

Pennsylvania Native Bee Survey
Citizen Scientist Pollinator
Monitoring Guide



Revised for Pennsylvania by:

Leo Donovall and Dennis vanEngelsdorp

**Pennsylvania Department of Agriculture
The Pennsylvania State University**

Based on the “California Pollinator Project: Citizen Scientist Pollinator Monitoring Guide”

Developed by:

Katharina Ullmann, Tiffany Shih, Mace Vaughan, and Claire Kremen

**The Xerces Society for Invertebrate Conservation
University of California at Berkeley**



**THE XERCES SOCIETY
FOR INVERTEBRATE CONSERVATION**



The Xerces Society for Invertebrate Conservation is an international, nonprofit, member-supported organization dedicated to preserving wildlife and its habitat through the conservation of invertebrates. The Society promotes protection of invertebrates and their habitat through science-based advocacy, conservation, and education projects. Its work focuses on three principal areas – endangered species, watershed health, and pollinator conservation. For more information about the Society or on becoming a member, please visit our website (www.xerces.org) or call us at (503) 232-6639.

Through its pollinator conservation program, the Society offers practical advice and technical support on habitat management for native pollinator insects.

University of California Berkeley collaborates with the Xerces Society on monitoring pollinator communities and pollination function at farm sites before and after restoration. University of California Berkeley conducts studies to calibrate the observational data collected by citizen scientists against the specimen-based data collected by scientists during standard surveys.

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Photographs

We are grateful to the many photographers who allowed us to use their wonderful photographs in this monitoring guide. None of the photographs may be reproduced without permission.

Pennsylvania Edition



The Pennsylvania Department of Agriculture encourages, protects and promotes agriculture and related industries throughout the commonwealth while providing consumer protection through inspection services that impact the health and financial security of Pennsylvania's citizens.



Penn State is a multi-campus public research university that improves the lives of the people of Pennsylvania, the nation, and the world through integrated, high-quality programs in teaching, research, and service.



The mission of the Penn State MG volunteer program is to support the Penn State Cooperative Extension by utilizing research-based information to educate the public on best practices in consumer horticulture and environmental stewardship.



The philosophy of Häagen-Dazs is simple: find the purest and finest ingredients in the world and craft them into the best ice cream, sorbet, and frozen yogurt available. It is a way of doing business that is as demanding as it is uncommon. It's the reason why the brand has epitomized fine ice cream for nearly half a century.

The Pennsylvania Native Bee Survey

The Pennsylvania Native Bee Survey is a collaborative effort of the Pennsylvania Department of Agriculture – Apiary Program and the Pennsylvania State University, with cooperators and volunteers from across the Commonwealth. The goals of this program are to survey and monitor native bees throughout Pennsylvania, provide opportunities and support for native pollinator research and to aide in the development of educational and outreach tools to support the conservation, restoration and protection of native pollinators, particularly in their role as support for honey bee pollination services in agricultural landscapes.

This document is a revision of the Citizen Scientist Pollinator Monitoring Protocol originally developed by the University of California at Berkeley and the Xerces Society for use in monitoring pollinator re-colonization at native vegetation restoration sites in California. This Pennsylvania edition is a collaborative effort between the Pennsylvania Native Bee Survey and the Penn State University Master Gardener program and is intended to document floral resource use in native plantings to better inform pollinator gardening efforts.

Front Cover

Mining bees (*Andrena* spp.) are a diverse group of pollinators that pollinate a wide range of flowering plants, including flowering trees and wildflowers. They are one of the earliest groups to begin pollinating in Pennsylvania, gathering nectar and pollen from even the earliest spring wildflowers, like Spring Beauty (*Claytonia virginica* L.). Photograph by Leo Donovall (2009).

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John Baker

CONTENTS

	<i>Page</i>		<i>Page</i>
1. Getting Started	4	4. A Guide to the Different Groups of Bees	16
Introduction	4	Introduction	16
How to Monitor and Observe Pollinators	5	Groups of Floral Visitors	17
Observing Insects Visiting Flowers	6	Honey Bees	18
		Bumble Bees	19
2. Identifying Floral Visitors	7	Large Carpenter Bees	20
Introduction and Bee Anatomy	7	Hairy Leg Bees	21
Identifying Bees	8	Large Dark Bees	22
Non-Bees: A Quick Reference	9	Small Dark Bees	23
Flies vs. Bees	10	Green Sweat Bees	25
Wasps vs. Bees	11	Metallic Hairy Belly Bee	26
		Dark Hairy Belly Bee	27
3. Understanding Bees	12	Cuckoo Bee	28
Introduction	12	5. Observational Data Collection	29
Bees: Body Size	12	Introduction and Materials	29
Bees: Body Shape	12	General Sampling-Day Routine	30
Bees: Body Coloration	13	Data Collection Procedure	30
Bees: Distribution of Hair	14	Sample Initial Observations Data Sheet	31
Bees: Location of Scopa	14	Sample Pollinator Monitoring Data Sheets	32
Bees: Body Stripes	15		
Bees: Antennal Length	15		
		Appendix A: The Bees of Pennsylvania	34

Section 1 GETTING STARTED

Bees are an amazingly diverse and very important group of insects, yet they remain poorly understood. When most people hear the word "bee," a single species comes to mind, *Apis mellifera* Linnaeus (the European Honey Bee), a species that is not even native to the United States. However, in Pennsylvania, there are more than 400 species of non-*Apis* bees (also referred to as "native", "solitary" or "wild" bees) that are extremely important pollinators of crops, garden and nursery flowers, wildflowers and trees. Conservatively, three out of every four plants on Earth depend on bees for pollination, including nearly 70% of all crop species. About one-third of a typical human diet depends directly or indirectly on insect pollination. Without insect pollinators, we would not be able to produce apples, almonds, blueberries, squash, and many other fruits, vegetables and nuts.

