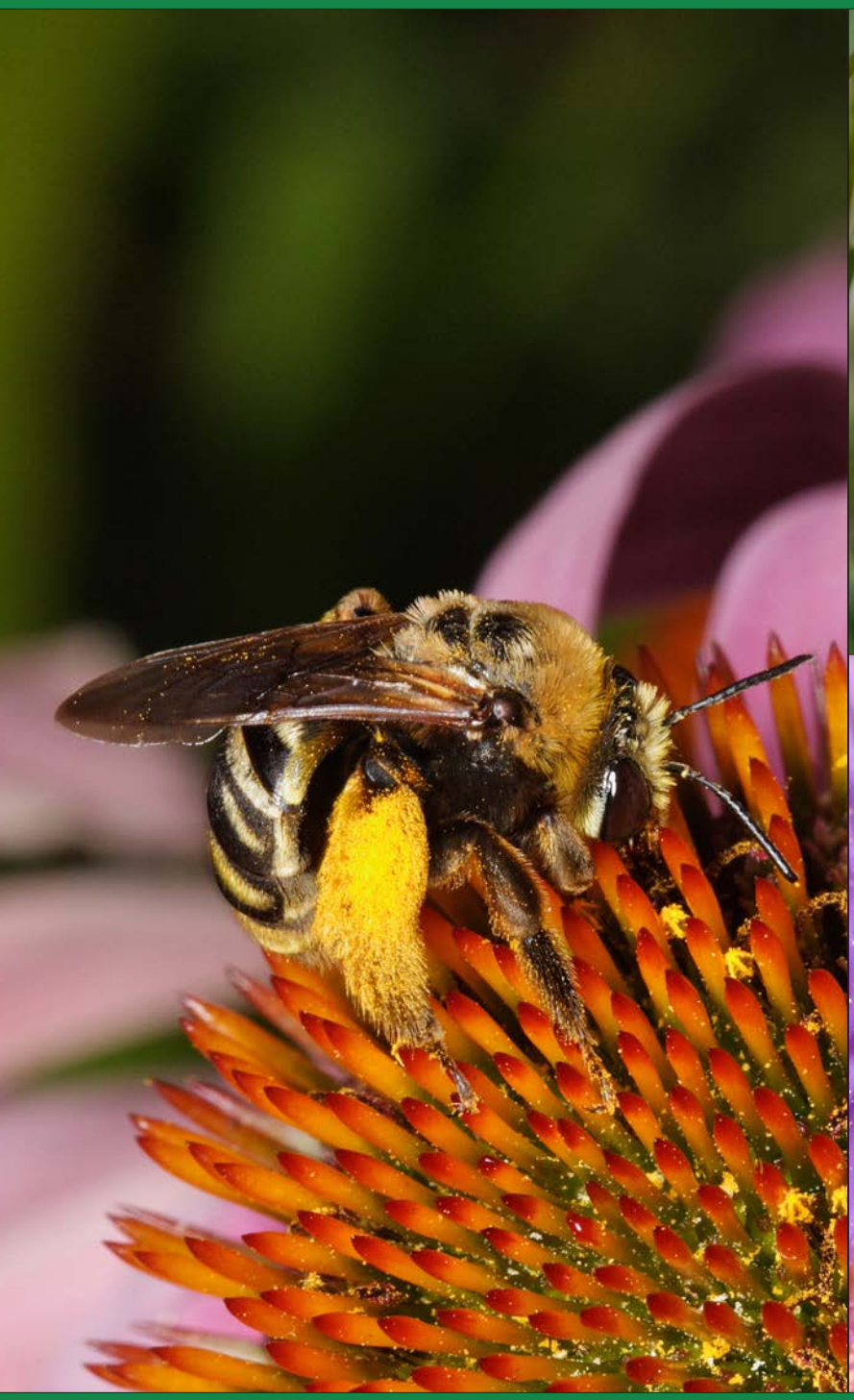
MARITIME NORTHWEST CITIZEN SCIENCE MONITORING GUIDE

NATIVE BEES & BUTTERFLIES



XERCES SOCIETY
for Invertebrate Conservation

The Xerces® Society for Invertebrate Conservation is a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. Established in 1971, the Society is at the forefront of invertebrate protection, harnessing the knowledge of scientists and the enthusiasm of citizens to implement conservation programs worldwide. The Society uses advocacy, education, habitat restoration, consulting, and applied research to promote invertebrate conservation.

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We are grateful to the many photographers who allowed us to use their wonderful photographs in this monitoring guide. The copyright for all the photographs is retained by the photographers. The photographs may not be reproduced without permission from the photographer.

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Front Cover Photos

Clockwise from left to right: Chap leg bee (*Svastra obliqua*), Rollin Coville; red admiral butterfly (*Vanessa atalanta*), Mace Vaughan; and yellow-faced bumble bee (*Bombus vosnesenskii*), Sean McCann.

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Getting Started

Introduction

Invertebrates are tremendously diverse and ecologically valuable. They filter water, recycle nutrients, pollinate flowers, and are food for other wildlife. Pollinators are especially vital because of the ecosystem services they provide by pollinating crops and wildflowers. Insect pollinators include bees, wasps, flies, beetles, butterflies, and moths. Of these, bees are the most effective pollinators because (with a few exceptions) they are the only group that actively collects pollen to feed their young and therefore have bodies that are very effective at carrying large amounts of pollen.

This Citizen Science Monitoring Guide will allow you to track bee richness and abundance in a variety of sites including farms, hedgerows, restoration sites, remnant prairies, and almost any habitat where bees occur.

For most people, when they hear the word "bee," a single species comes to mind, the nonnative European honey bee. However, North America is home to roughly 4,000 species of native bees. In the Maritime Northwest, there are between 200 and 300 species of wild native bees that are important for the pollination of the region's many specialty crops and wild flowering plants. Roughly one third of crop production and about 85 percent of the earth's flowering plants rely on pollinators to set seed and fruit.

In recent years, research has shown that native bees are valuable crop pollinators, and in many cases they can be more efficient at pollination than honey bees. This is especially relevant today as the honey bee industry continues to struggle with pests, diseases, pesticide exposure, habitat loss, and the phenomenon termed "Colony Collapse Disorder." Together, these threats combine to cause beekeepers to lose 25–35% of their hives each winter since 2006.

The Xerces Society for Invertebrate Conservation has partnered with the Natural Resources Conservation Service (NRCS), Soil and Water Conservation Districts (SWCDs), Bureau of Land Management (BLM), Forest Service (USFS), Port Authorities, and landowners across the country to protect, restore, create, and enhance native bee and butterfly habitat on the lands they manage. Since 2006, we and our university research partners have used professional, standardized monitoring protocols to document how bee and butterfly communities respond to restored pollinator habitat. To complement this professional monitoring, we worked with partners at the University of California–Berkeley to develop a simplified bee monitoring protocol for California and trained citizen scientists to observe and identify

Figure 1: Bees are the most important group of pollinators in North America, responsible for pollinating numerous crops and wildflowers. (Photograph by Mace Vaughan.)

Figure 2: The pollen carried on flower-visiting insects is an essential link in the web of life. Bumble bees, shown here, are very efficient pollinators of many specialty fruits produced in the Maritime Northwest—like raspberries. (Photograph by Mace Vaughan.)

morphogroups of bee species (that is, sets of species that look similar and, in some cases, are closely related). Comparative analysis of the data gathered by these citizen scientists and data gathered by experts suggests that the morphogroups used by citizen scientists are effective at detecting community level changes in bee abundance and richness.

The majority of the native bees in the Maritime Northwest can only be identified to species by looking at the specimens under a microscope and there are only a handful of taxonomists in North America who can accurately identify all bees to this species level! However, don't despair! By using the observation protocol and bee identification key found in this guide and by practicing observations with native bee experts, citizen scientists can learn to identify and monitor some of the most common bee species and morphogroups found in the Maritime Northwest.

Figure 3: Monitoring of pollinators usually requires nothing more than careful observation of what the insects on flowers are doing and what they look like. By following the same procedure each time, you can build up a valuable record of which pollinators are most abundant at your site and changes in their populations over time. (Photograph by Kelly Gill.)

Citizen Scientist Monitoring Protocol

The primary purpose of this monitoring protocol is to provide a method the public and land managers can use to measure the relative species richness and abundance of bees in a specific area, and to record changes in their populations over time. This information may be useful if land managers are working to increase the numbers and types of pollinators in an area by enhancing floral resources and/or nesting sites. Monitoring allows for the documentation of how restoration practices are affecting bee communities. Furthermore, if nearby crops need insect pollination to set fruit, monitoring bee visitation on these crops will give valuable information about the pollination service provided by local bee communities.

The monitoring protocol in this guide has been adapted from a standardized method of collecting bee data and setting up monitoring plots that was developed by bee biologists (see Bee Inventory Plot, http://online.sfsu.edu/~beeplot/).

The majority of this guide addresses monitoring for native bees. It also includes several sections on butterfly monitoring. Butterfly monitoring uses a different protocol and cannot be completed at the same time as bee monitoring. See pages 37 to 41 for details on butterfly monitoring.

Monitoring Bees

Bee communities vary depending on the quality of the immediate and surrounding habitat. Documenting changes in bee communities using this protocol will allow you to assess the efficacy of best management practices aimed at increasing pollinator abundance and richness. Best management practices may include enhancing floral resources, nest sites and host plants, reducing tillage, changing mowing regimes, and reducing the non-target impact of pesticides. Alternatively, using this protocol to monitor pollinators in field crops or orchards can provide insights into which native species provide farmers with free pollination services.

To develop an accurate picture of how bee communities are changing, however, it is important to keep in mind the following points:

- Because one of the primary goals of monitoring is to get comparative data about changes in bee richness and abundance over time, consistency in using the monitoring protocol is crucial.
- Bee populations vary depending on the time of year, time of day, and weather patterns. Because of this it is important to survey several times in a given season, and gather a few years of data before coming to any conclusions.
- While this approach is geared towards those who are not experts in insect identification, accurate monitoring does require training and practice in identifying the broad morphogroups of bees detailed in this guide.

Overview of Techniques and Guidelines

The bee groups addressed in the identification guide are for use in the Maritime Northwest from early spring to late summer. For the purposes of this guide, the Maritime Northwest is defined as west of the Cascade Mountains from Eugene, Oregon, to Vancouver, British Columbia. While bee groups in this guide overlap significantly with bees from other parts of the West Coast, you may come across species that do not fit into the categories found in this guide.

Standard monitoring techniques used by the research community to measure bee richness and abundance include collecting floral visitors with nets and using pan traps (bowls of soapy water). In both cases, specimens are collected, pinned, and then identified to species by a taxonomist. While these collection techniques provide the most refined data, they can be labor intensive and expensive. Additionally, if not carried out properly, they can lead to over-collecting. Collecting observational data on floral visitors is an economical and effective alternative way to monitor pollinator populations. This protocol focuses on collecting observational data; however, it can also be useful to build a local reference collection of the species you find at flowers. Building a reference collection will help you learn the floral visitors on-site and will be a useful tool for training future observers.

The Citizen Scientist Pollinator Monitoring Guide can be used to collect consistent observational data on bee communities. Guidelines in this publication include information on: (1) setting up monitoring transects, (2) sample timing, (3) appropriate weather conditions for monitoring, (4) observing bees at flowers, (5) recording data, (6) analyzing data, and (7) identifying groups of floral visitors. A sample step-by-step protocol for native bee monitoring is provided in Section 5 (p. 32).

This monitoring tool is designed to be used after training with Xerces Society staff or professional scientists familiar with this monitoring guide. Training is important because consistently and accurately identifying even broad categories of bees based on their appearance takes some practice and feedback from experienced people.

Setting up Transects in Bee Monitoring Plots

The goal of this monitoring protocol is to identify specific associations between pollinators and their habitat. Therefore, monitoring transects should be located within a relatively uniform habitat type, such as a meadow, restored prairie, hedgerow, or crop.

Transects should be equally spaced throughout the study area. For areas less than two acres in size, a single transect through the middle of the site should be sufficient. A transect lenght of at least 250′ is ideal, although in smaller areas this may not be possible. For areas that are greater than two acres in size, two to three transects should be used for a total length between 600–750′ (for example, three transects 200–250' long, or two transects 300–350' long). If multiple transects are use, they should be positioned 100' apart, or as far apart as possible while still being in the interior of the plot (ideally at least 10–25′ from edge)

For monitoring linear habitats like hedgerows or roadsides, transects should be at least 200' long and spaced evenly along the length of the habitat. If sampling both sides of a hedgerow, transects should be at least 25' apart.

It is important to map the study area and transect points. This will allow other researchers to monitor that area in the future. If possible, take coordinates using a GPS unit or phone. If no GPS is available, mark the study area and transects on a topographic map, aerial photo, or Google Earth. It is also helpful to stake and flag monitoring transect points before monitoring to ensure a consistent and efficient monitoring scheme. Tall stakes (e.g., bamboo) with bright flagging are more visible as vegetation grows, and will help observers walk in a straight line a long the transect.

Sample Timing

Many bee species only forage for pollen and nectar for a limited number of weeks every year. As a result, bee communities may vary greatly between samplings. While some bee groups appear consistently during every sample round, other groups are abundant only at certain times of the year. For this reason, it is ideal to monitor a study site monthly (or even more frequently). At a minimum, monitoring should occur at least three times throughout the course of the year, in the late spring/early summer, mid summer, and late summer (the specific months for these seasons vary depending upon where you are in the region). Early spring monitoring may also be important, particularly if you are monitoring a hedgerow or site with early blooming species.

Whichever method you choose for your site, consistency is very important. Once dates and frequency of monitoring are selected, they should be repeated as closely as possible from one year to the next.

Appropriate Weather Conditions and Time of Day

Weather conditions strongly affect bee behavior. Generally speaking, bees avoid cold, windy, or overcast weather. To optimize bee sightings, conduct observations when the temperature is at least 15.5° C (60° F), wind speeds are less than 6 mph, and when there is enough sunlight to see your shadow. These conditions usually exist between 10 am and 3 pm. In order to monitor during optimal and consistent conditions, the time of day when monitoring occurs can be adjusted for the season and daily weather patterns.

To determine wind speed, you can use an anemometer for a precise measure (available at some outdoor outfitters), check the nearest weather station on your phone, or you can use the Beaufort Wind Scale (Table 1, below) to come up with an estimate.

Table 1 **Beaufort Wind Scale**

WIND (MPH)	CLASSIFICATION	APPEARANCE OF WIND EFFECTS
0	Calm	Smoke rises vertically
1–3	Light air	Smoke drift indicates wind direction, still wind vanes
4–6	Light breeze	Feel the wind on your face, leaves rustle, and wind vanes begin to move
7–10	Gentle breeze	Leaves and small twigs will be in constant motion, light flags extended

Observing Bees at Flowers

It is important to keep the following points in mind when collecting observational data on floral visitors:

Only collect data on insects visiting the reproductive parts of the flower:

These insects likely will be collecting either pollen or nectar, and may include bees and non-bees (Figure 4). During the sampling period, don't focus on insects sitting on leaves, petals, stems, etc. (Figure 5) or visitors flying around the area.

Look at all flower types:

Pollinators may visit flowers that are less noticeable to people—such as flowers that are quite small or green. They may also forage in deep flowers (Figure 6). For example, many small bees forage inside tubular flowers like beardtongue (*Penstemon spp.*) and foxglove (*Digitalis purpurea*). Avoid focusing on only one or a few flower types.

FIGURE 4: Mining bees and beetles feeding on *Lomatium* sp. Non-bee floral visitors can help provide a picture of insect diversity at the site, and should be recorded if possible. Record bees first, then others. (Photograph by Mace Vaughan.)

Be careful not to disturb insects visiting flowers before you get a chance to observe them well:

Walk slowly, avoid sudden movements, and do not stand too close to the flower you are observing. Also, insects respond to shadows passing overhead; if possible walk so that your shadow trails you, rather than advances in front of you. If two people are monitoring together, it may be best for one person to observe and the other to record, with the recorder lagging behind so as not to further disturb pollinators.

Observe and identify insects as best you can and only to a level at which you are confident:

Pollinator groups and especially bee groups can be difficult to discern. Even noting whether a visitor is a honey bee, native bee, fly, wasp, butterfly or moth, is useful information. If you are particularly interested in monitoring native bees, it will be important for you to learn to distinguish, at minimum, honey bees from native bees.

Be patient:

If you are monitoring a newly planted area be aware that it may take a few years for the plants to get established before you see an increase in pollinator activity.

Recording Data

This monitoring protocol can be implemented with either a one- or two-person observer team. When using two observers, one person should make observations while the other records those observations. At the beginning of data collection, record all of the required information on the datasheet found at the back of this guide (pages 37 and 38, please photocopy the datasheet as needed; we recommend doing double-sided copies). This information includes the location, time, and date, as well as weather conditions.

When monitoring a transect, citizen scientists should pace themselves so that they move along a transect at an average rate of about 10' per minute. For example, a 250' transect should take about 25 minutes to monitor. Floral density may affect the pace of monitoring within a transect. For example, although the average recommended pace is 10' per minute, observers may slow the pace in portions of a transect with particularly high floral density and increase it where blooming plants are absent. Use a timer to help keep track of how quickly you are moving through the site (and how much time you have left). Do not stop the timer when you are looking at the floral visitors you are identifying and counting.

