat.

Seasonality and Range: In the spring**,** other floral visitors may be most commonly found in the rural areas east of Seattle and south of Olympia, WA. By summer, there may also be areas of high abundance in the urban gardens and landscapes within Seattle. In the late summer and fall, other floral visitors may be again most abundant outside of urban areas in rural farms and landscapes.

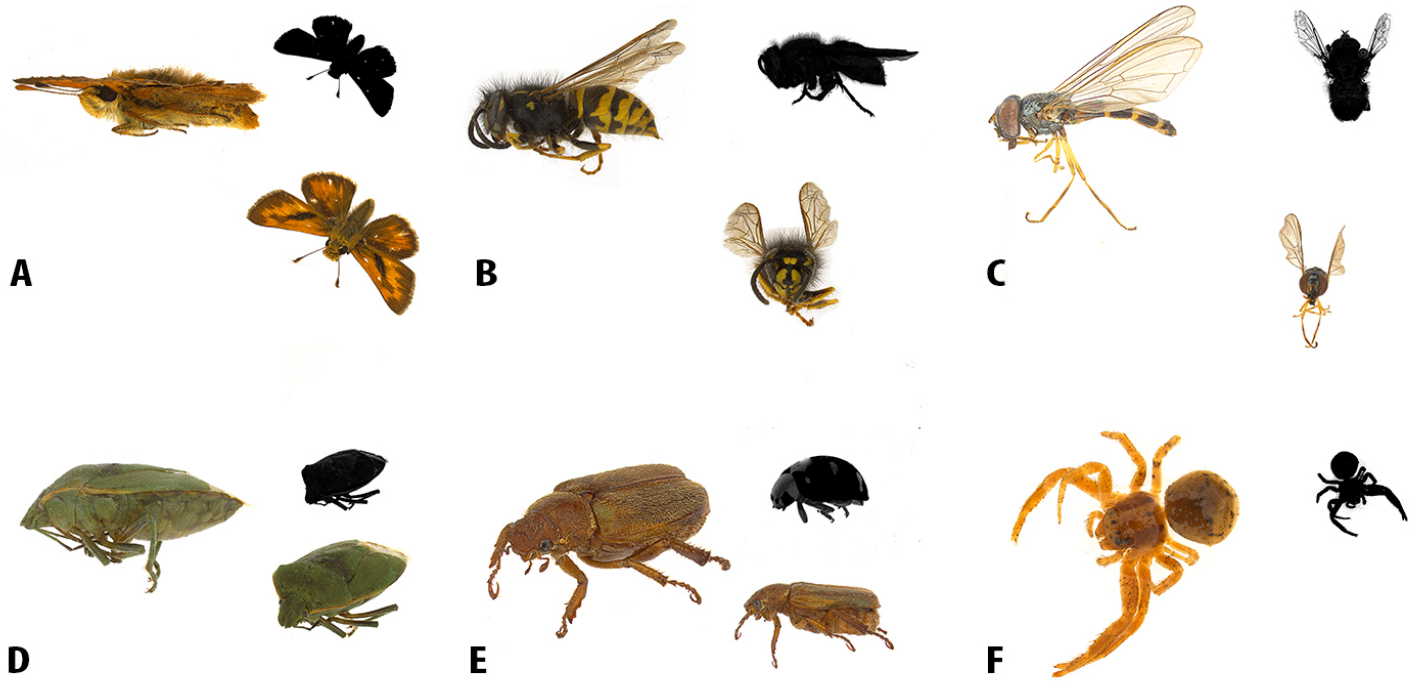

Figure 20. Lateral and frontal images of a: A) skipper butterfly; B) common wasp; C) hover flies; D) stink bugs; E) chafer beetle; and F) crab spider.

Section III: Wild Bee and Other Floral Visitor Monitoring

Making Observations of Wild Bees

When:

The best time to make observations of wild bees is when temperatures exceed 50° Fahrenheit and when wind speeds are below 5 mph.

Where:

For CSI Bees, we ask that you only submit observations of floral visitors on flowers in a garden, but these techniques can be used in any landscape. A garden is a place where ornamental flowers, fruit, or vegetables are intentionally grown by humans. A floral visit occurs when a bee lands on a flower for greater than one second. Bees can also be seen on leaves or on the ground. These bees may be resting, or looking for a place to nest. Bees or other floral visitors that are on the ground or leaves should not be counted in your surveys, since they are not providing pollination services.