Since 2005, the Pennsylvania Department of Agriculture has been collecting and identifying the bee diversity of Pennsylvania through the Apiary Inspection Program. Interest in native pollinators of Pennsylvania began with concern over honey bee declines and the need to better understand how native pollinators could support the state's pollination demands. Interest has greatly increased as a condition termed "Colony Collapse Disorder", or "CCD", has threatened to destroy much of Pennsylvania's beekeeping industry. In partnership with the Xerces Society for Invertebrate Conservation and the Pennsylvania State University, with funding from the Häagen-Dazs Loves Honey Bees® program, this project is now moving to promote pollinator education and to develop a citizen-



Bees are the most important group of insect pollinators, responsible for pollinating many different crops and wildflowers.

science program designed to train others to collect the information we need to better understand Pennsylvania's diverse pollinators so that we can protect them.

There are an estimated 400-450 species, or kinds, of bees in Pennsylvania. Some of these bee species can only be identified by specialists who look at traits and characteristics that are difficult to see, especially without a microscope. There are only a handful of taxonomists in North America who can accurately identify these bees to the species level! However, with a little practice and guidance, Citizen Scientists can learn to identify the most common bee species and "species-groups" (generally, sets of related species) found in the gardens, fields, and forests of Pennsylvania. In a similar study in California, paired data collection suggests that the diversity measured by easily identifiable species and species groups correlates with the data collected by bee experts.

This Citizen Scientist Monitoring Guide was developed specifically for the purpose of training Citizen Scientists. It includes an introduction to identifying bees, in general, as well as identifying bees at a "species-group" level. The final section outlines the procedures for collecting observational data. The data generated by this project, specifically, will help gauge the value of different plants and plant communities as food resources for Pennsylvania's bees.



The transport of pollen between flowers is an essential function of insect pollinators.

How to Monitor and Observe Pollinators

There are many different species of insect pollinators, including bees, butterflies, moths, wasps, beetles and true bugs. This monitoring protocol will allow you to measure both the diversity (different kinds) and abundance (number of each kind or of all kinds) of bees that are present on the habitat you are monitoring, and how the composition of those pollinators changes over time. There are many potential uses for this kind of information, including: quantifying the effectiveness of efforts to promote pollinator populations in gardens and yards; understanding the pollinator requirements of crops dependant on insect pollinators; or, simply, identifying the types of bees present on a particular habitat. This information will aide in generating guidelines on how to enhance pollinator habitat by improving or planting additional floral resources. Long term monitoring will allow us to assess how management practices are affecting local pollinator communities.

There are many ways to monitor pollinators, but most often specimens are collected or observations are made that note which insects are visiting flowers. In this program, we will not be collecting the insects, only observing them. Here, we present the necessary procedures designed to train the Citizen Scientist to:

- Select monitoring locations and collect habitat information.
- Identify pollinator species-groups.
- Record observational data on floral visitations.

Throughout the process, we will be evaluating the effectiveness of these guidelines to train Citizen Scientists to accomplish the goals outlined above. Important in this process is feedback from you, our Citizen Scientists, as you work through the material and begin to record observations. The data you collect and the feedback you provide will be important as we continue to develop a deeper understanding of our pollinators.



Leo Donovall

Monitoring of pollinators usually requires nothing more than careful observation of what the insects are doing and what they look like. By following the same procedures each time, you can begin to develop a valuable record of how insects are using your garden.



It is sometimes difficult to tell flies, wasps, and bees apart. Furthermore, some bees look very similar to each other, but are in fact different species. Remember when identifying insects that **it is much better to identify bees accurately at a coarse taxonomic level** than to identify them inaccurately at a fine taxonomic level. When in doubt, identify only to the level you are confident, and add notes to describe the insect further, as necessary.

Observing Insects Visiting Flowers

Before you begin monitoring your property it is important to know how to make observations and how to identify floral visitors. Much of this guide focuses on the latter, but it is important to keep the following points in mind when collecting observational data on floral visitors:

- Only collect data on floral visitors.
- Look at all flower types.
- Be careful not to disturb insects visiting flowers before you get a chance to observe them well.
- Avoid sudden movements and do not stand too close to the flower you are observing.
- Insects respond to shadows passing overhead by moving away; walk so that your shadow trails you, rather than advances in front of you.
- Observe and identify insects as best you can; even noting whether a visitor is a honey bee, native bee, fly or wasp is useful information.
- Bee species can be difficult to tell apart. As we are particularly interested in monitoring native bees it is important to distinguish, at minimum, honey bees from native bees. (See the example data sheets, pages 32 and 33)

1. Remember to only observe and identify insects visiting the reproductive parts of the flower.

Pollinating insects will be collecting either pollen or nectar. It can be difficult to observe this on very small flowers. In this case, observe the floral visitor's behavior and do your best. You do not need to identify or make notes on animals sitting on petals, leaves, stems, etc., or visitors flying around the area.

2. Remember to look at all flower types.

Sometimes you need to look inside deep flowers, too. For example, in Pennsylvania, bees may be foraging in the center of the cone-shaped flowers of squash (*Cucurbita* sp.) or bindweed (*Convolvulus arvensis*; also known as morning glory).

In addition, bees may visit flowers that are less noticeable to people – such as flowers that are quite small or green – so try not to focus on only one or a few flower types.