Transect width may vary depending on the site characterstics and plant community, but should be about 2.5′ to 3′ on each side of the observer. The goal is to establish a standard sampling duration and effort for each transect based on the size of the sampling area. This sample duration stays the same for each site and for each sample period and year, regardless of floral or insect density, in order to standardize a consistent level of effort. This could mean that the observers won't cover the whole transect (although, every effort should be made to cover the whole designated area at least once), or may need to backtrack if they complete the plot or transect before the allotted time is up.

For each floral visitor observed, the citizen scientist should record the following data (as outlined in the data sheets on p. 40–42): an identification of each floral visitor (only to the level at which the observer is confident), a description of the insect or pollinator group, and the number of times an individual of this insect or pollinator group was seen during the monitoring period.

Figure 5: Pollinators that are not visiting flowers during the sampling period should not be recorded. However, if the insect is a unique pollinator—like this unidentified sweat bee—not yet seen at the site, it could be noted in the additional data for your site. (Photograph by Sara Morris.)

Figure 6: Look inside deep flowers for insects, such as this bumble bee worker feeding on the nectar of foxglove. (Photograph by Sara Morris.)

Figure 7: Transects should be marked at each end with a tall stake and colorful flagging. High visibility, even as the vegetation grows, will help observers find the transect and move in a straight line through the transect. (Photograph by Emily Krafft).)

If the observer is comfortable with plant identification, it is also important to note which flower species each pollinator is visiting (see Additional Data to Collect, below). If using a two-person team, the observer dictates the floral visitors and their descriptions, while the observer's partner records this information on the datasheet.

Additional Data to Collect

As noted above, it is also valuable to collect data on the floral associations of pollinators at your site. This information will be help improve your understanding of which plants are important for each pollinator group; which plants are visited in each season; and how pollinator preferences may change over the years as a restoration project progresses. For restoration sites, the lists of species that were planted on site should be available. You may also need to bring plant identification guides with you. Keep in mind that it is important to document blooming plants that are not being visited, as well as those that are. All plants (native or nonnative) blooming in the transect during the time of the survey should be recorded.

It can also valuable to collect site specific data such as changes in land management techniques, additions to habitat structure, extreme climatic events, and anything else of ecological importance that might shed light on changing site conditions and animal richness and abundance.

Plotting Your Data

In order to draw meaningful conclusions about the effects of habitat on bee abundance and richness, data should be collected in a consistent manner over several years. To determine changes in abundance over time, tally the number of individual specimens observed during each monitoring event. These numbers could be averaged for each year (for example, combine results from the early spring, late spring/ early summer, midsummer, and late summer sampling periods into a single average figure for the year) and plotted on a graph or table to show change between years (for example, see Table 2(a) and Figure 8; p. 11). Alternatively, you could total the number of individual specimens observed during each monitoring event or period, and look at each sampling period individually (for example, you could examine changes in the total number of bees observed during the mid-summer sampling from year 1 to year 2, etc.). Note: For an analysis of bee abundance, you may want to exclude honey bees because the placement of even a couple of hives within a few miles radius of the study site could dramatically increase the overall number of bees observed.

Similarly, to calculate a measure of species richness for each sample period or year, you could tally the total number of the ten different bee morphogroups represented in the Monitoring Guide (e.g., striped sweat bees, metallic sweat bees, bumble bees, etc.) that were observed. Once again, the richness could be plotted to record changes over time, either comparing the average or total number of groups observed across all sample periods for each year, or comparing the total number of groups observed during the same sample period from year to year (e.g., see Table 2(b) and Figure 8, p. 11).

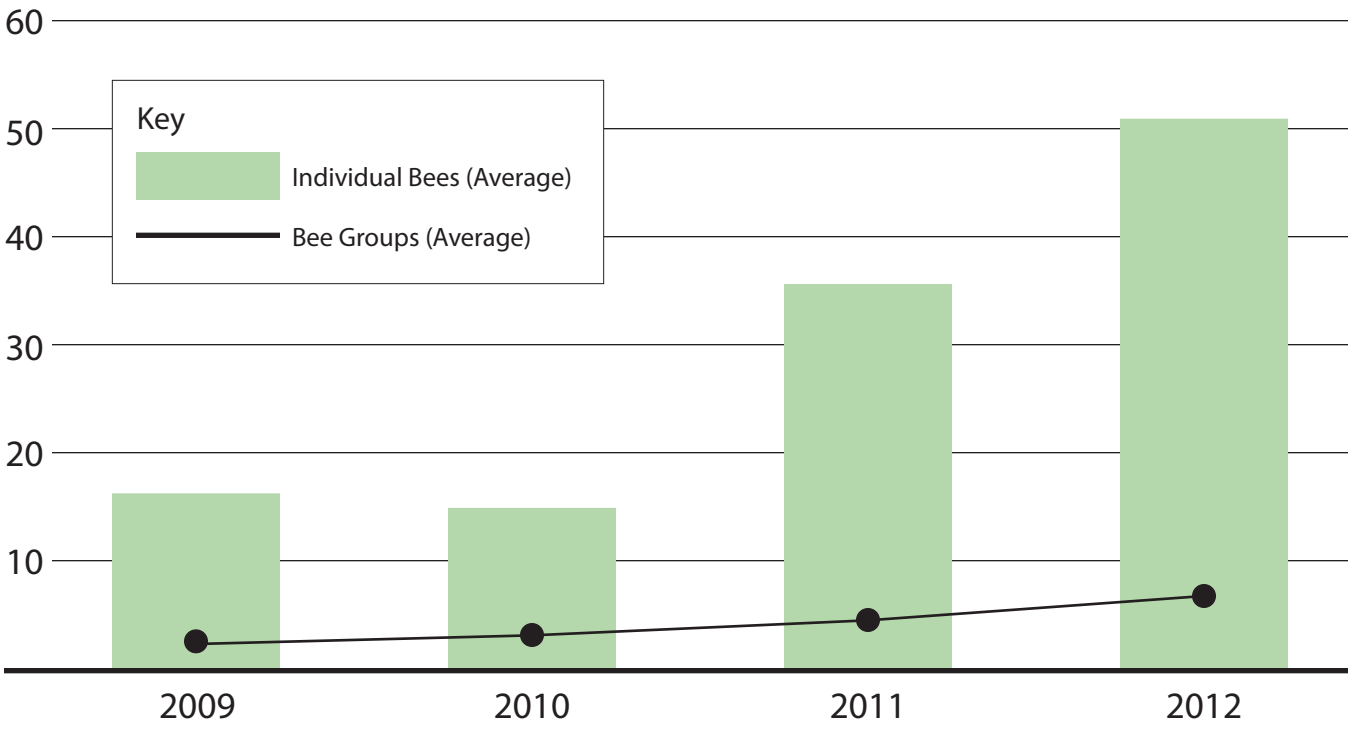
It is important to note that bee populations can vary greatly from season to season as well as from year to year, even in areas where the habitat is essentially unaltered. Thus, the number of species represented and the number of individual pollinators observed within a study area are likely to be highly variable. It is for this reason that monitoring should be conducted for many years in a row in order to draw any substantial conclusions. Sites should be monitored for a minimum of three years, and ideally five. The longer surveys are conducted, the more meaningful the results. In areas where specific habitat and management improvements have been made to attract and protect pollinators, there should be an upward trend in both pollinator abundance and richness over the course of several years. If possible, when habitat improvements are planned, it is useful to acquire baseline data on the pollinator community on site. before enhancing the habitat.

Table 2 **Example Data Spreadsheets**

(A) INDIVIDUAL BEES OBSERVED				
YEAR	LATE SPRING	MIDSUMMER	LATE SUMMER	AVG
2009	Date: 5/1	Date: 6/27	Date: 8/9	15.3
	Bees: 4	Bees: 14	Bees: 28	
2010	Date: 5/3	Date: 7/4	Date: 8/8	13
	Bees: 8	Bees 16	Bees: 15	
2011	Date: 4/30	Date: 6/30	Date: 8/11	35.7
	Bees: 22	Bees: 43	Bees: 42	
2012	Date: 5/6	Date: 6/29	Date: 8/14	51
	Bees: 28	Bees: 58	Bees: 67	

(B) BEE GROUPS OBSERVED				
YEAR	LATE SPRING	MIDSUMMER	LATE SUMMER	AVG
2009	Date: 5/1	Date: 6/27	Date: 8/9	3.3
	Groups: 2	Groups: 3	Groups: 5	
2010	Date: 5/3	Date: 7/4	Date: 8/8	4
	Groups: 4	Groups: 3	Groups: 5	
2011	Date: 4/30	Date: 6/30	Date: 8/11	5.3
	Groups: 4	Groups: 6	Groups: 6	
2012	Date: 5/6	Date: 6/29	Date: 8/14	7.3
	Groups: 6	Groups: 9	Groups: 7	

Figure 8 **Example Graph Showing Bee Community Changes**



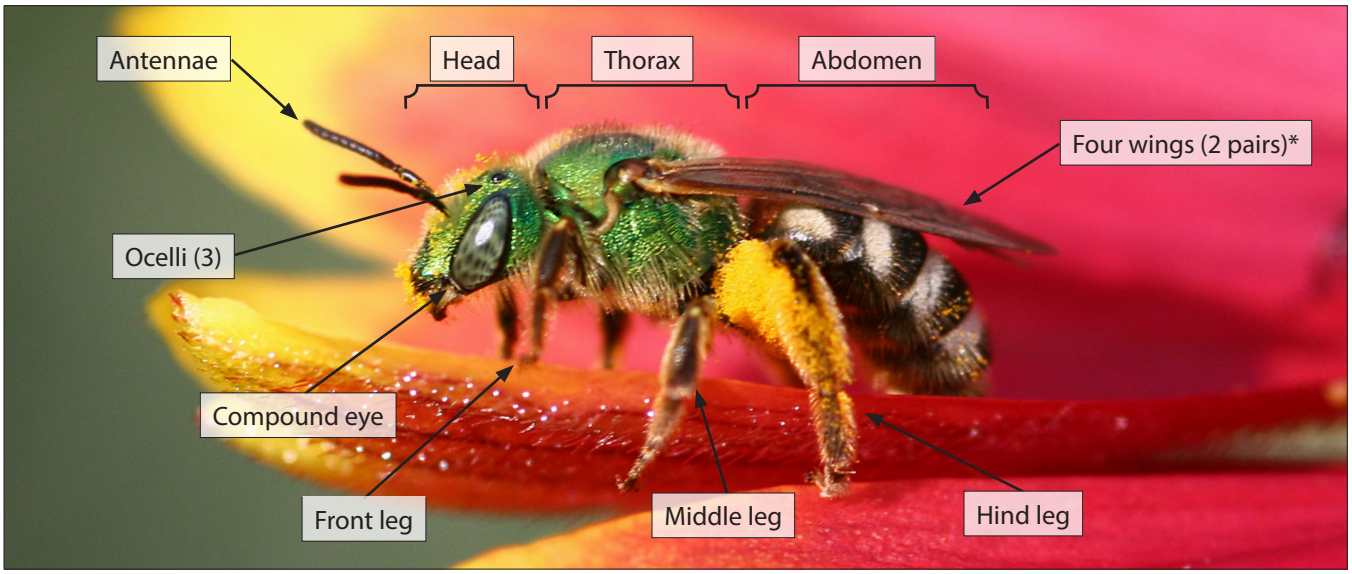
In order to analyze how bee communities change over time it is important to standardize the monitoring protocol, sampling effort, and weather conditions. Specifically, monitoring should occur at roughly the same time every year, for the same amount of time, over the same area, and under similar conditions using a standardized protocol. Once a protocol has been established for a site, it should be clearly written out so that it may be referenced in future years or easily replicated by a different trained observer.

Section 2

IDENTIFYING FLORAL VISITORS

Distinguishing butterflies, moths, or spiders from bees is simple. Separating bees from wasps or flies—especially those that mimic bees—can be harder. The following pages provide more information on how to identify the principal groups of bees and key characteristics to look for when identifying specific bee groups.

Basic Bee Anatomy

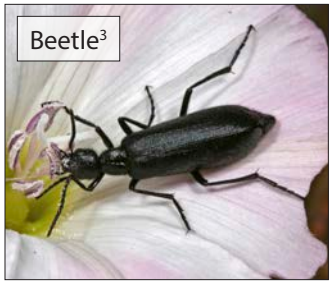


*Note: it can be difficult to see all four wings because sometimes the wings are held on top of each other.

Photograph courtesy of sankax.

Non-Bee Quick Reference

Bees, in general, have evolved to be the most efficient pollen transporters. However, many other animals that visit flowers have the potential to pollinate as well, and may also be indicators of a healthy ecosystem. For this reason, you may wish to note all floral visitors.



Photographs courtesy of Mace Vaughan[1], Celeste Ramsay[2], Rollin Coville[3,6], John J. Kehoe[4], Sara Morris[7], and TJ Gehling[5,8].

Bees

KEY CHARACTERISTICS:

- Bees have two pairs of wings (difficult to see when held over the body).
- Bees have large eyes located on the sides of their heads.
- Bees are typically more robust (i.e., rounder bodies) than wasps and flies. Abdomen usually looks broad near thorax compared with wasps.
- Bees have antennae that are long and bent.
- Most bees are hairy, especially on their legs and/or on their abdomen.
- Female bees can carry large loads of pollen, either on their legs or on their abdomen in a "scopa" or "corbicula."

SIZE: Can range from less than ⅛" to more than 1".

COLOR: Can be black, brown, grey, orange, red, silver, or metallic blue, green, or copper-colored and sometimes yellow.

STRIPES: Stripes can be formed by the hair color (e.g., yellow, orange, white, black, or brown) as well as the color of the exoskeletcon (body covering).

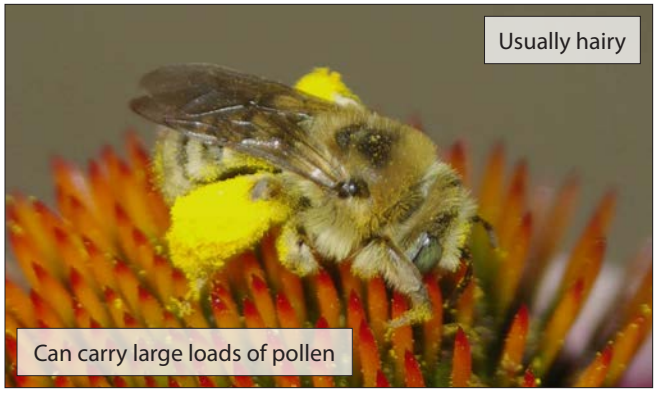
A NOTE ABOUT STINGS:

When working around bees (and wasps) there is always a risk of getting stung. Most bees are not aggressive and will not sting unless handled improperly. Bees are very docile when visiting flowers. Most wild native bees are far less defensive than the European honey bee or social wasps.

Should you be stung by any bee (or wasp) while out in the field, try to identify the type of bee (or wasp) that stung you and let someone know so they can help watch for symptoms. Most people have mild reactions to bee and wasp stings and exhibit a reaction only at the site of the sting (mild swelling, redness, itchiness, or mild pain). However, it is important to monitor yourself after a sting for signs of a more severe reaction.

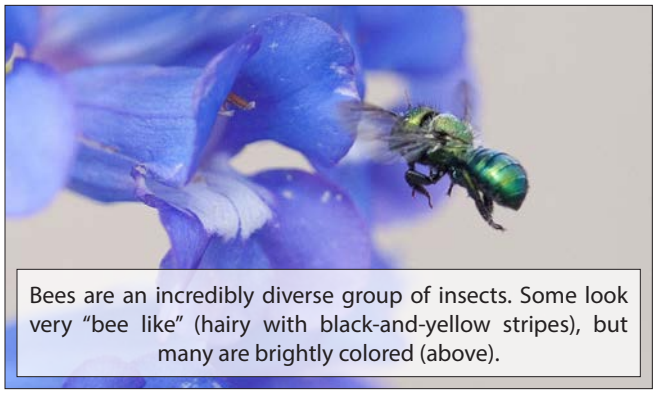
Symptoms of a serious reaction include swelling elsewhere on the body, vomiting, dizziness, hoarseness, thickened speech, or difficulty breathing, and should receive prompt medical attention from a physician.

Photograph by Sara Morris.



Photograph by Mace Vaughan.

Photograph by Matthew Shepherd.



Photograph courtesy of Rod Gilbert.

Flies vs. Bees

KEY CHARACTERISTICS:

- Flies often have short thick antennae (sometimes difficult to see).
- Flies often have very large eyes near the front of their head, usually converging on the top of the head.
- Flies only have one pair of wings.
- Flies are usually less hairy than bees.
- Many flies can hover (most bees are not able to hover, except for carder bees where hovering is common).
- Flies do not carry large loads of pollen although some grains may stick to their bodies.

SIZE: Range similar to bees: from ⅛" to 1".

COLOR: Can be black, brown, yellow, or metallic blue or green.

STRIPES: Can have stripes, usually from exoskeleton color.

NOTE: Many hover/syrphid/flower flies, bee flies, and robber flies are convincing mimics of bees and wasps. Look carefully at the eyes, legs, wings, antennae, and behavior to distinguish these look-alikes. Syrphid flies are frequent floral visitors that are impressive honey bee and bumble bee mimics.

Photograph by Mace Vaughan.

Photograph courtesy of Rollin Coville.

Photographs courtesy of Sean McCann (top), Mace Vaughan (bottom left), and sankax (bottom right).