How:

Bees are mobile and may fly away if disturbed. Avoid sudden movements or casting your shadow over them. Observe bees before less mobile floral visitors like beetles and bugs. Unlike bees, beetles and bugs are more stationary, and may not take to flight as readily as bees and flies. To learn how to collect bees for later identification, see Droege (2015). For the purposes of our project, we recommend digital images.

Recording Data

A data sheet can be found in Appendix I. We recommend photocopying this sheet to replenish your guide as needed. Before starting your observations, note the date, time, location, temperature, and weather.

Step 1:

If you observe a floral visitor, and you can confidently classify it, note the floral visitor group [e.g., bee (B), wasp (W), fly (F), butterfly (BTF), beetle (BTL), bug (BG), or spider (S)] on your data sheet. Use the color photos in Section II and dichotomous key to help you classify your observations.

Step 2:

If the floral visitor is a bee, and you can confidently classify it, note the bee group [e.g., honey bee (HB), bumble bee (BB), green bee (GB), other large bee (OLB), or small bee (SB)] on your data sheet.

Step 3:

If possible, photograph the floral visitor and plant. Bees will fly away if you get too close, so experiment with the distance that is appropriate. Take at least one side image showing the full body length of the bee or other floral visitor. Then photograph the plant. Take a picture of the flower, leaf, and where the leaf attaches to the stem. Pictures provide data to verify your observations and stand as a record for your own reference.

Step 4:

Add additional notes about the garden, plant, and floral visitor. Your notes are helpful in the monitoring process and will allow you to build a complete garden record. An example of notes can be found on the data sheet.

Step 5:

CSI Bees participants should submit their observations, images, and notes to our website.

Conclusion

Wild bees and other floral visitors exhibit great diversity in the Puget Sound Region. While they may be difficult to identify on-the-wing, basic morphological classification into the groups described in this guide is possible. Monitoring may be difficult, yet observations and documentation of floral visitors and wild bees is essential to guide biological conservation plans. You are again invited to join our citizen science program (CSI Bees) and connect with a wider group of conservation-oriented people and scientists interested in better understanding wild bees and floral visitor biodiversity trends in the Puget Sound Region. We hope that this guide acts as an introduction to wild bee diversity and serves you as a tool for their monitoring and identification.

Acknowledgements

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United States Department of Agriculture
National Institute of Food and Agriculture

Further Reading:

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Useful Internet Links:

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Appendix I

Your Name:_____ **Date (eg. MM/DD/YY):** _____/_____/_____
Email address:_____ **Duration of Observations:** (eg. 4-4:30pm)_____
Location of garden (GPS or street address):_____
Weather (Circle): sunny / partly cloudy / overcast **Temperature (Circle):** <60 / 60-69 / 70-79 / 80-89 / 90+ °F

Observation Number	Step 1 Floral Visitor Code	Step 2 Bee Visitor Code	Step 3 Photograph floral visitor and plant	Steps 4 Take Notes
	Bee=B Wasp=W Fly=F Butterfly=BTF Beetle=BTL Bug=BG Spider=S	Honey bee=HB Bumble bee=BB Green bee=GB Other large bee=OLB Small bee=SB	1) Photo of bee 2) Photo of flower 3) Photo of leaf 4) Photo of leaf attachment to stem	Use the space below to describe the plant, insect, and garden. Include as much detail as possible.
Example	(B) / W / F / BTF / BTL / BG /S	HB / BB / (GB) / OLB / SB		*Bee was narrow, metallic, and collecting pollen from Cosmos in my garden.*
1	B / W / F / BTF / BTL / BG /S	HB / BB / GB / OLB / SB		
2	B / W / F / BTF / BTL / BG /S	HB / BB / GB / OLB / SB		
3	B / W / F / BTF / BTL / BG /S	HB / BB / GB / OLB / SB		
4	B / W / F / BTF / BTL / BG /S	HB / BB / GB / OLB / SB		
5	B / W / F / BTF / BTL / BG /S	HB / BB / GB / OLB / SB		

Any other relevant information or observations:

Any comments or inquiries:

Please use one of the following options to enter your data:
i) Enter directly onto the CSI: Bees! Website (www.nwpollinators.org)
ii) Enter by email: elias.bloom@wsu.edu
iii) Enter by Post: Washington State University, ATTN: Elias Bloom, 166 FSHN PO Box 646382, Pullman, WA 99164-6382

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