Section 2

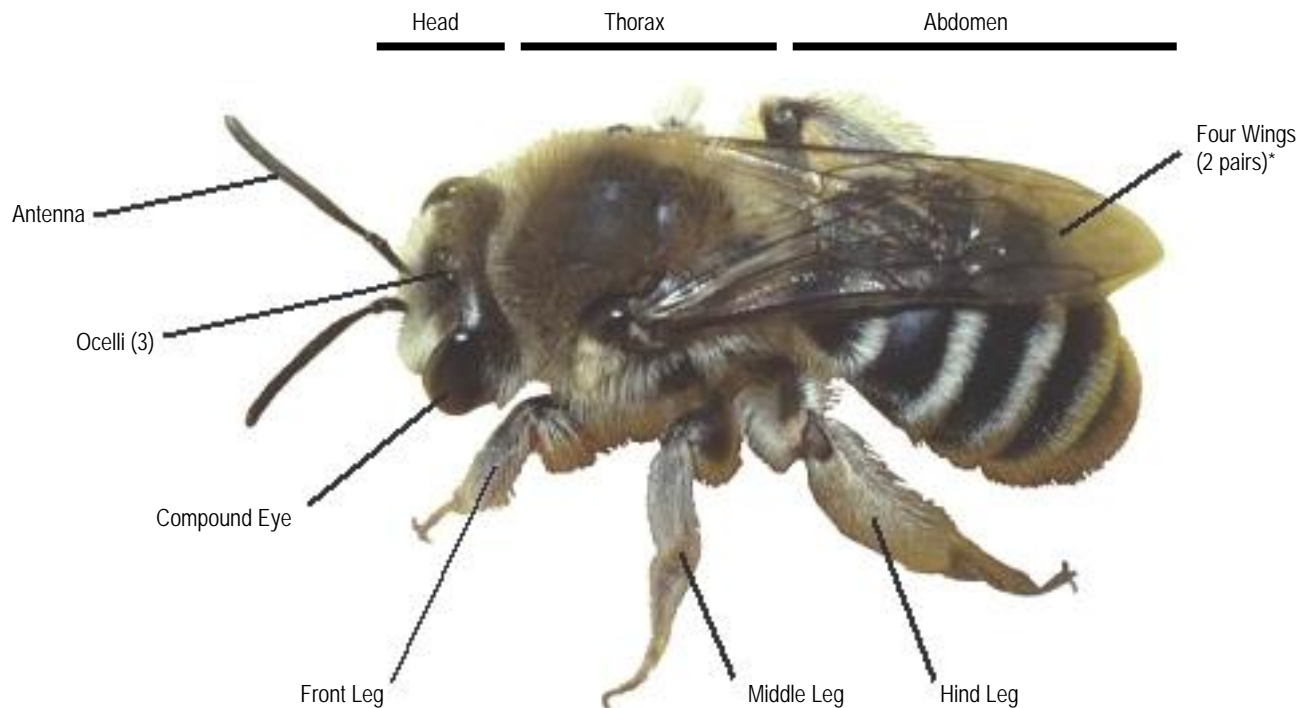
IDENTIFYING FLORAL VISITORS

Bees, in general, are the best pollinators; they have evolved to be the most efficient pollen transporters. However, some birds, bats and other rodents, flies, wasps, butterflies and moths, beetles, and bugs visit and pollinate flowers, as well. For this reason it is important to note *all* floral visitors.

Identifying butterflies and moths or a spider from a bee is simple. Separating bees from wasps or flies – especially those that mimic bees or wasps – can be harder. The following pages give more

information on how to identify the principle groups of pollinators and key characteristics to look for when identifying specific bee groups.

But first, let's focus on bees. To help you get to know a bee, take a look at the diagram below, on which the major body parts have been labeled. On the next page you will find more about the key characteristics of bees.



* It can be difficult to see all four wings because sometimes the wings are folded on top of each other.

A NOTE ABOUT STINGS

There is always a risk of being stung when working with and around bees (and wasps). Most bees are not aggressive and only sting if handled improperly; you will rarely be stung while simply observing bees. If, however, you happen to be stung while in the field, try to identify the type of bee (or wasp) stung you and let someone know so that they can help watch for symptoms. Most people have mild reactions to bee stings and exhibit a reaction only at the site of the sting (mild swelling, redness, itchiness and/or mild pain). Symptoms of a serious reaction include swelling elsewhere on the body, vomiting, dizziness, hoarseness, thickened or slurred speech, or difficulty breathing, and should receive prompt medical care from a physician. If you suspect you have an allergy to bee stings, consult your doctor and ask about an EpiPen®.

Identifying Bees

Key characteristics:

- Bees have **four wings** (two pairs; difficult to see when folded over the body).
- Bees have **long, elbowed antennae**.
- Bees have **large, well separated eyes** with **three small eyes** (or “ocelli”) **on top of the head**.
- Bees are **more robust** (i.e. rounder bodies) than wasps and flies; abdomen usually broad near thorax (vs. most wasps).
- Most bees are **hairy-bodied**, with multi-branched hairs (resemble pipe-cleaners or brushes) for carrying pollen.
- Female bees can **carry large loads of pollen**, either on their legs or on their abdomen in a “scopa”.

Size: Range from 2 to 25 mm (less than 1/8 inch to 1 inch) or more.

Body Color: Can be black, brown, orange, yellow, red, or metallic blue, green, or copper-colored.

Stripes: Body color (exoskeleton) or hair colors (yellow, orange, white, black or brown) can form stripes.



John Baker

Bees are an incredibly diverse group of insects. Some look very “bee-like” (hairy with black-and-yellow stripes), but many are brightly colored.