Photographs courtesy of Rollin Coville (top), Celeste Ramsay (bottom left), and Sara Morris (bottom right).

Wasps vs. Bees

KEY CHARACTERISTICS:

- Wasps, like bees, have four wings (two pairs; often folded lengthways), but it can be hard to see them
- Wasps usually have narrower bodies and a very constricted (pinched) abdomen where it connects to the thorax (more obvious than in bees)
- Wasps tend to have more extensive and obvious coloration and patterns on their exoskeleton (bee markings are usually colored hairs)
- Wasps are generally not hairy
- Wasps do not carry pollen loads, although some pollen grains may stick to their bodies
- Some female wasps have long, obvious ovipositors

Photograph courtesy of Rollin Coville.

SIZE: Can be very tiny to ~1".

COLOR: Can be black, brown, red, orange, yellow, white, or metallic blue, green, or copper.

STRIPES: Can have body stripes or coloration patterns on their exoskeleton that closely resemble a bee. Stripes and markings are usually not from hair patterns.

Photograph courtesy of John J. Kehoe.

Photograph courtesy of Rollin Coville.

Photographs courtesy of Louis Moore.

Section 3

UNDERSTANDING BEES

This section describes the key characteristics that identify different bees. You can then use these to help you navigate the key found on p. 23.

If you see that a floral visitor is carrying loads of pollen on its hind legs or abdomen, this visitor is likely a bee. Female bees collect pollen from flowers to bring back to their nests, where they use it to feed their offspring. For this reason, they have evolved to be very efficient pollen transporters. All bees have branched ("feathery") hairs to which pollen easily sticks. In addition, bees also have dense hairy patches or other structures for storing pollen for transportation. Depending on the family, these hairs will be on the hind legs or the underside of the abdomen. Some bees, such as honey bees and bumble bees, will add nectar to pollen that they have collected so that it is moist. This moist pollen is then packed onto "pollen baskets," a cup-shaped area on the middle part of the hind legs. However, some bees lack pollen carrying structures altoghter—namely, the yellow-faced bees (p. 29), who carry pollen internally in their crop; and cuckoo bees (p. 31), who do not construct or provision their own nests. To confuse things slightly, males do not collect and transport pollen, and so are usually less hairy than females, and in some species both males and females have few hairs.

HAIR—KEY CHARACTERISTICS:

- Is the bee **hairy**?
- If so, **where** is it the ***most hairy***?

Photographs courtesy of Katharina Ullmann[1], Whitney Cranshaw[2], Rollin Coville[3,4,6], and Kevi Mace-Hill[5].

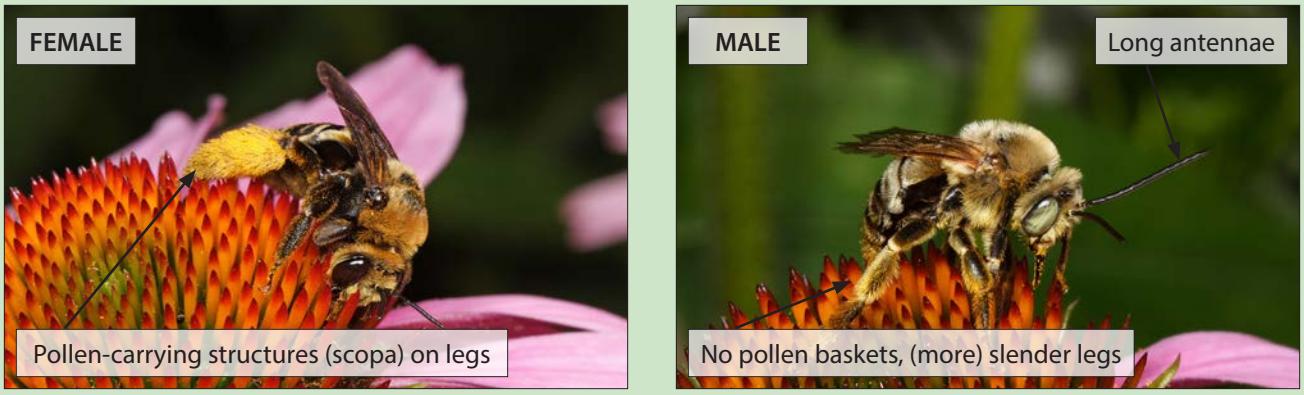
POLLEN—KEY CHARACTERISTICS:

- Does the bee have **pollen** on its body?
- If so, **where?**
- Does the pollen look **moist and packed**, or **dry and loose**?

Photographs courtesy of Sean McCann[1], Sara Morris[2], Rollin Coville[3,4,6], and Leithen M'Gonigle[5].

Gender Differences in Bees

Females bees typically carry pollen in a specialized structure called a scopa (cluster of hair) or corbicula (cup-shaped disc fringed with hair) on the hind legs or abdomen. Male bees lack pollen-carrying structures and have longer antennae (this is more noticeable in some groups). Within a given species, females are usually larger than males.



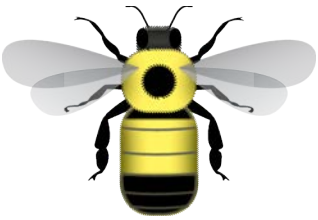
Photographs courtesy of Rollin Coville.

SIZE AND SHAPE

WHAT SIZE IS THE BEE?

Perdita minima, the smallest bee in North America, placed on the face of one of the largest, *Xylocopa varipuncta*.

Photograph courtesy of Stephen L. Buchmann.



EXTRA-LARGE
(16–25mm)

LARGE
(13–16mm)

MEDIUM
(9–13mm)

SMALL
(7–9mm)

TINY
(≤7mm)

WHAT SHAPE IS THE BEE?

Photographs courtesy of Rollin Coville.

ANTENNAE—KEY CHARACTERISTICS:

- Does the bee have long or short antennae relative to the size of its body?

Photograph by Matthew Shepherd.

Photograph by Sara Morris.

COLOR—KEY CHARACTERISTICS:

- What are the predominant color(s) of the bee? *(Note: predominant colors could come from either the hair or the exoskeleton)*
- Are the head, thorax, or abdomen different colors?
- Is it metallic?

Photographs courtesy of Mace Vaughan[1,6], Rollin Coville[2,3,7,9], Sara Morris[4], Louis Moore[5], and Jack Dykinga[8].

STRIPES—KEY CHARACTERISTICS:

- Does the bee have stripes on its body?
- If so, where?

Photograph courtesy of Rusty Burlew.

Photograph courtesy of Rollin Coville.

Section 4

GUIDE TO 10 GROUPS OF BEES

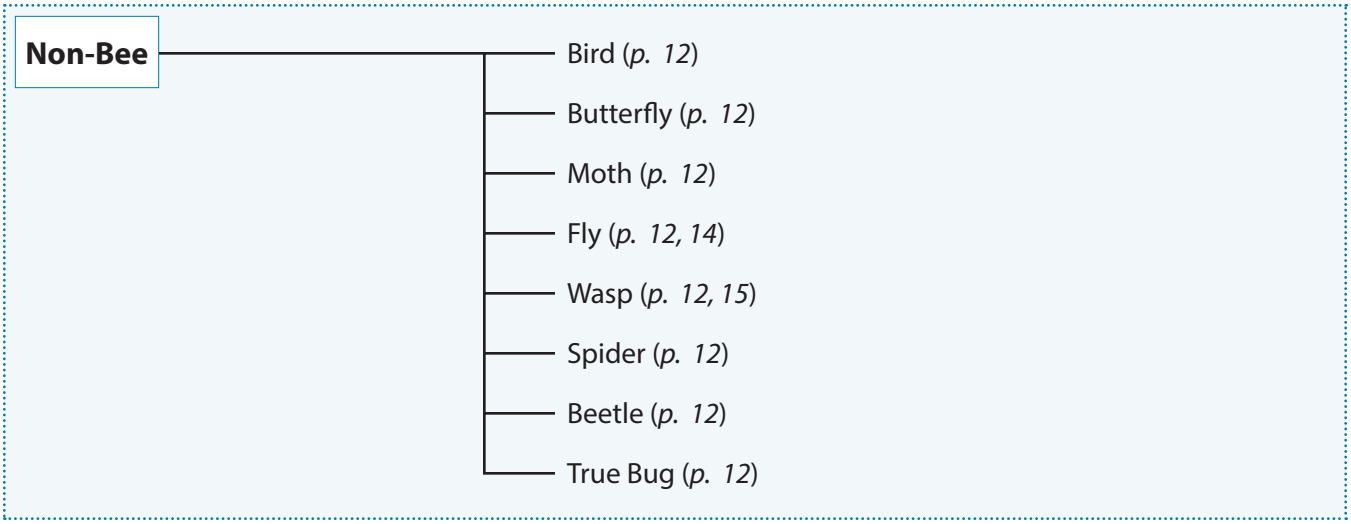
There are roughly 200 to 300 species of bees in the Maritime Northwest. This guide will help you identify some of the most common bee morphogroups. The photos on this page illustrate some of the diversity of these bees.

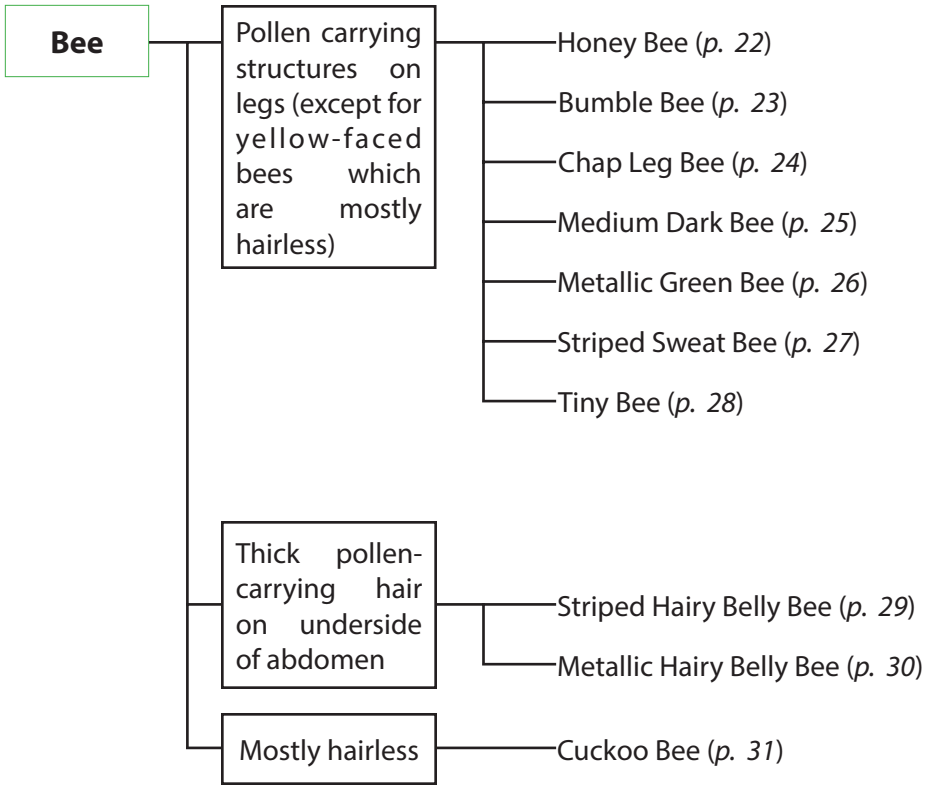
Remember, this guide is not exhaustive, so if you observe a bee that does not fall into an identified morphogroup, note the bee as "Other bee" and describe the it thoroughly in the observational notes. Even if you can't identify the bee precisely, it is important to document that it was observed.

In particular, it is important to distinguish the honey bees, which are nonnative, from native bees. Whenever possible, attempt at minimum to distinguish honey bees from the rest of the bee categories. Before monitoring, study the "honey bee" page carefully.

Photographs courtesy of Mace Vaughan[1,3,9], Matthew Shepherd[2], Rod Gildbert[4], Rollin Coville[5,6,7,8], and Sarah Foltz Jordan[10].

Key to Identifying Floral Visitors





Identify bees to the most specific group possible. For example, if you do not know what type of bee you see, but you know that it is not a honey bee, note only that "it is not a honey bee." In some cases (e.g., bumble bees) it will be possible to distinguish species within a bee group.

Honey Bees

FAMILY: Apidae
GENUS SPECIES: *Apis mellifera*

For most people, it is the honey bee that comes to mind when they hear the word "bee."

IDENTIFICATION:

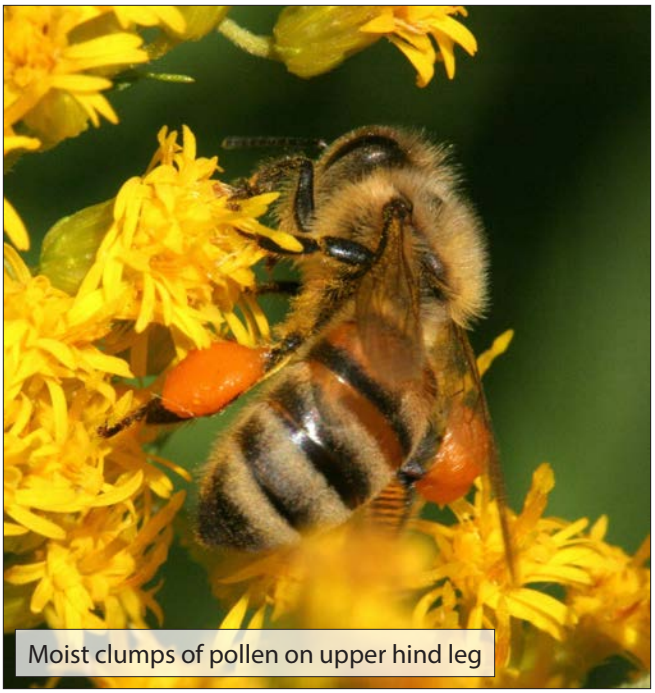
- **Size and shape:** Medium to large with torpedo shaped bodies.
- **Color and hair:** Amber-brown to nearly black; moderately fuzzy thorax and head, legs and abdomen less hairy.
- **Stripes:** Abdomen tri-toned with black, pale and orange-brown stripes.
- **Corbicula:** Enlarged, flattened plates fringed with hairs on hind legs to carry moist pollen.

NOTE: Makes buzzing sound when flying and often flies methodically from flower to flower.

IMPORTANT: Honey bees are not native to North America, whereas most other wild bees are. During monitoring, distinguishing between honey bees and the rest of the bee categories is the most important observation you can make.

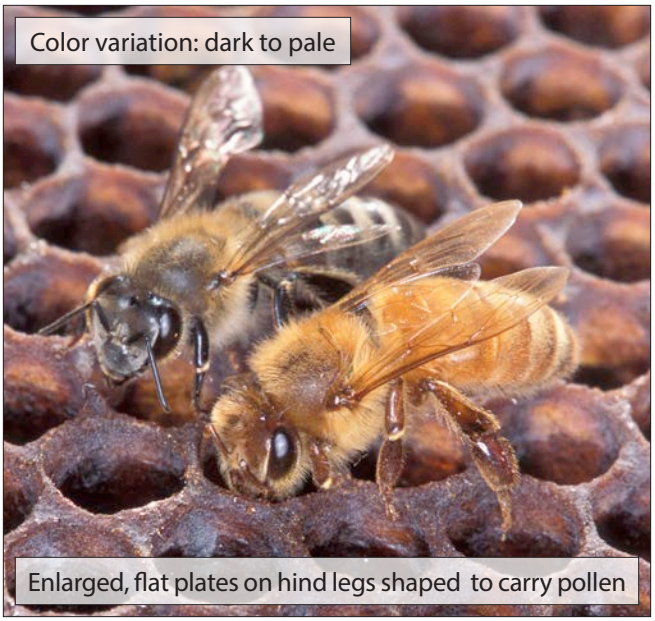
CAUTION: There are some flies that mimic honey bees (p. 14). To distinguish flies, look for two wings (one pair), short stubby antennae, large eyes that meet in the middle, and skinny hind legs. These flies will also hover, whereas honey bees do not.

SIZE RANGE: 12–15 mm



Photograph courtesy of David Cappaert.

Photograph courtesy of Rollin Coville.



Photograph courtesy of Scott Bauer.

Bumble Bees

FAMILY: Apidae
GENUS: *Bombus*

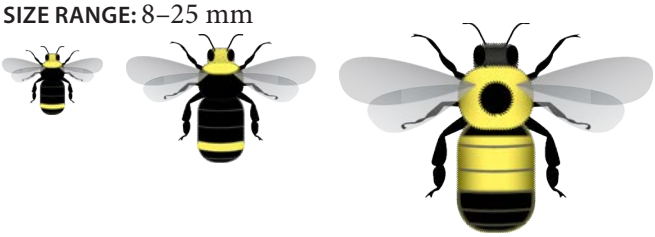
IDENTIFICATION:

- **Size and shape:** Medium to very large, robust (workers & males are smaller than queens).
- **Color and hair:** Mostly black with yellow, orange, or brown markings. Entire body is fuzzy.
- **Stripes:** Hair can form yellow, black, orange, or brown stripes or markings.
- **Corbicula:** Females have flattened plate on upper hind leg for carrying moist clumps of pollen.

NOTES: Make a low buzzing sound when flying. Several flies are excellent bumble bee mimics (see p. 14), but they only have two wings (one pair).