Often have rounder bodies



John Baker

Have antennae that are long and elbowed

Can carry large loads of pollen



John Baker

Hairy body

Four wings



John Baker



Male bees are often less hairy than female bees, often have longer antennae, and rarely carry pollen. Only females forage on flowers to collect pollen to bring back to their nests.

Non-Bees: A Quick Reference

Birds



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Flies (detailed on page 10)



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Wasps (detailed on page 11)



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Spiders



John Baker

Butterflies and Moths



John Baker

Butterfly



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Moth

Other (beetle, bug, etc.)



John Baker

Beetle



Leo Donovall

True Bug

Flies vs. Bees

Key characteristics:

- Flies often have **short thick antennae** (sometimes difficult to see).
- Flies often have **large eyes near the front of their head** usually converging (coming together) on top of the head, almost touching; small eyes (“ocelli”) on front of head, above antennae.
- Flies only have **two wings (one pair)**.
- Flies are usually **less hairy** than bees.
- Flies **can hover** (most bees are not able to hover).
- Flies **do not carry large loads of pollen** although some grains may stick to their bodies.

Size: Range similar to bees: tiny, small, medium, or large.

Body Color: Can be black, brown, red, orange, yellow, creamy-white or metallic blue, green or coppery.

Stripes: Can have stripes, usually from body color (exoskeleton); some look like bees (i.e. mimics)!

Short, thick antennae



Leo Donovall

Large eyes near front of head

Two wings (one pair)



John Baker

Less hairy



John Baker

Little or no pollen



Some flies can be very bee-like in appearance. This is a drone fly (*Eristalis tenax*), a honey bee mimic, and like the honey bee, an introduced species from Europe.

Wasps vs. Bees

Key characteristics:

- Wasps, like bees, have **four wings** (two pairs; often folded lengthwise).
- Wasps usually **narrower-bodied** than bees, with the abdomen more obviously constricted near the thorax.
- Wasps are usually **not obviously hairy**.
- Wasps are often **long-legged**.
- Wasps can have **bright markings or stripes** on their bodies (exoskeleton); stripes and marks usually not from hair patterns.
- Wasps **do not carry pollen loads**.

Size: Similar in size to bees and flies, but wasps that resemble bees are often larger.

Body Color: Can be black, brown, red, orange, yellow, pale to creamy white, or metallic green, blue or coppery.

Stripes: Can have body stripes (exoskeleton), that closely resemble a bee (close relatives often are difficult to tell from bees until seen under a microscope); stripes and markings usually not from hair patterns.



Wasps are often described as appearing "more tough" or "more rugged" than bees.

Four wings (folded lengthwise)



Narrower body, abdomen more constricted near thorax

Stripes and markings on exoskeleton (not hair patterns)



Less hairy



Do not carry pollen loads (some grains stuck to body)

Section 3

UNDERSTANDING BEES

Introduction

If you see that a floral visitor is carrying clumps of pollen on its body, this visitor is likely a bee. Female bees collect pollen from flowers to bring back to their nests, where they pack it into brood cells for their larvae (i.e. young bees) to feed on. For this reason, their bodies are highly adapted to be very efficient pollen transporters.

In this section, we will examine some of the characters that will help you to identify bees visiting flowers. For most bees, we will only be able to identify to a larger group (i.e., family, genus, species groupings) or to a body-type.

The characteristics that will be covered in this section are:

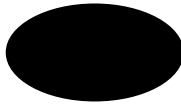
- Body size and shape
- Body coloration
- Body hair distribution
- Location of scopa
- Body stripes
- Antennal length

Bees: Body Size

The size of the bee is often a great initial separator, especially when combined with other characters.

What size is the bee?

Extra
Large



Medium



Large



Small



Tiny



Bees: Body Shape

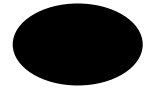
Some species groups are consistent in body shape.

What shape is the bee?

Narrow



Broad/
Robust



Narrow



John Baker

Robust



John Baker

Bees: Body Coloration

Color can be assigned in two ways with bees: 1) body surface (exoskeleton) color and 2) hair color. We will refer to bee color in both contexts, as necessary. In general, look at the overall color pattern to begin to make broad classifications.

What colors are present on the bee (body and hair)?

- Metallic or non-metallic
- Hair color vs. body color
- General distribution of colors (thorax, head, abdomen)

Brown



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Black



John Baker

Whitish stripes



John Baker

Yellow



John Baker

Metallic green



John Baker

Metallic blue



John Baker

Bees: Distribution of Hair

The pattern of hair distribution is an important tool for identification. Some bees are “fuzzy”, with the entire body covered in hairs. Others are sparsely covered in hairs or hairs are covering only certain areas of the body.

Which body regions are covered in hair?

- Thorax and abdomen thickly covered
- Thorax thickly covered, abdomen sparse or in bands
- Body appears nearly hairless

Thorax and abdomen thickly covered



John Baker

Bees: Location of Scopa

The scopa, or “pollen basket”, is an area of densely arranged, often highly-branched hairs that are modified for transport of the “pollen load”, or packet of collected pollen. The scopa is only present on female bees and is most often located on the hind legs, resembling pipe cleaners or bottle brushes. For others, the scopa is on the underside (or bottom) of the abdomen or completely absent. If unsure, look for an area with lots of pollen packed against the body.

Where is the scopa (pollen basket) located?

- Hind legs, underside of abdomen or absent

On the underside of its abdomen



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Thorax thickly covered and abdomen sparse or in bands



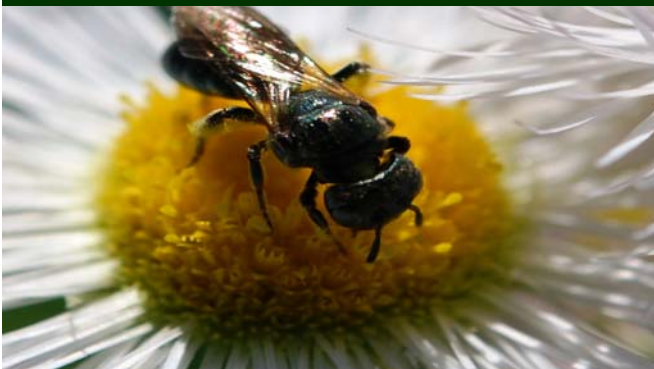
John Baker

On its legs



John Baker

Appears nearly hairless



John Baker

Scopa lacking



John Baker

Bee: Body Stripes

Bees are often identified by the pattern of stripes, or bands, of colored hair or exoskeleton markings. The region or relationships of these stripes to one another are distinguishing features for species and species-groups.

Does the bee have stripes on its body?

- Hair or exoskeleton markings
- Pattern (color, location of bands or marks)

On its thorax



John Baker

On its abdomen



John Baker

Bee: Antennal Length

Antennal length is important for distinguishing sex: males have longer antennae (literally, one segment longer – 12 for females, 13 for males). In general, bees have “short” antennae. However, one group is called the “long-horned” bees, because they have longer antennae than normal.

How long are the antennae?

- Long or short

Long



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Short



John Baker

Section 4

A GUIDE TO THE DIFFERENT GROUPS OF BEES

There are more than 400 species of bees in Pennsylvania. This guide will help you identify some of the common bee groups you will see in your garden. 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 is not/does not fall into an identified species-group, note the bee as "Other bee" and describe the bee thoroughly in the observational notes. Even if you can't identify the bee precisely, it is important to document that it was observed.

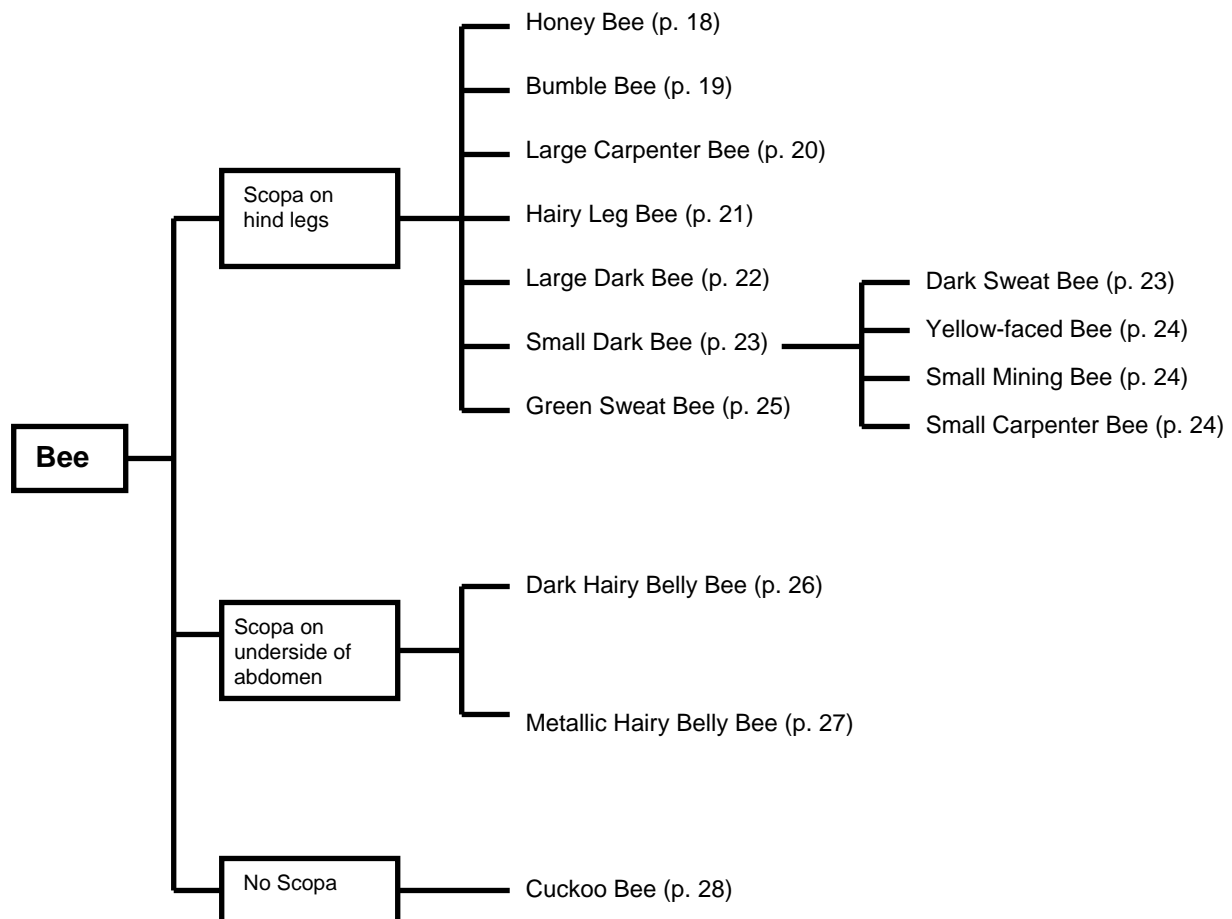
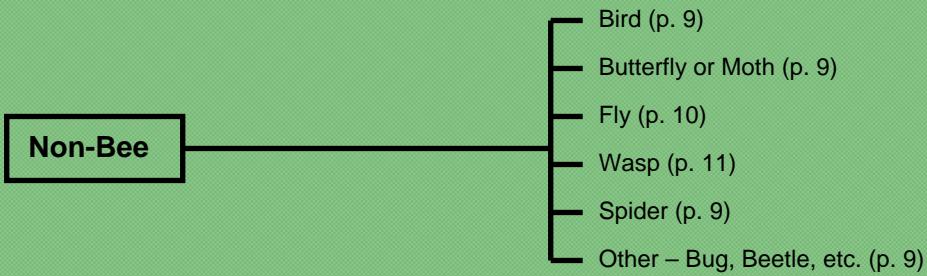
In particular, it is important to distinguish the honey bees, which are non-native, from the native bees. Whenever possible, attempt at minimum, to distinguish honey bees from the rest of the bee categories. So, study the "honey bee" page carefully.