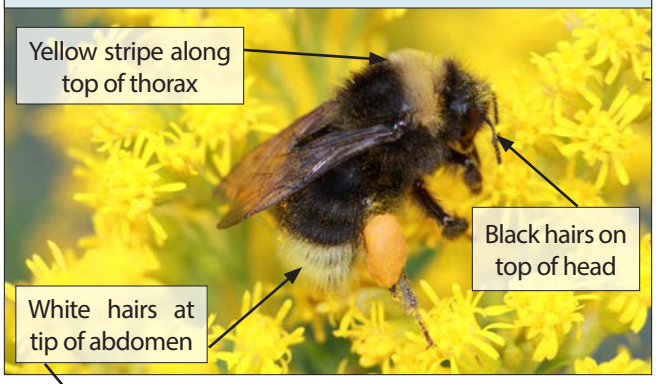
LOOK-ALIKES: In addition to flies that mimic bumble bees, there are numerous native bee species that appear similar to bumble bees. Large carpenter bees (not included in this guide) look very similar to bumble bees, but they are shinier (less hairy), especially on the abdomen. Large carpenter bees are rare in the Maritime Northwest, but occur in the southern parts of Oregon. Additionally, some larger species of chap leg bees (p. 24) and medium dark bees (p. 25) can also be confused with bumble bees.

SIZE RANGE: 8–25 mm



Photographs courtesy of Sean McCann.

The western bumble bee (*B. occidentalis*) is a species of conservation concern in the Maritime Northwest



Photographs by Rich Hatfield.

Photograph by Louis Moore.

Chap Leg Bees

FAMILY: Apidae
GENERA: *Melissodes* (Long-horned bees), *Peponapis* (Squash bees) , and others

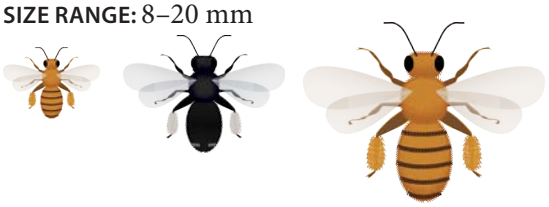
FAMILY: Apidae
GENUS: *Anthophora* (Digger bees) and others

KEY CHARACTERISTICS:

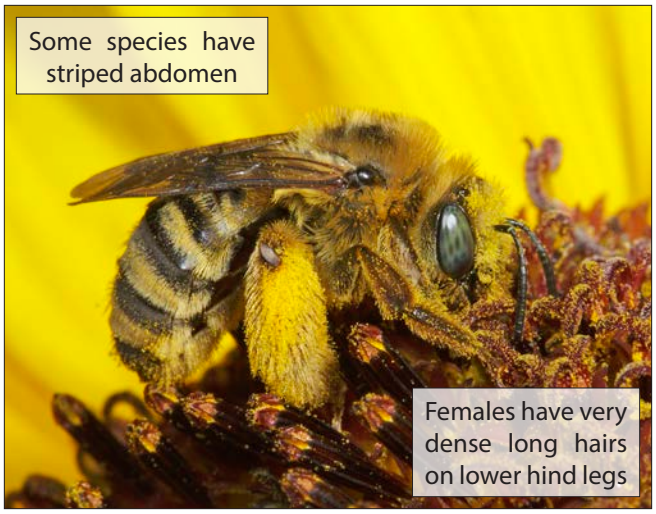
- **Size and shape:** Medium to large, robust.
- **Color and hair:** Dark with white, yellow or brown hairs; often very hairy—especially on thorax—with short, dense, velvety hair. Some species in the Maritime Northwest are almost solid black or grey, usually with lighter hairs on their legs or scopae (females).
- **Stripes:** Often with bands of pale hair on abdomen.
- **Scopa:** Carries dry pollen on noticeably dense hairs on lower hind legs, but pollen is often on the whole body.

NOTES: Antennae are typically longer than most other bees, especially on males. The legs of males are not as hairy as the legs of females because males do not transport pollen. Some fly fast (usually in smooth motions that almost look like they are tracing a figure 8) and can visit flowers rapidly.

SIZE RANGE: 8–20 mm



Photograph courtesy of Ian Marsman.



Photograph courtesy of Rollin Coville.

Photograph courtesy of Sean McCann.

Medium Dark Bees

FAMILY: Andrenidae (Mining bees)
GENUS: *Andrena* and others

FAMILY: Colletidae (Polyester bees)
GENUS: *Colletes*

KEY CHARACTERISTICS:

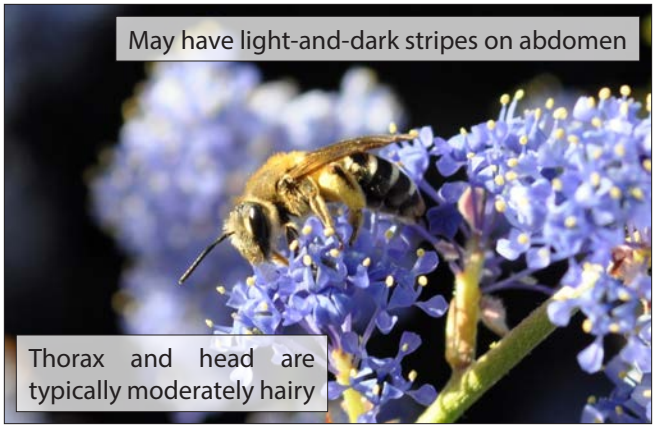
- **Size and shape:** Small to large; relatively narrow to moderately robust.
- **Color and hair:** Most *Andrena* and *Colletes* species in the Martime Northwest are dull and dark-bodied with a moderately hairy thorax and face. Some western species of *Andrena*, however, are a dark metallic blue-black with mixed light and dark hairs or all-black with dark hairs.
- **Stripes:** May have bands of pale hair on abdomen.
- **Scopa:** Carries pollen on upper hind legs and back of thorax (armpits).
- **Face** may have two hairy depressions between the eyes (*Andrena*) or be heart shaped (*Colletes*)

NOTES: Among the first to emerge in early spring. Nest in the ground, often in large aggregations.

ANDRENIDAE (7–18 mm)

COLLETIDAE (7–18 mm)

Photograph courtesy of Rod Gilbert.



Photograph by Sara Morris.

Photograph by Mace Vaughan.

Photographs courtesy of Rollin Coville[1], and Rusty Burlew[2], and Celeste Ramsay[3].

Metallic Green Bees

FAMILY: Halictidae
GENERA: *Agapostemon*, *Lasioglossum* [in part]

KEY CHARACTERISTICS:

- **Size and shape:** Medium sized, narrow bodied.
- **Color and hair:** Bright metallic green; abdomen can be green like the thorax, or dark with stripes; body covered in pale hairs that are less noticeable.
- **Stripes:** Some with yellow and black striped abdomen.
- **Scopa:** Carries dry pollen on hairs on hind legs, less noticeable than other bees, unless covered in dry pollen.

NOTES: Relatively fast flying and numerous. Antennae are short on females and longer on males.

CAUTION: Some cuckoo wasps (Chrysididae) are metallic green and very easy to confuse with metallic green bees (see below). Mason bees and some mining bees can also be metallic green. Look to see whether the green visitor is a bee or not, and also check where it is carrying pollen or where it is hairy. Sweat bees carry pollen on their hind legs; mason bees carry pollen on the underside and of their abdomens, and also tend to be darker, almost green-blue. In addition, it is important to note if the green visitor has stripes on abdomen (characteristic of *some* metallic green bees, but not chrisid wasps or mason bees)

AGAPOSTEMON (9–11 mm)

Photograph courtesy of Rollin Coville

Photograph courtesy of Rollin Coville

Photograph courtesy of Sean McCann.

Photograph courtesy of Rollin Coville

Striped Sweat Bees

FAMILY: Halictidae
GENERA: *Halictus*, *Lasioglossum* (in part)

KEY CHARACTERISTICS:

- **Size and shape:** Small to medium, narrow bodied.
- **Color and hair:** Usually dark with bands of pale hairs on abdomen.
- **Stripes:** Stripes on abdomen may appear faint and vary in color from creamy to dark gray.
- **Scopa:** Brush of hair on upper part of hind legs, sometimes loaded with pollen.

NOTES: May crawl around the base of flowers or inside flowers. Fast moving; sometimes with jagged movements.

SIZE RANGE: 7–15 mm

Photograph courtesy of Rollin Coville

Stripes vary in color from bright cream to yellow or dark grey

Photographs courtesy of Rollin Coville

Photograph by Mace Vaughan

Photograph courtesy of Joseph Berger.

Tiny Dark Bees

FAMILIES Halictidae, Apidae, Colletidae
GENERA: *Lasioglossum* (Small sweat bees), *Ceratina* (Small carpenter bees), *Hylaeus* (Yellow-faced bees)

KEY CHARACTERISTICS:

- **Size and shape:** Tiny and narrow bodied.
- **Color and hair:** Can be dull black/brown, pale golden, metallic black/brown or blue/green. Sometimes with white or yellow markings on face. Body sparsely covered in pale hairs that are less noticeable, but some with dense patches of hair on abdomen.
- **Stripes:** Faint stripes on abdomen, if any.
- **Scopa:** Small carpenter bees and sweat bees have brushes of pollen collecting hairs on hind leg. Yellow-faced bees carry pollen in a crop, and lack external scopa.

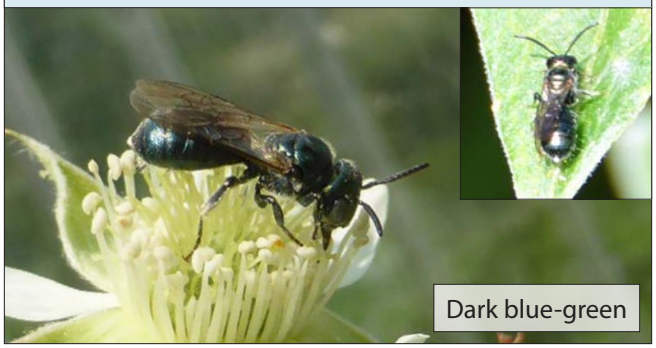
NOTES: Often crawl deep into flowers. Can move fast—some with jagged movements. Members of this morphological group are not closely related and have different life histories and habitat needs (e.g., *Ceratina* and *Hylaeus* are stem nesting, whereas *Lasioglossum* is ground nesting). As such, if you are comfortable distinguishing these genera, you may wish to record them separately in your data sheet.

LASIOGLOSSUM (4–7 mm) **HYLAEUS** (5 mm) **CERATINA** (4–8 mm)

Yellow-faced bees (yellow facial stripes or mask)

Photographs courtesy of Rollin Coville (main) and the USGS (inset).

Small carpenter bee (pointed abdomen with shield-like tip)



Photographs by Sarah Foltz Jordan (top main), Sara Morris (top inset), and courtesy of Rollin Coville (bottom).

Small sweat bee (tip of abdomen rounded)

Photographs courtesy of Rollin Coville (top main) and Rusty Burlew (bottom right), and Sara Morris (top insect, bottom left).

Striped Hairy Belly Bees

FAMILY: Megachilidae

GENERA: *Megachile* (Leafcutter bees), *Heriades* (Small resin bees), *Anthidium* (Carder bees), *Hoplitis* (Mason bees)

KEY CHARACTERISTICS:

- **Size and shape:** Small to medium and typically very robust. Often with a broad head and strong jaws used to cut leaves for nesting materials.
- **Color and hair:** Black with thorax and head covered in silver, white, or yellow hairs OR black with yellow markings on exoskeleton
- **Stripes:** Abdomen has light hairs that create stripes, or markings are on exoskeleton.
- **Scopa:** Females carry dry pollen on thick hairs on underside of abdomen.

NOTES: When visiting flowers, these bees often elevate abdomen, revealing pollen underneath.

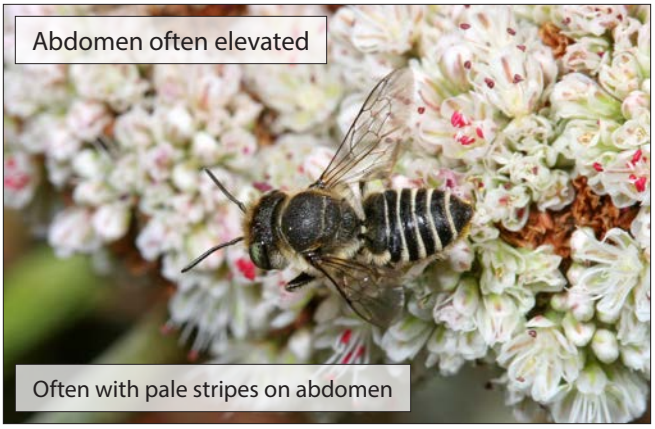
APPROXIMATE SIZE RANGE: 8–12 mm

Pollen carried on the underside of its abdomen

Photograph courtesy of Rollin Coville

Thick brushes of hair on underside of abdomen

Photograph courtesy of Whitney Cranshaw.



Abdomen often elevated

Often with pale stripes on abdomen

Photograph courtesy of Rollin Coville

The nonnative wool carder bee (*Anthidium*) may be seen collecting fiber from fuzzy plants like lamb's-ear

Photograph courtesy of Celeste Ramsay.

May be very small

Photograph by Sara Morris.

Metallic Hairy Belly Bees

FAMILY: Megachilidae
GENUS: *Osmia* (Mason bees)

KEY CHARACTERISTICS:

- **Size and shape:** Small to medium, stout, robust bodies.
- **Color and hair:** Metallic green, blue or bluish black. Brushes of hair beneath abdomen—no prominent hair bands.
- **Stripes:** None.
- **Scopa:** Females carry dry pollen loads on underside of abdomen.

NOTES: Among the first bees seen during the pollinating season. Most are observed in early spring and summer. As their name suggests, some species of Mason bees gather mud and pebbles to construct their nests. These bees are also often called orchard bees, due to their frequent pollination of fruit tree blossoms.

APPROXIMATE SIZE RANGE: 8–12 mm

Photograph by Mace Vaughan

Photograph courtesy of Jack Dykinga, USDA–ARS.

Photograph courtesy of Rollin Coville

Photograph by Mace Vaughan

Photographs courtesy of Seabrooke Leckie (inset) and Elizabeth Sellers (main).

Cuckoo Bees

FAMILIES: Halictidae, Megachilidae, Apidae
GENERA: *Sphecodes*, *Coelioxys*, *Nomada*, *Epieolus*, *Triepeolus*, and others

Cuckoo bees are a very diverse group of bees united by similar life histories—they lay their eggs in other bees' nests. Because they do not provision their own nests, they lack pollen-carrying structures.

KEY CHARACTERISTICS:

- **Size and shape:** Small to large, often narrow bodied.
- **Color and hair:** Variable, can be shiny black, cream, red, or yellowish. Can have red or black legs. Usually not very hairy.
- **Stripes:** Can have wasp-like markings made from short, thick hairs.
- **Scopa:** Lack pollen carrying structures. This can help differentiate *Sphecodes* from some *Lasioglossum* species (p. 28).

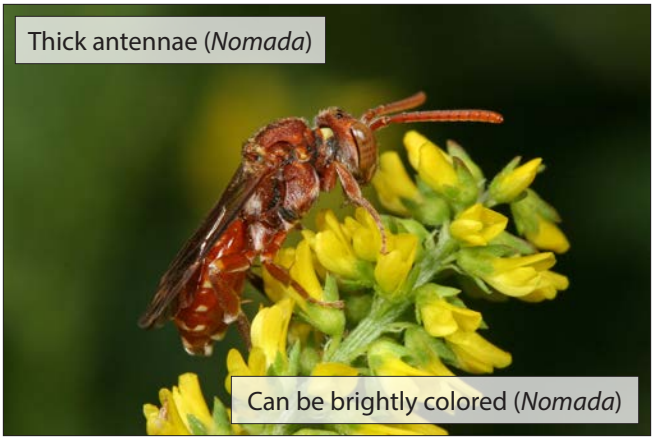
NOTE: These bees are not key pollinators, since they do not actively collect pollen and are generally not very hairy. However, their presence can indicate healthy populations of native bees. During the day, they fly low to the ground searching for nests to parasitize. They are also often seen on flowers, looking for nectar in the evening when their hosts have stopped foraging and returned to their nests.

Cuckoo bees tend to look very wasp-like and may be difficult to identify in the field. Generally, when comparing with wasps, look for shorter legs, elbowed antennae, and more bee like body stature. It may also be wise to learn the patterns and shapes of some of the most common cuckoo bees in your region (e.g., those shown here). If still unsure, mark in the "other" category and report your suspicion of a cuckoo bee.

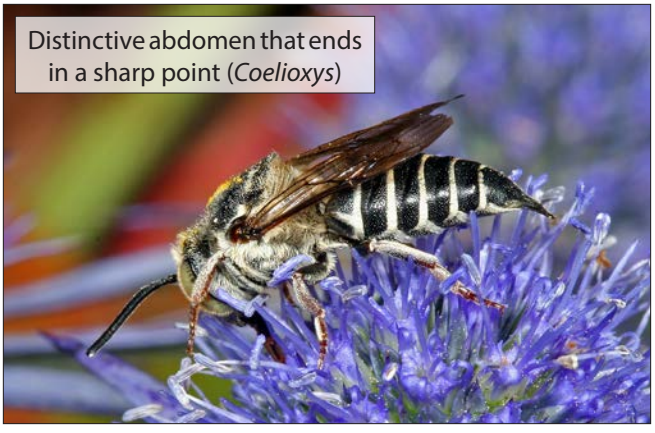
SPHECODES (7–10 mm)

NOMADA (9–12 mm)

Photograph by Sarah Foltz Jordan.



Photograph courtesy of Rollin Coville



Photograph courtesy of Rollin Coville

Section 5

BEE MONITORING PROTOCOL AND DATASHEET

This sample pollinator monitoring protocol can be used to collect observational data on the abundance and richness of native bees, and is designed for observers working on their own or in pairs.

EXAMPLE OF APPLYING THE PROTOCOL

- **Note:** This is an example; the exact timing may vary depending upon weather and the size of the site being monitored.

SETTING UP A SITE

- Prior to conducting site monitoring, transects need to be established. It is also important to map the site or take GPS coordinates of transect end and start points. If GPS is not available, mark the transect(s) on an aerial photo or using Google Earth.

MATERIALS REQUIRED

- Identification and monitoring guides (*Citizen Science Pollinator Monitoring Guide*)
- Clipboard
- Pencil
- Datasheet(s)
- Permits (if necessary)
- Timer
- Thermometer
- Wind meter (optional)
- Sunscreen
- Hat
- Water
- First aid kit (including an Epi-Pen or other appropriate medicine if allergic to bees)
- Site specific monitoring protocol
- Optional: Plant list for the site or plant identification guide

TO SET UP TRANSECT, BRING:

- Measuring tape (100–150') or wheel
- Stakes and flagging to mark the transect end
- Aerial photo or map to document location of transect
- Optional: GPS or phone to record the start and end points of the transect.

Monitoring a site

10:00 AM—ARRIVE AT SITE

- Set up thermometer in the shade, and fill out the site/ date information in the data sheet.

10:10 AM—RECORD START WEATHER DATA AND DETERMINE SAMPLE DURATION

1. **Shade temperature:** should be greater than 15.5° C (60° F)
2. **Wind speed:** average wind speed over one minute (at shoulder height, facing the wind) should ideally be less than 6 mph
3. **Cloud cover:**
   - Clear—clouds rarely/ never cover sun
   - Partly cloudy—clouds cover sun sometimes
   - Bright overcast—even haze/ clouds, but sun or light shadows are visible
   - Overcast—more overcast than bright overcast; no shadows are cast

   NOTE: *Do not sample in overcast, rainy, or windy conditions.*
4. **Sample duration:**
   - To determine the number of minutes you need to sample your site divide the total length (in feet) of the transect(s) by ten.
   - Record this number of minutes on the top of the data sheet.

10:20 AM–11:20 AM—OBSERVATIONS

1. Set timer to 60 minutes. Note start time and then start timer.
2. Begin walking the transect through your study area. Pace yourself. Try to cover the study area (transects) as evenly as possible—it is important not to rush through the area, but it is also important to keep moving (i.e., do not spend more than a couple of observational minutes at any flower or group of flowers). Remember to look at a diversity of flowers, and not just the showy ones. It is also important to be as consistent as possible each time you visit a site so that you collect data with the same level of effort. This will allow you to more reliably compare data from year to year.
3. When you see an animal visiting the reproductive parts of a flower:
   - Observe, identify and note the animal(s) as best you can until you are satisfied with your identification or until the visitor flies away. The recorder should note your observations, including flower species if that is part of your methods.
   - If you see more than one floral visitor on a single flower, first note the number of visitors and then identify them.
4. Begin walking again and continue with your observations until your sampling time is finished.
5. Note end time.

11:20 AM—RECORD END WEATHER DATA

- See above.

11:25 AM—RECORD ANY ADDITIONAL NOTES ABOUT THE SITE

- After you have finished collecting data on the bees, note each additional flower species that is in bloom but did not have floral visitors during your survey. (This could also be noted by either the observer or reporter during the survey if it does not distract from monitoring). You can also record unique insects seen at the site, the intensity of visitation to specific flowers, vigor of the planting, needs for site maintenance, observer contact information, etc.

NOTE:

- This example is based on a 600' long transect.
- During monitoring, the observer and recorder work together to collect observational data for a total of one hour. The observer and recorder should cover the study area (transect) as evenly as possible.

DURING YOUR OBSERVATION

- Only identify and make notes on the animals visiting the reproductive parts of the flower. You do not need to record animals sitting on petals, leaves, stems, etc., or visitors flying around the area.
- Be careful not to disturb insects visiting flowers before you get a chance to observe them well. Avoid sudden movements. Insects respond to a shadow passing overhead by moving away; if possible walk so that your shadow trails you, rather than advances in front of you. Also, do not stand too close to the flower you are observing.
- If you have walked through the entire study area (transect) before the allotted time has expired (in the case of this example, 60 minutes for the whole plot), you may go back to monitor particularly rewarding areas until the time runs out.
- Bee species can be difficult to tell apart. If you are particularly interested in monitoring the native bees on your property, it will be important for you to distinguish, at minimum, honey bees from native bees.

Figure 8: Monitoring in pairs can be highly efficient, allowing the oberserver and recorder to collect data continuously without stopping to take notes. (Photograph by Jessa Kay Cruz.)

CITIZEN SCIENCE MONITORING DATASHEET: NATIVE BEES

STEP 1—Photocopy or print copies of this datasheet in advance (www.xerces.org/csmdatasheets)

STEP 2—Site Details

SITE NAME: _____ **TRANSECT:** _____

MONITORING TIME*: _____ **DATE:** _____

**1 minute per 10' of transect*

OBSERVER: _____ **DATA RECORDER:** _____

STEP 3—Site Conditions *(Remember to note* Observation End Time *upon completion!)*

OBSERVATION START TIME: _____ **SHADE TEMP:** _____ °C / °F **Wind:** (*circle one*) Calm / light air / light breeze / gentle breeze **Sky:** (*circle one*) Clear / partly cloudy / bright overcast **OBSERVATION END TIME:** _____

STEP 4—Monitoring

Set timer and hit start when ready. Note any floral visitors you see and identify to your confidence level. Pace the transect until the time is up.

FLORAL VISITOR CATEGORIES:

Bees:

- Honey bee
- Bumble bee
- Chap leg bee
- Medium dark bee
- Metallic green bee
- Striped sweat bee
- Tiny dark bee
- Striped hairy belly bee
- Metallic hairy belly bee
- Cuckoo bee

Non-bees:

- Butterfly
- Moth
- Beetle
- True bug
- Bird
- Fly
- Wasp
- Spider

OBSERVATIONS:

Important: Remember to look at a diversity of flowers, stand so that you do not cast a shadow, and only ID floral visitors to the level at which you are confident in your identification. In order to track floral attractiveness, tally individual floral visitors from the same species by floral association.

#	FLORAL VISITOR	DESCRIPTION (GENUS, COLOR, SIZE, ETC.)	# OBSERVED (TALLY)	FLORAL ASSOCIATION
1				
2				
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13				

STEP 4—Monitoring, *continued*

FLORAL VISITOR CATEGORIES:

Bees:

- Honey bee
- Bumble bee
- Chap leg bee
- Medium dark bee
- Metallic green bee
- Striped sweat bee
- Tiny dark bee
- Striped hairy belly bee
- Metallic hairy belly bee
- Cuckoo bee

Non-bees:

- Butterfly
- Moth
- Beetle
- True bug
- Bird
- Fly
- Wasp
- Spider

OBSERVATIONS, *continued*: (attach any Additional Monitoring Sheet(s) if necessary, available at: www.xerces.org/csmdatasheets)

#	FLORAL VISITOR	DESCRIPTION (GENUS, COLOR, SIZE, ETC.)	# OBSERVED (TALLY)	FLORAL ASSOCIATION
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

STEP 5—Notes (include changes in weather or other pertinent details)

Example

CITIZEN SCIENCE MONITORING DATASHEET: NATIVE BEES

STEP 1—Photocopy or print copies of this datasheet in advance (www.xerces.org/csmdatasheets)

STEP 2—Site Details

SITE NAME: Goverment Island

TRANSECT: Pollinator Planting Transect 2

MONITORING TIME*: 1 hour

DATE: August 26, 2015

*1 minute per 10' of transect

OBSERVER: Mace Vaughan

DATA RECORDER: Jillian Vento

STEP 3—Site Conditions *(Remember to note* Observation End Time *upon completion!)*

OBSERVATION START TIME: 9:43 am

SHADE TEMP: 74 °C / (°F)

Wind: (*circle one*) Calm / light air / (light breeze) / gentle breeze

Sky: (*circle one*) (Clear) / partly cloudy / bright overcast

OBSERVATION END TIME: 10:40 am

STEP 4—Monitoring

Set timer and hit start when ready. Note any floral visitors you see and identify to your confidence level. Pace the transect until the time is up.

FLORAL VISITOR CATEGORIES:

Bees:

- Honey bee
- Bumble bee
- Chap leg bee
- Medium dark bee
- Metallic green bee
- Striped sweat bee
- Tiny dark bee
- Striped hairy belly bee
- Metallic hairy belly bee
- Cuckoo bee

Non-bees:

- Butterfly
- Moth
- Beetle
- True bug
- Bird
- Fly
- Wasp
- Spider

OBSERVATIONS:

Important: Remember to look at a diversity of flowers, stand so that you do not cast a shadow, and only ID floral visitors to the level at which you are confident in your identification. In order to track floral attractiveness, tally individual floral visitors from the same species by floral association.

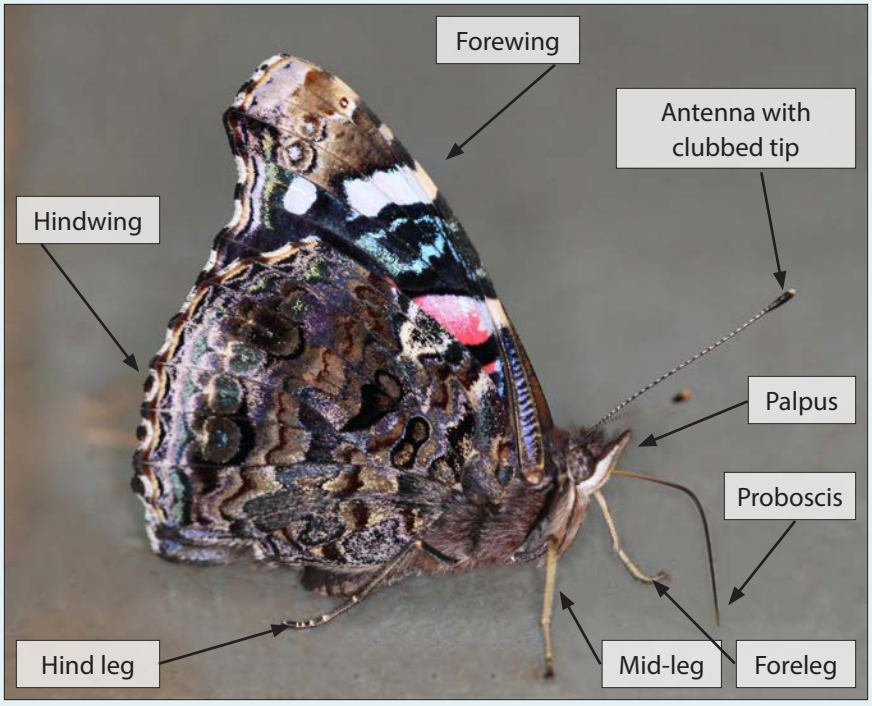
#	FLORAL VISITOR	DESCRIPTION (GENUS, COLOR, SIZE, ETC.)	TIMES OBSERVED (TALLY)	FLORAL ASSOCIATION
1	Bumble	Bombus vosnesenskii	𝍸 𝍸	Canada goldenrod
2	Honey		𝍸	Canada goldenrod
3	Bumble	not sure what species	I	aster
4	Chap leg bee	Melissodes female	𝍸 IIII	thistles (native)
5	Chap	very long antennae, male?	𝍸	thistles (native)
6	STR-Hairy	hairs and pollen on under-side of Abd.	I	coneflower
7	Green bee	striped abdomen, green thorax	IIII	gumweed
8	Cuckoo	black w/ red abdomen	I	aster
9	Honey		I	aster
10	Bumble	Bombus nevdensis	I	gumweed
11	Red admiral			spirea
12	Hoverfly	large, yellow + black	I	unknown mustard (weed)
13	Bumble	Bombus vosnesenskii	III	spirea

Section 6
IDENTIFYING BUTTERFLIES

Butterflies can be excellent indicators of biodiversity and functioning ecosystems. They are easily recognizable and iconic floral visitors. Butterflies and moths both belong to the insect order Lepidoptera. Lepidoptera are a diverse order of insects with more than 12,000 species in North America. Moths make up most of this diversity, but there are approximately 800 butterfly species north of Mexico and 69 species in the Maritime Northwest. In this guide, we group butterflies by the five families of butterflies found in North America, all of which are found in the Maritime Northwest.

For adept citizen ccientists, many butterflies found in the Maritime Northwest can be identified on the wing to species level. Use the identification guides listed in Appendix D. Remember to only identify butterflies to the taxonomic level that you are comfortable with.

Basic Butterfly Anatomy



Photograph courtesy of John Flannery.

Butterflies

ORDER: Lepidoptera
SUPERFAMILIES: Papilionoidea, Hesperioidea

KEY CHARACTERISTICS:

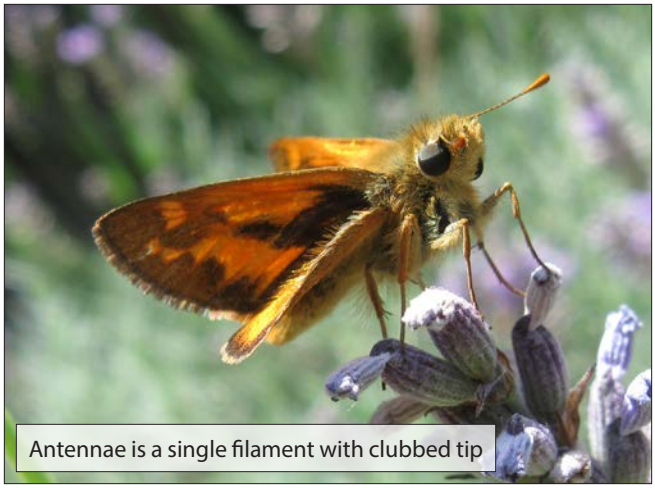
- Butterflies are often brightly colored
- Butterflies fly by day
- Butterflies tend to hold their wings either partially open or closed vertically over their bodies
- Butterfly antennae is a single filament with a clubbed tip

WINGSPAN: 2–10 cm

Photograph courtesy of Rod Gilbert.

Photograph courtesy of Brad Smith

Photograph courtesy of Rod Gilbert.



Photograph by Matthew Shepherd.

Photograph courtesy of Rod Gilbert.

Moths

ORDER: Lepidoptera
SPECIES: 1,200+ in the region

KEY CHARACTERISTICS:

- Moth antennae may be broad and feathery (usually males), or a single filament that tapers to a point (females)
- Moths are often harrier and have more robust bodies then butterflies
- Moths tend to hold their wings flat with forewings covering hind wings
- Moths tend to be colored in muted grays and browns
- Moths tend to fly at night

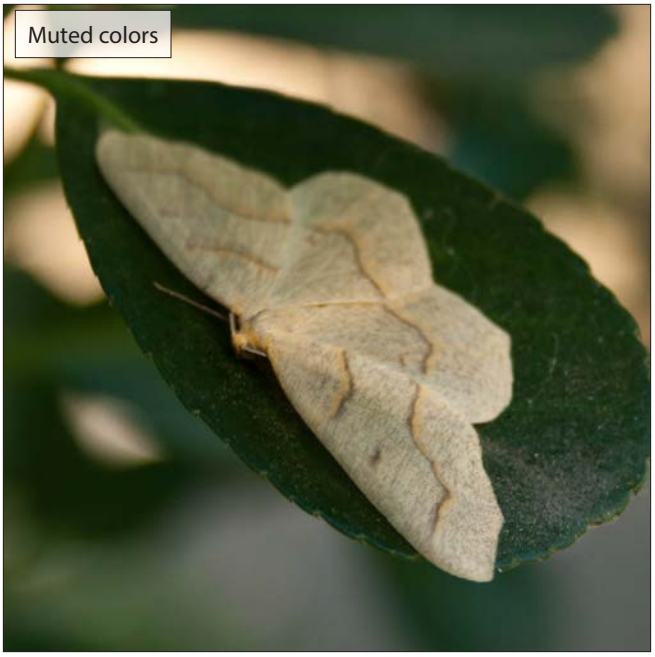
NOTE: Some moths are brightly colored and fly by day. The most reliable methods of identification are the antennae and wing position.

WINGSPAN: 1.1*–16.5 cm

**Excluding micro-moths*

Photograph courtesy of Brad Smith

Photograph by Matthew Shepherd.



Photograph courtesy of Celeste Ramsay..

Section 7
GUIDE TO DIFFERENT GROUPS OF BUTTERFLIES

The butterfly groups found in this Citizen Science Guide follows the modern concept of five families of American butterflies. All of these families are found in the Maritime Northwest and are described in this guide. With practice and use of an identification guide (see Appendix D), many butterflies found in the Maritime Northwest can be identified on the wing to species level for adept citizen scientists. Remember to only identify butterflies to the taxonomic level that you are comfortable with.