Keep in mind the characteristics that will help you identify your bees (refer to Section 3: Understanding Bees, pages 12-15):

- Body size, shape and coloration
- Distribution of body hairs
- Type and pattern of stripes
- Location of scopa
- Antennal length



Groups of Floral Visitors



NOTE: Identify bees to the most specific group you are comfortable with; knowing both what type a bee is and what it is not is valuable information. For example, if you do not know the 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 (even if you cannot comfortably identify to species, identify that it is a "bumble bee").

Honey Bees

When most people hear the word “bee”, it is the honey bee that comes to mind.

Key Characteristics

- **Size and Shape:** Medium to large, moderately robust.
- **Color:** Orange-brown to nearly black.
- **Hair:** Fuzzy thorax and head, legs and abdomen less hairy.
- **Stripes:** Abdomen tri-toned, with black, pale and orange-brown stripes of hair and body coloration.
- **Scopa:** Enlarged, flattened hind legs; hairless in the center.
- **Antennal Length:** Short.
- **Notes:** Makes a buzzing sound when flying; the only bee with “hairy eyes”.

Approximate size range:



Important:

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 and wasps that mimic honey bees. For flies: look for two wings (one pair), small antennae, big eyes, and skinny hind legs. For wasps: look for nearly hairless body with exoskeletal (body) markings rather than markings made by hair patterns.

Drone Fly: a honeybee mimic



One pair of wings (i.e. 2 wings)

Striped abdomen

Fuzzy thorax



Hind legs enlarged and flattened, shaped to carry pollen

Color variation: dark to pale



Bumble Bees

Key Characteristics

- **Size and Shape:** Medium to very large, robust.
- **Color, Hair and Stripes:** Body black, with yellow, black, and, sometimes, orange hair stripes over thorax and abdomen.
- **Scopa:** Hind legs enlarged and flattened; hairless in center.
- **Antennal Length:** Short in females (the majority of bumble bees encountered), long in males.
- **Notes:** Make a low buzzing sound when flying; painful sting that does not linger.

Approximate size range:



Caution: There are a number of flies and other bees that mimic bumble bees. Look for a completely hairy abdomen and large hind legs, usually with short antennae.

Bombus vagans



John Baker

Bombus graseocollis



John Baker

Bombus perplexus



John Baker

Bombus fervidus



John Baker

Bombus bimaculatus



John Baker

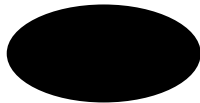
Large Carpenter Bees

Large carpenter bees look like less hairy bumble bees, with a shiny, nearly hairless abdomen.

Key Characteristics

- **Size and Shape:** Very large and robust.
- **Color and Hair:** Shiny black abdomen, thorax black with yellow/light hair; males with a yellow spot on face.
- **Stripes:** None.
- **Scopa:** Hind leg enlarged, covered with a brush of thick hair (scopa) throughout (compare with “Bumble Bees”, page 19).
- **Antennal Length:** Short.
- **Notes:** Only one type (species) in Pennsylvania: *Xylocopa virginica* (Linnaeus); often found in residential areas around exposed wood (decks, porches, trim, wood piles, etc.); males territorial (may buzz by your head); will “hover” for short period of time, “staring you down”.

Approximate size:



Comparison Note: Carpenter bees and bumble bees look very similar. Note the larger head, shiny and relatively hairless abdomen, fuzzy legs (particularly the female) and yellow spot on the face (male only). Also, if you see the nesting site, carpenter bees nest in wood, like your deck or porch, while bumble bees nest in underground burrows and cavities.

Black, shiny abdomen (appears hairless)



John Baker

Males with a yellow spot on the face



John Baker

Hairy Leg Bees (Digger or Long-horned Bees)

Key Characteristics:

- **Size and Shape:** Small/medium to medium/large and robust.
- **Color and Hair:** Dark, with white to yellowish/orange hairs; thorax covered in short, dense, velvety hair.
- **Stripes:** Abdomen often with pale stripes.
- **Scopa:** On hind legs; appear as dense stands of long hair (like pipe-cleaners), usually quite prominent.
- **Antennal Length:** Generally longer than most, especially males, who have very long antennae.
- **Notes:** Some species are very quick and can visit flowers rapidly; difficult to collect.

Approximate size range:



Important:

Note key characteristics for this group when you see them visiting flowers (e.g. pollen, hairy, size/shape, color, stripes, antennae, and flight).

The legs of males will not be as hairy as the legs of females because males do not transport pollen. Additionally, in general, males in this group often have much longer antennae than females.