Photograph courtesy of Rod Gilbert.

Photograph courtesy of Rod Gilbert.

Photograph courtesy of Rod Gilbert.

Photograph courtesy of Rod Gilbert.

Photograph courtesy of Rod Gilbert.

Skippers

SUPERFAMILY: Hesperioidea
FAMILY: Hesperiidae

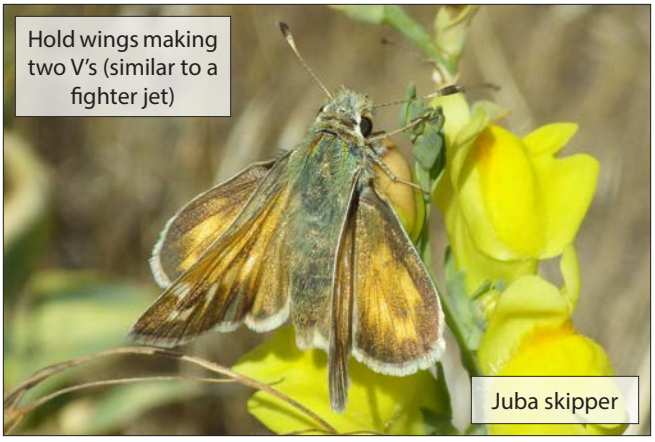
KEY CHARACTERISTICS:

- Short wings
- Must flap rapidly to gain flight
- Bodies are compact and broad
- Antennae are often short, with hooked bulb at the end
- Fairly small, usually brown or orange-brown
- Fly in speedy, skipping, stop-and-go manner
- Often hold their wings partially making two V's

NOTE: Grass skippers are small butterflies, usually brown or orange-brown. Dicot (spreadwing) skippers have the hooked bulb antenna but do not usually keep their wings in a V-shape.

Photograph courtesy of Gary Chang.

Photograph courtesy of Gary Chang.



Photograph courtesy of Gary Chang.

Photographs courtesy of Rod Gilbert.

Swallowtails

SUPERFAMILY: Papilionoidea
FAMILY: Papilionidae

Swallowtails include the largest butterflies in the world. Most species have tails on their hind wings (except for the subfamily Parnassiinae); many are black and yellow or black and white, with blue and orange markings on their hind wings.

KEY CHARACTERISTICS:

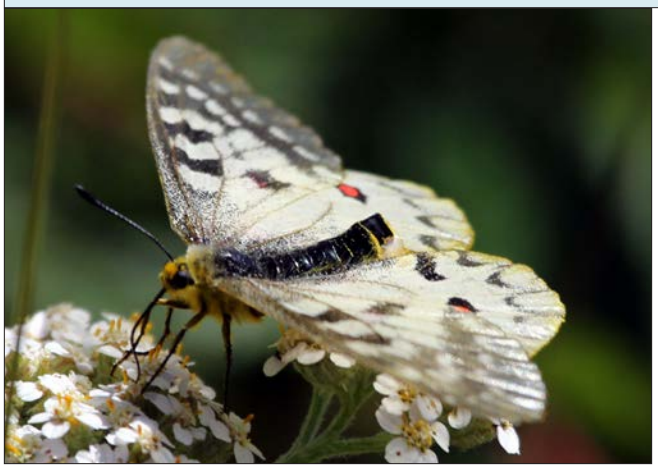
- Large butterflies
- Swift, sailing flight pattern
- Unhooked antenna, generally longer wings, and more slender bodies than the skippers
- Less wing loading, allowing them to soar (or scud)
- Can possess hind wing extensions

Photograph courtesy of Andrew Reding

Many are black, yellow, or white, with hind wing extensions

Photographs courtesy of Rod Gilbert.

SUBFAMILY Parnassiinae does not have hind wing extensions (shown: Clodius parnassian)



Photographs courtesy of Peter Pearsall, USFWS, and David Robichaud

Whites & Sulphurs

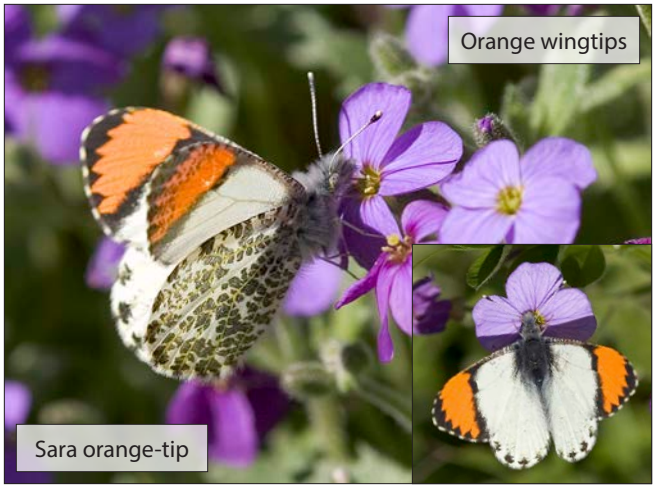
SUPERFAMILY: Papilionoidea
FAMILY: Pieridae

As the name implies, these butterflies are usually white or yellow. They are generally medium sized and are widely distributed throughout the United States.

KEY CHARACTERISTICS:

- Yellow and white colors predominate among most of the species
- Bright orange wingtips and strikingly black marginal patterns are common

Photograph courtesy of Rod Gilbert.



Photographs courtesy of Rod Gilbert.

Photograph courtesy of Rod Gilbert.

Photographs courtesy of Rod Gilbert.

Photograph courtesy of Rod Gilbert.

Gossamer-wings

SUPERFAMILY: Papilionoidea
FAMILY: Lycaenidae

This large family includes most of North America's smallest butterflies: coppers, hairstreaks, blues, and metalmarks.

KEY CHARACTERISTICS:

- Many of the smallest and brightest butterflies
- Brightly colored in blues, greens, or coppers
- May be dotted with bold spots or checkers
- Glittering, silky wings

Photograph courtesy of Brad Smith.

Identifiable by silky, glittering wings that shimmer in direct light

Photograph courtesy of Rod Gilbert.

Photograph courtesy of Rod Gilbert.

Photograph courtesy of Brad Smith.

Some have dots or checkers

Photographs courtesy of Rod Gilbert.

Brush-footed Butterflies

SUPERFAMILY: Papilionoidea
FAMILY: Nymphalidae

This large family of colorful butterflies contains monarchs and painted ladies.

Because of their great diversity, no single field characteristic makes the members of this family easy to identify as a group.

- Various shades of orange, red, brown, and black are common among brush-footed butterflies
- The front pair of legs is reduced to tiny, brush like appendages with fused tarsi that are held tightly beneath the thorax rather like an importuning kitten's paws. Thus, "brush-footed".

Photograph courtesy of Brad Smith.

Oranges, red, black, and brown are common colors

Photograph courtesy of Rod Gilbert.

Photograph courtesy of Brad Smith.

Photograph courtesy of Rod Gilbert.

Only four legs are clearly visible

Photograph courtesy of Andrew Reding.

Photograph courtesy of Brad Smith.

Photograph courtesy of Rod Gilbert.

Section 6
BUTTERFLY MONITORING PROTOCOL AND DATASHEET

This sample monitoring protocol is based on the standardized Pollard Walk and can be used to collect observational data on the abundance and richness of butterflies. It is designed for observers working on their own or in pairs. Monitoring butterflies must be done on different routes and at a different time than bee monitoring.

TRANSECTS:

- Prior to conducting site monitoring, a permanent butterfly monitoring route needs to be established.
- The route should be at least 50 meters long and relatively easy to walk on a continuing basis. It can be as long as you would like, and should be fairly representative of the site's habitat diversity.
- The butterfly monitoring transect should not overlap with other transects established for bee monitoring and there should be at least 30 meters between any other transact.
- It is also important to map the site and/or take GPS coordinates of transect end and start points. If no GPS is available, mark the transect(s) or plots on an aerial photo or Google Earth.
- It's also helpful to stake and flag the transect.

WEATHER:

Similar to bee monitoring, temperature and precipitation have significant impacts on butterfly activity. Therefore, it is best to collect observational data on days when the temperature is at least 15.5° C (60° F), wind speeds are less than 6 mph, and when there is enough sunlight to see your shadow. The best time of day is generally between 10 am and 3 pm.

MATERIALS REQUIRED

- Identification and monitoring guides (*Citizen Science Pollinator Monitoring Guide* and local butterfly field guide)
- Clipboard
- Pencil
- Datasheet(s)
- Permits (if necessary)
- Timer
- Thermometer
- Wind meter (optional)
- Sunscreen
- Hat
- Water
- First aid kit
- Site specific monitoring protocol

OPTIONAL MATERIALS:

- Binoculars (close-focusing) are highly recommended
- Plant list for the site and/or plant identification guide

TO SET UP TRANSECT, BRING:

- Measuring tape (50 meters)
- Stakes and flagging to mark the transect ends and plot corners
- Aerial photo or map to document location of transect
- Optional: GPS or phone to record the start and end points of the transect.

OBSERVATIONS:

The objective of each transect is not to count all the butterflies that are present at the site, or in the habitat where you are counting, but to count only those individual butterflies that occur in, or move through, the transect's sampling area while you are walking at a steady, reasonable pace.

Butterflies are identified and counted on the wing if they occur within 5 meters of the transect line. This includes butterflies above and to the sides of the observer. Do not count butterflies that fly in from behind to avoid the possibility of counting the same individual twice.

Monitoring a site

ARRIVE AT SITE

- Set up thermometer in the shade, and fill out the site/date information in the data sheet.

RECORD START TIME AND WEATHER DATA

1. **Shade temperature:** should be greater than 15.5° C (60° F)
2. **Wind speed:** average wind speed over one minute (at shoulder height, facing the wind) should ideally be less than 6 mph (if you do not have a wind meter, use the Beaufort Wind Scale, included below)
3. **Cloud cover:**
   - Clear—clouds rarely/ never cover sun
   - Partly cloudy—clouds cover sun sometimes
   - Bright overcast—even haze/ clouds, but sun or light shadows are visible
   - Overcast—more overcast than bright overcast; no shadows are cast

   NOTE: *Do not sample in overcast, rainy, or windy conditions.*

OBSERVATIONS

1. 1. Use a stopwatch to keep track of monitoring time and pace of survey.
2. 2. Begin walking the route through your study area. Pace yourself. Be as consistent as possible each time you walk the route so that you collect data with the same level of effort. This will allow you to more reliably compare data from year to year.
3. 3. Record butterfly species between 0 and 5 meters above and on either side of your route.
   - Observe, identify and note the butterflies nectaring or flying within 0 and 5 meters on either side of your route.
   - Do not count butterflies that fly in from behind to avoid possibly counting the same individual twice.
4. 4. Begin walking again and continue with your observations until you reach the end of your route.
5. 5. At the end of the transect, note the time as well as the current weather conditions, even if they are the same as before you began the transect.

RECORD ANY ADDITIONAL NOTES ABOUT THE SITE

- After you have finished collecting data on the butterflies in each transect, include any observations about the site in the field notes section—such as information on the plant community, such as invasive plants, available host and nectar plants, or conifer encroachment; threats to the site or butterfly resources, which may include the presence of livestock, other people, or another species; general site conditions, including habitat changes or land management practices; and butterfly population details, such as unusual behavior, additional butterfly species not listed on form, etc.

Beaufort Wind Scale

WIND (MPH)	CLASSIFICATION	APPEARANCE OF WIND EFFECTS
0	Calm	Smoke rises vertically
1–3	Light air	Smoke drift indicates wind direction, still wind vanes
4–6	Light breeze	Feel the wind on your face, leaves rustle, and wind vanes begin to move
7–10	Gentle breeze	Leaves and small twigs will be in constant motion, light flags extended

CITIZEN SCIENCE MONITORING DATASHEET: BUTTERFLIES

STEP 1—Photocopy or print copies of this datasheet in advance (www.xerces.org/csmdatasheets)

STEP 2—Site Details

SITE NAME: _____ **DATE:** _____

PRIMARY OBSERVER: _____ **DATA RECORDER:** _____

OTHER OBSERVERS _____ _____

STEP 3—Monitoring

Note the start time and weather conditions for each transect. Set timer and hit start when ready. Note any butterflies you see and can identify to your confidence level. Walk each transect at a consistent pace. Remember to note end time and weather conditions after completing each transect.

BUTTERFLY MORPHOGROUPS:

Grass skipper	Blue	Checkerspot/ crescent	Other brush-foot (i.e., monarch)
Spreadwing skipper	Copper	Comma	Satyr (e.g., nymph, ringlet)
Whites & orange-tip	Hairstreak	Fritillary	Tortoiseshell
Sulphur	Metalmark (uncommon)	Lady/ admiral	Swallowtail/ parnassian

WEATHER CONDITIONS & OBSERVATIONS:

Important: Observe, identify and note the butterflies within 0–5 meters on either side of your route. Do not count butterflies that fly in from behind to avoid possibly counting the same individual twice.

	TRANSECT 1		TRANSECT 2		TRANSECT 3		TRANSECT 4	
	START	END	START	END	START	END	START	END
TIME:								
SHADE TEMP:	°C / °F	°C / °F	°C / °F	°C / °F	°C / °F	°C / °F	°C / °F	°C / °F
WIND*: (*circle one*)	0 MPH / 1–3 MPH 4–6 MPH / 7–10 MPH	0 MPH / 1–3 MPH 4–6 MPH / 7–10 MPH	0 MPH / 1–3 MPH 4–6 MPH / 7–10 MPH	0 MPH / 1–3 MPH 4–6 MPH / 7–10 MPH	0 MPH / 1–3 MPH 4–6 MPH / 7–10 MPH	0 MPH / 1–3 MPH 4–6 MPH / 7–10 MPH	0 MPH / 1–3 MPH 4–6 MPH / 7–10 MPH	0 MPH / 1–3 MPH 4–6 MPH / 7–10 MPH
SKY: (*circle one*)	clear partly cloudy bright overcast	clear partly cloudy bright overcast	clear partly cloudy bright overcast	clear partly cloudy bright overcast	clear partly cloudy bright overcast	clear partly cloudy bright overcast	clear partly cloudy bright overcast	clear partly cloudy bright overcast

**Use the Beaufort Wind Scale to estimate wind speed (see Butterfly Monitoring Protocol for details)*

MORPHOGROUP OR SPECIES OBSERVED #	TRANSECT 1	TRANSECT 2	TRANSECT 3	TRANSECT 4
1				
2				
3				
4				
5				
6				
7				
8				

STEP 3—Monitoring, *continued*

BUTTERFLY MORPHOGROUPS:

Grass skipper	Blue	Checkerspot/ crescent	Other brush-foot (i.e., monarch)
Spreadwing skipper	Copper	Comma	Satyr (e.g., nymph, ringlet)
Whites & orange-tip	Hairstreak	Fritillary	Tortoiseshell
Sulphur	Metalmark (uncommon)	Lady/ admiral	Swallowtail/ parnassian

OBSERVATIONS, *continued*: (attach any Additional Monitoring Sheet(s) if necessary, available at: www.xerces.org/csmdatasheets)

MORPHOGROUP OR SPECIES OBSERVED		TRANSECT 1	TRANSECT 2	TRANSECT 3	TRANSECT 4
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

STEP 4—Field notes, *including:*

- Information on the plant community, such as invasive plants, available host and nectar plants, or conifer encroachment;
- Threats to the site or butterfly resources, which may include the presence of livestock, other people, or another species;
- General site conditions, including habitat changes or land management practices;
- Butterfly population details, such as unusual behavior, additional butterfly species not listed on form, etc.

Example

CITIZEN SCIENCE MONITORING DATASHEET: BUTTERFLIES

STEP 1—Photocopy or print copies of this datasheet in advance (www.xerces.org/csmdatasheets)

STEP 2—Site Details

SITE NAME: Johnson Creek Corridor **DATE:** July 30, 2015

PRIMARY OBSERVER: Candace Fallon **DATA RECORDER:** Michelle Blackburn

OTHER OBSERVERS:

STEP 3—Monitoring

Note the start time and weather conditions for each transect. Set timer and hit start when ready. Note any butterflies you see and can identify to your confidence level. Walk each transect at a consistent pace. Remember to note end time and weather conditions after completing each transect.

BUTTERFLY MORPHOGROUPS:

Grass skipper	Blue	Checkerspot/ crescent	Other brush-foot (i.e., monarch)
Spreadwing skipper	Copper	Comma	Satyr (e.g., nymph, ringlet)
Whites & orange-tip	Hairstreak	Fritillary	Tortoiseshell
Sulphur	Metalmark (uncommon)	Lady/ admiral	Swallowtail/ parnassian

WEATHER CONDITIONS & OBSERVATIONS:

Important: Observe, identify and note the butterflies within 0–5 meters on either side of your route. Do not count butterflies that fly in from behind to avoid possibly counting the same individual twice.

	TRANSECT 1		TRANSECT 2		TRANSECT 3		TRANSECT 4	
	START	END	START	END	START	END	START	END
TIME:	10:02 am	10:26 am	10:43 am	11:01 am	11:35 am	11:52 am	1:00 pm	1:17 pm
SHADE TEMP:	70 °C / (°F)	72 °C / (°F)	74 °C / (°F)	75 °C / (°F)	76 °C / (°F)	78 °C / (°F)	84 °C / (°F)	84 °C / (°F)
WIND*: (circle one)	(0 MPH) / 1–3 MPH / 4–6 MPH / 7–10 MPH	(0 MPH) / 1–3 MPH / 4–6 MPH / 7–10 MPH	0 MPH / (1–3 MPH) / 4–6 MPH / 7–10 MPH	0 MPH / (1–3 MPH) / 4–6 MPH / 7–10 MPH	(0 MPH) / 1–3 MPH / 4–6 MPH / 7–10 MPH	0 MPH / (1–3 MPH) / 4–6 MPH / 7–10 MPH	0 MPH / 1–3 MPH / (4–6 MPH) / 7–10 MPH	0 MPH / (1–3 MPH) / 4–6 MPH / 7–10 MPH
SKY: (circle one)	(clear) / partly cloudy / bright overcast	(clear) / partly cloudy / bright overcast	(clear) / partly cloudy / bright overcast	(clear) / partly cloudy / bright overcast	(clear) / partly cloudy / bright overcast	(clear) / partly cloudy / bright overcast	clear / (partly cloudy) / bright overcast	(clear) / partly cloudy / bright overcast

Use the Beaufort Wind Scale to estimate wind speed (see Butterfly Monitoring Protocol for details)

MORPHOGROUP OR SPECIES OBSERVED #	TRANSECT 1	TRANSECT 2	TRANSECT 3	TRANSECT 4
1	swallowtail |	red admiral ||	Cab. white (puddling) |||	purple copper 𝍸
2	skippers ||||	lady (western?) |	sulphurs (puddling) 𝍸 𝍸 |||	skippers |||
3	grey hairstreak |	skippers |||	skippers (puddling) |||	silver-spot skipper |
4	eastern-tailed blue |	grey hairstreak |	swallowtails (puddling) 𝍸	small blue |
5	purple copper |||	Sara orange-tip |		cabbage white ||
6		comma |		swallowtail |
7				
8				

Example

STEP 3—Monitoring, *continued*

BUTTERFLY MORPHOGROUPS:

Grass skipper	Blue	Checkerspot/ crescent	Other brush-foot (i.e., monarch)
Spreadwing skipper	Copper	Comma	Satyr (e.g., nymph, ringlet)
Whites & orange-tip	Hairstreak	Fritillary	Tortoiseshell
Sulphur	Metalmark (uncommon)	Lady/ admiral	Swallowtail/ parnassian

OBSERVATIONS, *continued*: (attach any Additional Monitoring Sheet(s) if necessary, available at: www.xerces.org/csmdatasheets)

MORPHOGROUP OR SPECIES OBSERVED		TRANSECT 1	TRANSECT 2	TRANSECT 3	TRANSECT 4
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

STEP 4—Field notes, *including:*

- Information on the plant community, such as invasive plants, available host and nectar plants, or conifer encroachment;
- Threats to the site or butterfly resources, which may include the presence of livestock, other people, or another species;
- General site conditions, including habitat changes or land management practices;
- Butterfly population details, such as unusual behavior, additional butterfly species not listed on form, etc.

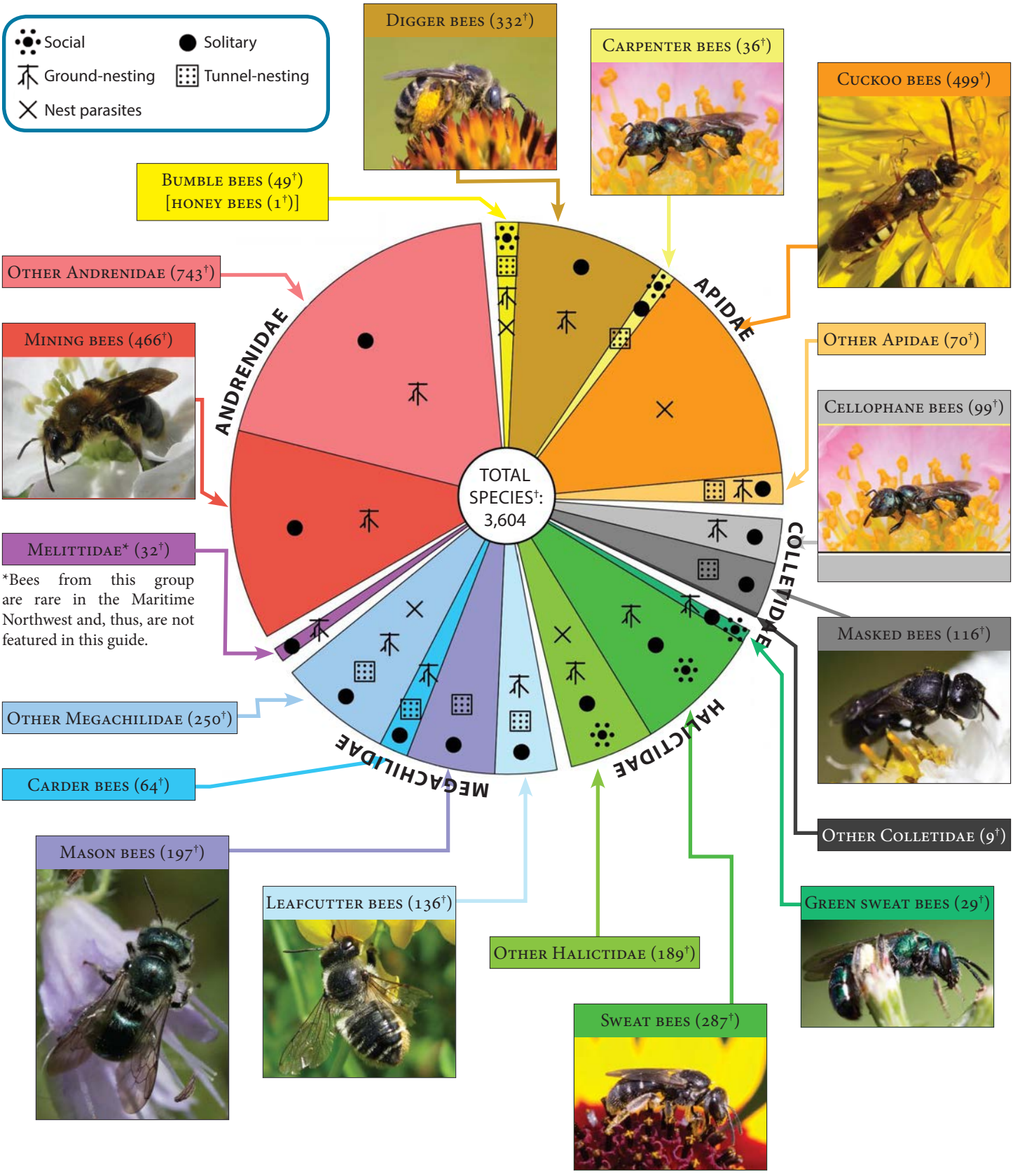
Johnson Creek Corridor habitat restoration in progress, some paths unavailable.

Transect 1 has some slight weedy forb encroachment.

Observed numerous groups mud-puddling in transect 3.

Took a break between transects 3 and 4 for lunch.

Appendix A: BEE SPECIES DIVERSITY IN THE UNITED STATES



†Total number of species in the United States.
Chart, content, and photographs* courtesy of Joel Gardner, University of Minnesota/ Bee Squad. (*Cellophane bee photo courtesy of Heather Holm.)
Data source: Ascher, J. S., and J. Pickering. 2015.Discover Life bee species guide and world checklist. (Available at: www.discoverlife.org/mp/20q?guide=Apoidea_species)

Appendix B: BEE GROUPS & SPECIES OF INTEREST*

Group	Common Name	Scientific name
Honey Bee		
	Honey bee	*Apis mellifera*
Bumble Bees		
Striped abdomen	Two-form	*Bombus bifarius*
	California	*B. californicus*
	Yellow	*B. fervidus*
Red-tailed	Central	*B. centralis*
	Hunt's	*B. huntii*
	Black-tailed	*B. melanopygus*
	Fuzzy-horned	*B. mixtus*
	Red-belted	*B. rufocintus*
Black-tailed	Yellow-headed	*B. flavifrons*
	Brown-belted	*B. grisecollis*
	Nevada	*B. nevadensis*
	Half-black	*B. vagans*
	Fuzzy-horned	*B. mixtus*
White hair	Mountain	*B. appositus*
	White-shouldered	*B. franklini*
	Western	*B. occidentalis*
Yellow-faced	Obscure	*B. caliginosus*
	Van Dyke's	*B. vandykei*
	Yellow-faced	*B. vosnesenskii*
Cuckoo bees	Cuckoo	*B. flavidus*
	Fernald cuckoo	*B. fernaldae*
	Indiscriminate	*B. insularis*
	Suckley's	*B. suckleyi*
Chap Leg Bees		
	Flower-bearer bee	*Anthophora* spp.
	» Bumble-bee-mimic	*A. bomboides*
	Long-horned bee	*Eucera* spp.
		Mellisodes spp.
	Squash bee	*Peponapis* spp. *Xenoglossa* spp.
	Sunflower bee	*Svastra* spp.
Medium Dark Bees		
	Mining bee	*Andrena* spp.
	» Black-banded	*A. transnigra*
	Cellophane bee	*Colletes* spp.
Metallic Green Bees		
Bright green	Green sweat bee	*Agapostemon* spp.
Dark green	Green sweat bee	*Lasioglossum* spp.

Group	Common Name	Scientific name
Striped Sweat Bees		
Small	Small sweat bee	*Halictus tripartitus*
		Lasioglossum spp.
Medium	Medium sweat bee	*Halictus ligatus*
		Lasioglossum spp.
Tiny Dark Bees		
Rounded tip	Sweat bee	*Lasioglossum* spp.
	» Red abdomen	*L. ovaliceps*
Shield-like tip	Small carpenter bee	*Ceratina* spp.
Yellow mask	Yellow-masked bee	*Hyleaus spp.*
Striped Hairy Belly Bees		
Tiny	Leafcutter bee	*Ashmeadiella* spp.
Small/Medium	Leafcutter bee	*Megachile* spp.
Metallic Hairy Belly Bees		
Blue	Mason bee	*Osmia* spp.
Green	Mason bee	*Hoplitis* spp.
Cuckoo Bees		
Red Abdomen	Cuckoo bee	*Sphecodes* spp.
Thick antenna	Cuckoo bee	*Nomada* spp.
Pointed abdomen	Cuckoo bee	*Coelioxys* spp.

**This list is limited to species included in this guide or of interest when monitoring a site.*

Appendix C: MARITIME NORTHWEST BEE GROUPS GUIDE

HONEY BEES

COLORS:

» **15 mm**/ 0.59″

12–15 mm / 0.47–0.59″

- Torpedo-shaped; fuzzy head and thorax; tri-tone striped abdomen
- Moist pollen on hind legs

CHAP LEG BEES

COLORS: W

8–20 mm / 0.31–0.79″

- Robust; velvety all over; pale bands on abdomen
- Dry pollen on hind legs
- Males are less hairy, often have longer antennae

STRIPED SWEAT BEES

COLORS: W

7–15 mm / 0.28–0.59″

- Narrow; fuzzy head & thorax; pale stripes on abdomen
- Dry pollen on hind legs and thorax
- May be found inside or at base of flowers; move very fast

TINY DARK BEES

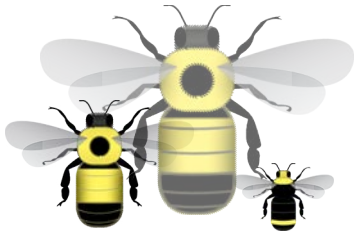
COLORS: W

4–7 mm / 0.16–0.28″ **5 mm** / 0.2″ **6–8 mm** / 0.24–0.31″

- Narrow; sparse hair; faint or no stripes on abdomen
- Dry pollen on hind legs or in stomach
- May have yellow or white markings on face, often metallic green or blue-green in bright light (also black, brown, or pale gold)

BUMBLE BEES

COLORS: W



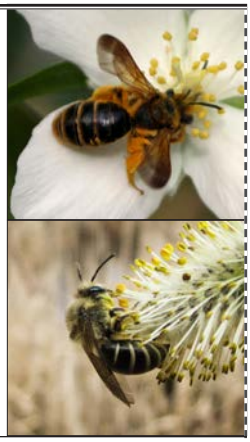
8–25 mm / 0.59–0.98″

- Robust; fuzzy all over, markings vary by species
- Moist pollen on hind legs
- Workers & males are smaller than queens

MEDIUM DARK BEES

COLORS: W

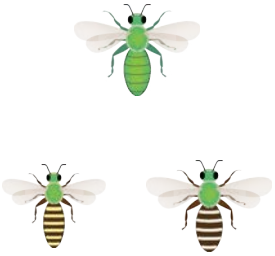
7–18 mm / 0.28–0.71″



- Narrow–robust; fuzzy head & thorax; some species have striped abdomen
- Dry pollen on hind legs and under thorax arm pits
- Some species nest in large aggregations in the ground

METALLIC GREEN BEES

COLORS: W



9–11 mm / 0.35–0.43″

- Narrow; fuzzy head & thorax; striped abdomen
- Dry pollen on hind legs
- Coloration varies—may have a blue-violet or coppery cast, or have a light-and-dark striped abdomen

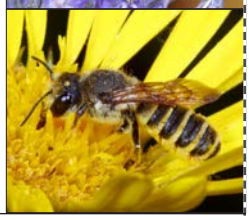
KEY

W White/light	Yellow	Amber	Orange	Red	
Green	Blue-green	Blue	Brown	Black	

STRIPED HAIRY BELLY BEES

COLORS: W

8–12 mm / 0.31–0.47″



- Very robust; fuzzy all over, pale hair stripes on abdomen
- Dry pollen on belly (under abdomen)
- When visiting flowers, females bees often elevate abdomen

METALLIC HAIRY BELLY BEES

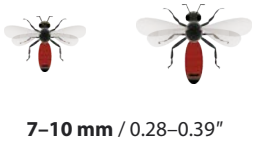
COLORS: W

8–12 mm / 0.31–0.47″

- Robust; fuzzy all over, no stripes on abdomen
- Dry pollen on belly
- Among the first bees seen in early spring

CUCKOO BEES

COLORS: W



7–10 mm / 0.28–0.39″

9–12 mm / 0.35–0.47″

- Small–large, very narrow; usually not hairy; wasp-like stripes
- Lack pollen-carrying structures—very narrow legs
- Look similar to wasps; often seen flying low to the ground or on flowers

HOME PRINT SCALE CHECK

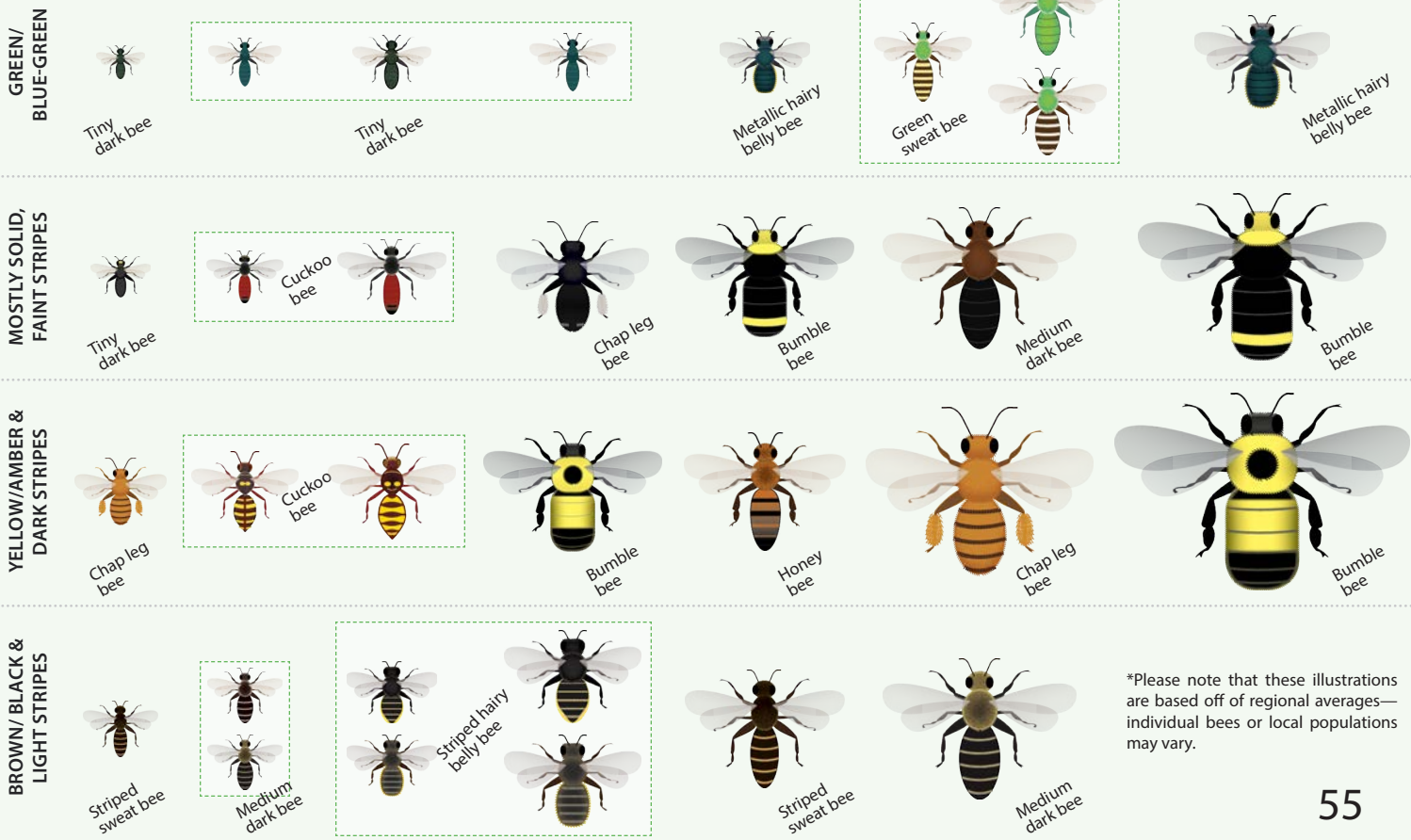
This bar should be **25.4 mm/ 1″ long** at 100% scale.