Hairy – especially on the legs and thorax of females



John Baker

Stripes on abdomen



John Baker

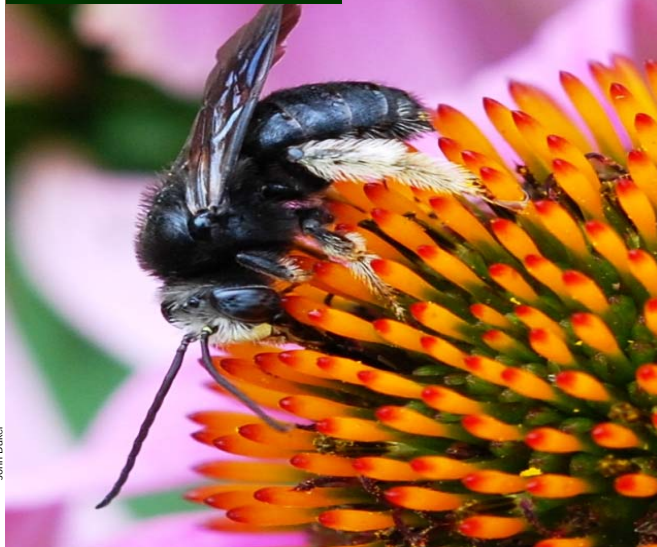
Collect dry pollen – can be all over body

Can have short antennae



John Baker

Can have long antennae



John Baker

Large Dark Bees (Mining and Plasterer Bees)

Key Characteristics

- **Size and Shape:** Small to medium/large, relatively narrow to moderately robust.
- **Color and Hair:** Dark-bodied; most with densely hairy thorax (hairs white to pale yellow/orange) compared to abdomen, which is much less hairy
- **Stripes:** Often present on abdomen, made of pale hairs; a (rare) few with iridescent integumental (body) stripes on the abdomen.
- **Scopa:** On hind legs; often pale and short (compare with “Hairy Leg Bees”, page 21).
- **Antennal Length:** Short in females, longer in males.
- **Notes:** Extremely numerous in early Spring and late Fall; possibly a valuable early season group of pollinators; some are very bumble bee-like, but have a completely hairy scopa.

Approximate size range:



Notes:

Females have dense patches of short, pale hair (called the facial fovea) along inner margin of eye and males often have thick “beards” or “mustaches”, some with yellow exoskeletal markings on face.

Mining and Plasterer Bees are some of the earliest-emerging bees in Pennsylvania’s spring. They are found on many of the early-blooming spring wildflowers and flowering trees from March through May.



Thorax and head densely hairy

Abdomen often with hair stripes

Leo Donovan

Female with dense hair patches on face (i.e. “fovea”)



John Baker

Males with a dense patch of hair on face



John Baker

Small Dark Bees (Dark Sweat Bees, Small Carpenter Bees, Yellow-faced Bees and Small Andrenid Bees)

Floral resources are visited by a large number of small dark bees, including dark sweat bees (Halictidae), yellow-faced bees (Colletidae: Hylaeinae), small carpenter bees (Apidae: Xylocopinae), and small mining bees (Andrenidae). Often, a flower patch is swarmed by these bees. The “Key Characteristics” of this section will describe any of the bees included in this group, with the small dark sweat bees as the primary example. Some distinguishing characteristics for the other species or groups of small dark bees are listed below.

Key Characteristics

- **Size and Shape:** Tiny to small/medium, moderately narrow.
- **Color:** Black to dull metallic blue, green or coppery; abdomen can be yellowish or reddish, but usually dark
- **Hair:** Body covered in pale hairs that are less noticeable, but some with large, dense patches, especially on abdomen.
- **Stripes:** Usually absent, but some have whitish to pale yellowish stripes on dark abdomen.
- **Scopa:** On hind legs; less noticeable than other bees, unless covered in pollen.
- **Antennal Length:** Short in females, longer in males.
- **Notes:** Usually the most numerous group of bees visiting flowers, and also the most difficult to tell apart.

Approximate size range:



Dark Sweat Bees

Dark sweat bees are quite variable. They range in size from tiny to slightly smaller than a honey bee, are usually dark or dull metallic in coloration with few markings and are usually honey bee-shaped.



John Baker

Whitish-yellow stripes on abdomen



John Baker

Stripes usually absent; may sometimes have dark stripes



John Baker

Medium (8 to 12 mm)



John Baker

Yellow-faced Bees

Yellow-faced bees are similar in shape as dark sweat bees, but with white to yellow markings on face, thorax and legs. The body is much less hairy, and the scopa is absent.



John Baker

Yellow markings on face, thorax and legs

Small Carpenter Bees

Small, or “dwarf”, carpenter bees do not resemble their much larger-bodied relatives, the large carpenter bees. Small carpenter bees are entirely dull metallic green to blue-green and cylindrically shaped. The abdomen is shield-like, with a pointed tip. Males have a large pale patch on the face and broad, flat hind legs.



Small Mining Bees

Mining bees are often quite hairy, many with stripes of hair on the abdomen. Females have patches of pale hair on the face (called the facial foveae), and males have a hairy face, often resembling a “mustache” or “beard”. Some mining bees have elaborate facial markings and yellow legs, resembling yellow-faced bees. This group is most numerous in the Spring and Fall.