If it is not, check your printer's scale settings.

CREDITS: Photographs by Sara Morris (honey bee, chap leg bee, striped sweat bee), Mace Vaughan (bumble bee, *top* medium dark bee, *bottom* green sweat bee, metallic hairy belly bee), Sarah Foltz Jordan (*right* tiny dark bee, *top* and *bottom* cuckoo bees), Nancy Lee Adamson (*left* tiny dark bee), courtesy of Jason King (*bottom* medium dark bee), Anita Gould (*middle* tiny dark bee), and Rollin Coville (*top* metallic green bee, *top* and *bottom* striped hairy belly bees, metallic hairy belly bee). Bee group icons created by Sara Morris.

BEE GROUPS SIZE & COLOR CHEAT SHEET*

SMALL → LARGE



*Please note that these illustrations are based off of regional averages—individual bees or local populations may vary.

Appendix D: MARITIME NORTHWEST BUTTERFLY SPECIES

FAMILY	MORPHOGROUP	SCIENTIFIC NAME	COMMON NAME	OCCURRENCE	WINGSPAN
HESPERIIDAE (SKIPPERS)	Grass (monocot) skippers	*Amblyscirtes vialis*	Common roadside-skipper	Occasional	2.2–3.2 cm
		Atalopedes campestris	Sachem skipper	Occasional	3.2–4.2 cm
		Carterocephalus palaemon	Arctic skipper	Occasional	2.5–3.2 cm
		Hesperia juba	Juba skipper	Occasional	3.2–4.2 cm
		Ochlodes sylvanoides	Woodland skipper	Common	2.5–3.2 cm
		Polites sonora	Sonora skipper	Common	2.5–3.2 cm
	Spreadwing (dicot) skippers	*Epargyreus clarus*	Silver-spotted skipper	Common	4.5–6.7 cm
		Erynnis persius	Persius duskywing	Occasional	2.9–4.2 cm
		E. propertius	Propertius duskywing	Occasional	3.5–4.5 cm
		Euphyes vestris	Dun skipper	Common	2.9–3.5 cm
		Pyrgus ruralis	Two-banded checkered-skipper	Occasional	2.5–2.9 cm
PAPILIONIDAE (SWALLOWTAILS)	Parnassians & Swallowtails	*Papilio eurymedon*	Pale swallowtail	Occasional	6.4–9 cm
		P. rutulus	Western tiger swallowtail	Common	7–10 cm
		P. zelicaon	Anise swallowtail	Common	7–9 cm
		Parnassius clodius	Clodius Parnassian	Rare	5–6.2 cm
PIERIDAE (WHITES & SULPHURS)	Sulphurs	*Colias eurytheme*	Orange sulphur	Common	3.5–7 cm
		C. philodice	Clouded sulphur	Rare	3.8–7 cm
	Whites & Orange-tips	*Anthocharis sara*	Sara orange-tip	Common	2.7–4.0 cm
		Neophasia menapia	Pine white	Rare	4.5–5.8 cm
		Pieris marginalis	Margined white	Occasional	3.8–5.7 cm
		P. rapae	Cabbage white	Common	4.5–5.8 cm
		Pontia occidentalis	Western white	Rare	3.8–5.3 cm
LYCAENIDAE (GOSSAMER-WINGS)	Blues	*Celastrina echo*	Echo azure	Common	2.3–3.2 cm
		Cupido amyntula	Western tailed-blue	Occasional	2.2–2.9 cm
		C. comyntas	Eastern tailed-blue	Common	2.2–2.9 cm
		Glaucopsyche lygdamus	Silvery blue	Common	2.2–3.2 cm
		Plebejus lupini	Lupine blue	Occasional	2.2–2.9 cm
	Coppers	*Lycaena helloides*	Purplish copper	Common	3–3.8 cm
	Hairstreaks	*Callophrys augustinus*	Brown elfin	Occasional	2.2–2.9 cm
		C. dumetorum	Bramble green hairstreak	Rare	2.5–3.2 cm
		C. gryneus	Cedar/ juniper hairstreak	Rare	2.6–3.2 cm
		Satyrium sylvinus	Sylvan hairstreak	Rare	2.5–3.5 cm
		Strymon melinus	Gray hairstreak	Common	2.2–3.5 cm
NYMPHALIDAE (BRUSH-FOOTS)	Checkerspots & Crescents	*Euphydryas chalcedona*	Chalcedon checkerspot	Occasional	3.2–5.7 cm
		Phyciodes mylitta	Mylitta crescent	Common	3–3.8 cm
		P. pulchella	Field crescent	Rare	2.5–4.5 cm
	Commas	*Polygonia faunus*	Green comma	Occasional	4.5–6.4 cm
		P. gracilis	Hoary comma	Rare	3.9–5.7 cm
		P. oreas	Oreas comma	Rare	4.2–4.8 cm
		P. satyrus	Satyr comma	Common	4.5–6.4 cm
	Fritillaries	*Boloria epithore*	Western meadow fritillary	Common	3.5–4.5 cm
		Speyeria cybele	Great spangled fritillary	Occasional	6.3–10.1 cm
	Ladies	*Vanessa annabella*	West Coast lady	Common	3/8–5.7 cm
		V. atalanta	Red admiral	Common	4.5–7.6 cm
		V. cardui	Painted lady	Occasional	5.1–7.3 cm
		V. virginiensis	American lady	Occasional	4.5–6.7 cm
	Other Brush-foots	*Danaus plexippus*	Monarch	Rare	8.6–12.4 cm
		Limenitis lorquini	Lorquin's admiral	Common	5.1–6.7 cm
	Satyrs	*Cercyonis pegala*	Common wood-nymph	Common	4.5–7.6 cm
		Coenonympha tullia	Ochre ringlet	Common	3.4–3.8 cm
	Tortoiseshells	*Aglais milberti*	Milbert's tortoiseshell	Common	4.2–6.3 cm
		Nymphalis antiopa	Mourning cloak	Common	5.7–10.1 cm
		N. californica	California tortoiseshell	Rare	3.2–7 cm

Below are some common species found in the Maritime Northwest, rated for occurrence around the Portland Metropolitan Area. For a more information on other species in the region, see the Additional Resources section (p. 60).

HABITAT
Open and wooded areas, often near streams; low to high elevations
Disturbed, open areas (parks, gardens, roadsides, etc.); occasional in open woodlands or prairies; low elevations
Moist woodlands, favoring open areas around riparian corridors; ≲7,000′
Xeric grasslands (e.g., sagebrush, chapparal) and open woodland; <9,500′
Grassy areas (e.g., forest roadsides and riparian corridors, meadows, yards, and steppes); <7,000′
Wet grassy areas (e.g., meadows, prairies, roadsides, clearings, streambanks, occasional in disturbed habitat); <11,000′
Open areas (e.g., meadows, scrubland, riparian corridors); not found at high elevations
Open areas, particularly forest clearings and clear-cuts, roadsides, and scrubland; ≲9,000′
Primarily open oak woodlands, adults also visit meadows and roadsides near oaks; low to mid-elevations
Open, wetland areas with sedges and nectar sources (e.g., riparian corridors, fields, and roadsides); <5,000′
Open areas in moist woodlands (e.g., riparian corridors, clearings, and roadsides); <10,000′
Widespread across region (e.g., open woodlands and forested areas, grasslands, disturbed areas, etc.)
Widespread across region (e.g.,gardens/ suburbs, riparian corridors, meadows, etc.).; ≲7,000′
Widespread across region except in dense forests (e.g., gardens/suburbs, riparian corridors, grasslands and meadows, etc.); found at high elevations
Forests, favoring open areas (e.g., roadsides, riparian corridors, meadows); <8,000′
Seasonal migrant, favors a wide variety of open, disturbed sites (e.g., clover and alfalfa fields, pastures, dry meadows, lawns, road edges, etc.)
Favors open areas, including native meadows and disturbed sites (e.g., farms fields, gardens, etc.)
Widespread across region where wild mustard grows, most commonly in lowland riparian corridors
Coniferous forests; sea level to mid-elevation
Wet forests and wooded areas (e.g., damp meadow edges and coast forests); 6,000–7,000′
Widespread across region, favoring disturbed sites over native habitat (e.g., weedy areas, gardens, parks)
Favors open alpine sites, occasional in lowland disturbed sites (e.g., roadsides, fields, etc.); high elevations
Shrubby, riparian areas with host plants (e.g., woodlands, scrubland, suburbs)
Open forested areas (e.g. clearings and roadsides)
Favors dry, disturbed sites (e.g., weedy fields, roadsides)
Widespread across region, favoring sites with multiple legume species (e.g., meadows, roadsides, clearings, riparian corridors, grasslands, etc.)
Open areas and outcrops (e.g., mountain meadows and slopes, prairies, canyons, shrubland, etc.)
Disturbed sites and open areas (e.g., yards, weedy fields, farms, riparian corridors, and meadows); <10,000′
Open forested areas (e.g., clearings, roadsides, chapparal, scrublands)
Prefers open, shrub-steppe areas, rare in chapparal
Open areas near large stands of cedar or juniper (e.g., roadsides, clearings, etc.)
Open areas in forests and shrubland (e.g., meadows, roadsides, riparian corridors); ≲3,500′
Widespread across region, favoring open, non-forested areas and disturbed sites (e.g., roadsides, meadows, yards, weedy lots, scrubland)
Open forested or shrubby areas at higher elevations (e.g., alpine meadows, shrubland, chapparal)
Widespread across region in both native and disturbed habitat, including weedy lots, marshes, and agricultural areas; <8000′
Open areas, including meadows, prairies, wooded foothills, and mountainous forests; low to high elevations
Moist woodlands, favoring open areas around riparian corridors; favors mid to high elevations
Open foothill and montane areas (e.g., meadows, trails, streambanks); ≳3,000′
Moist forested areas at mid to high elevations (e.g., foothills and mountains); <5,000′
Moist areas, including deciduous woodlands and disturbed sites (e.g., suburbs, parks, weedy fields); ≲7,000′
Open areas in moist forests (e.g., roadsides, meadows, riparian corridors, etc.); ≲8,000′
Favors moist sites (e.g., woodlands, meadows, riparian corridors); low to mid-elevations
Migrant species, favors open and disturbed sites (e.g., roadsides, yards and gardens, weedy lots, etc.); low to high elevations
Widespread across region in most habitats, including urban areas, gardens, farms and orchards, woodlands, and meadows; ≲7,000′
Migrant species, favors open and disturbed sites (e.g., roadsides, yards and gardens, weedy lots, etc.); low to high elevations
Migrant species, favors open and disturbed sites (e.g., roadsides, yards and gardens, weedy lots, etc.)
Open areas along riparian corridors
Widespread across region in most habitats, including urban areas, gardens, farms and orchards, woodlands, and meadows
Open, grassy areas (e.g., meadows, prairies, fields); ≲7,000′
Widespread in open, grassy areas (e.g., fields, meadows, grasslands,etc.); low to high elevations
Widespread across region in most habitats, including parks and gardens, woodlands, meadows, and riparian corridors; low to high elevations
Widespread across region where host plants occur, favoring riparian areas; low to high elevations
Montane woodlands and shrublands where host plants occur (e.g., chaparral steppes, forest edges, and stands of conifers); low to high elevations

Appendix E: ADDITIONAL RESOURCES

Bee Conservation Publications

Black, S. H., N. Hodges, M. Vaughan, and M. Shepherd. 2007. *Pollinators in Natural Areas. A Primer on Habitat Management*. Portland: The Xerces Society. (Available at http://www.xerces.org/guidelines/.)

Buchmann, S.L. and G.P. Nabhan. 1996. *The Forgotten Pollinators*. Washington: Island Press.

Mäder, E., M. Shepherd, M. Vaughan, S. H. Black, and G. LeBuhn. 2011. *Atttracting Native Pollinators: Protecting North America's Bees and Butterflies*. North Adams, MA: Storey Publishing.

National Research Council. 2006. *Status of Pollinators in North America*. Washington: National Academies Press. (Available online at http://www.nap. edu/catalog/11761.html.)

Vaughan, M., Hopwood, J., Lee-Mäder, E., Shepherd, M., Kremen, C., Stine, A., and S. Hoffman Black. 2015. *Farming for Bees*. Portland: The Xerces Society. www.xerces.org/wp-content/uploads/2008/11/farming_for_bees_guidelines_xerces_society.pdf.

Xerces Society Pollinator Habitat Assessment Guides: www.xerces.org/pollinator-conservation/habitat-assessment-guides/

Xerces Society Pollinator Plant Lists: www.xerces.org/pollinator-conservation/plant-lists

Xerces Society Pollinator Conservation Resource Center: www.xerces.org/pollinator-resource-center/

Bee Biology and Identification Publications

BugGuide. An online resource devoted to North American insects, spiders and their kin, offering identification, images, and information. www.bugguide.net

Koch, J., Strange, J.P. , Williams, P. 2012. *Bumble bees of the Western United States*. USDA Forest Service Research Notes. Publication No. FS-972. 144 pp.

Michener, C.D., R.J. McGinley, and B.N. Danforth. 1994. *The Bee Genera of North and Central America.* Washington: Smithsonian Institution Press.

Michener, C.D. 2000. *The Bees of the World*. Baltimore: The Johns Hopkins University Press.

O'Toole, C. and A. Raw. 1999. *Bees of the World*. London: Blandford.

Rykken, J. Bee Observer Cards. *Encyclopedia of Life and the National Park Service*. Edited by Holmes, J.

Stephen, W. P. , G. E. Bohart, and P. F. Torchio. 1969. *The Biology and External Morphology of Bees; with a Synopsis of the Genera of Northwestern America*. Corvallis: Agricultural Experiment Station, Oregon State University. (Available at http://ir.library.oregonstate.edu/jspui/handle/1957/2080.)

Wilson, J. S., O. M. Carril. 2016. *The Bees In Your Backyard. A Guide to North America's Bees*. 288. Princeton, NJ: Princeton University Press.

Butterfly Biology and Identification

Gilbert, R., Potter, A. 2014. *A Region Specific Guide to Butterflies of South Pudget South, Washington.*

Makarushka, M. 2003. *Butterflies of Lane County. A pocket guide to 78 species of Land County, Oregon*. Oregon: North American Butterfly Association.

Neil, W. 2001. *The Guide to Butterflies of Oregon and Washington*. Colorado: Westcliffe Publishers.

Pyle, R.M. 2002. *The Butterflies of Cascadia. A field guide to all the species in Washington, Oregon, and surrounding territories*. Washington: Seattle Audubon Society

More Citizen Science Opportunities

Bumble Bee Watch. Citizen science database for reporting bumble bee observations in North America. Photos required with each submission. www.bumblebeewatch.org.

The Great Sunflower Project. Citizen science – ID and report bees that visit sunflowers. www.greatsunflower.org.

Appendix F: ADDITIONAL ACKNOWLEDGEMENTS

Photographs

We are grateful to the photographers for allowing us to use their wonderful photographs. The copyright for all photographs is retained by the photographers. None of the photographs may be reproduced without permission from the photographer:

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Joseph Berger [Bugwood.org]: page 27.

Stephen L. Buchmann: page 18.

Rusty Burlew, Honey Bee Suite [honeybeesuite.com]: pages, 19, 25, 28.

David Cappaert, Michigan State University [Bugwood.org]: page 22.

Gary Chang [flickr.com/gcchang]: pages 41,

Rollin Coville [covillephotos.com]: front cover; pages 12, 14, 15, 16, 17, 18, 19, 20, 22, 24, 26, 27, 28, 29, 30, 31, 54, 55

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TJ Gehling [flickr.com/tjgehling/]: pages 12,

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Justin Meissen [flickr.com/40855483@N00]: page 18.

Leithen M'Gonigle: page 17.

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Celeste Ramsay [flickr.com/cramsay23]: pages 12, 14, 25, 29, 39

Andrew Reding [flickr.com/seaotter]: pages 42, 45

Anne Reeves [flickr.com/charlock]: page 17.

David Robichaud [flickr.com/77552493@N02/]: back cover, page 42.

sankax [flickr.com/sankax]: pages 12, 14

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USGS Bee Inventory and Monitoring Lab [flickr.com/usgsbiml]: page 28.

Mace Vaughan, The Xerces Society: front cover, figures 1, 2, 4; pages 12, 13, 14, 19, 20, 25, 27, 30, 54, 55

Artwork

Bee Groups icons (p. 22–31, 34–35) were created by Sara Morris, the Xerces Society. *Bee Species Diversity in the United States* chart (p. 33) by Joel Gardner, University of MN Bee Lab.

Clodius parnassian butterfly perchimg. (Photograph courtesy of David Robichaud.)

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