John Baker

Facial foveae



Green Sweat Bees

Key Characteristics

- **Size and Shape:** Small to medium, relatively narrow.
- **Color and Hair:** Metallic green; abdomen can be dark and/or striped; body covered in pale hairs that are less noticeable.
- **Stripes:** Usually absent, some with yellow-and-black striped abdomen.
- **Scopa:** On hind legs; less noticeable than other bees, unless covered in pollen.
- **Antennal Length:** Short in females, longer in males.
- Approximate size range: 

Notes

Relatively fast flying and numerous; most are ground nesters, but one especially numerous species nests in rotting wood, and, so, may be found in areas with a lot of woody debris.

Caution:

Some orchard bees (Megachilidae) and cuckoo wasps (Chrysididae) can be metallic green. Orchard bees are more robust, duller metallic, hairier and with the scopa on the underside of the abdomen (see “Metallic Hairy Belly Bees”, page 26). Cuckoo wasps tend to be more blue-green, look nearly hairless and have dark wings and will be on vegetative parts rather than flowers.

Cuckoo Wasps (Chrysididae) mimic Sweat Bees



© Rajwinder Singh

Body nearly hairless, with dark wings

Scopa on hind legs; may be loaded with pollen



John Baker

Males can have yellow and brown striped abdomens



John Baker

Metallic Hairy Belly Bees (Orchard and Mason Bees)

Metallic hairy belly bees (or Orchard Bees, *Osmia* sp.) are important pollinators in fruit orchards in early Spring. They are among the first bees seen during the pollinating season.

Key Characteristics

- **Size and Shape:** Small to medium/large and robust.
- **Color:** Dull to bright metallic green or blue; some very hairy and dark with coppery reflections.
- **Hair and Stripes:** Black, white or dull yellow, brownish or orange; stripes absent or faint on abdomen.
- **Scopa:** On underside of abdomen (look for pollen load).
- **Antennal Length:** Short.

Approximate size range:



Notes:

- Most observed in spring and early summer.
- Often called Orchard Bees (found pollinating blossoms of tree fruits) or Mason Bees (because some species gather mud and pebbles to construct nests). Others use plant materials to construct their nests.
- A few non-native (i.e. from outside of North America) species with horns on the face.

Metallic blue



Stout, round body

John Baker

Metallic green



Scopa (and pollen load, when present) on abdomen

John Baker

Dark, coppery-metallic; hairy



Face with "horns"

Robert Snyder

Dark Hairy Belly Bees (Leaf-cutter Bees)

Key Characteristics

- **Size and Shape:** Small to medium/large and very robust; a few are very large and narrow; some with abdominal projections.
- **Color:** Black or dark with coppery metallic reflections; some with bright yellow or red markings on thorax and abdomen.
- **Hair and Stripes:** Thorax and head thickly covered in white/pale to orange-colored hairs; abdomen with pale to white stripes or not striped above, with dark, pale or orange-colored hairs underneath.
- **Scopa:** Located on underside of abdomen (look for pollen).
- **Antennal Length:** Short.
- **Notes:** When visiting flowers, abdomen often flexed upward (or elevated) revealing pollen underneath.

Approximate size range:



Some with pointed abdomens or with small projections



John Baker

Scopa on underside of abdomen



John Baker

Look for pollen to find scopa

Often grey/white stripes on abdomen



John Baker

Abdomen often flexed upward at rest

Some have yellow or red markings on body



John Baker

Large, carpenter bee-like



John Baker

Cuckoo Bees

Cuckoo bees are nest parasites: they lay their eggs in other bees' nests. Because they do not provision their own nests, they lack the pollen-carrying scopa, but adults still visit flowers to "tank up" on nectar. There are many groups of bees represented in this category, and are not separated because they are very minor pollinators.

Key Characteristics

- **Size and shape:** Tiny to medium and often narrow-bodied.
- **Color:** Body black, red, or yellowish; often wasp-like, with elaborate body markings or light-colored hair patterns.
- **Hair and Stripes:** Usually not very hairy; some with short, densely-arranged hair covering entire body.
- **Scopa:** Lack pollen carrying structures.
- **Antennal Length:** Sometimes short, often long (especially males).

Approximate size range:



Caution: These bees tend to look very wasp-like and are often quite difficult to identify in the field – they usually need to be identified under a microscope to be sure. This is the least important group of pollinators, since they do not actively collect pollen and are generally not very hairy. During the day, they fly low to the ground searching for nests to parasitize. They are most often seen on the flowers, looking for nectar, in the evening when their hosts have stopped foraging and returned to their nests.

Generally, look for shorter legs, elbowed antennae, and more bee-like body stature. If still unsure, mark in the "other" category and report your suspicion of a cuckoo bee.

Cuckoo bees lack a scopa (pollen-carrying hairs)



Wasp-like markings formed by markings on exoskeleton

Cuckoo bees appear to be less hairy than other bees



Red abdomen

Small to medium



Wasp-like markings formed by bands of short, thick hair

Tiny



Wasp-like markings formed by clumps of short, thick hair

Section 5

OBSERVATIONAL DATA COLLECTION

Introduction

Documenting bee abundance and diversity is important for understanding the health of an ecosystem. Pollinators are a good measure of environmental health – changes in bee populations reflect changes in habitats and their inhabitants. Bee diversity can be affected by changing the composition of the flowering plant community. In this section, we will outline the protocols for conducting and recording observational data on floral visitors.

Observational data collection is both an active and a passive approach to measuring pollinator-floral host relationships. Along with identifying who a pollinator is in a particular habitat or floral source and what day that general interaction took place, observational data on floral visitors produces specific relational information about weather, habitat, floral visitations, behavior (i.e. mating, communication, predator avoidance, etc.), flight patterns, activity schedule and interactions with other organisms. If carried out consistently, observational data can add much to our knowledge of how pollinators interact with their plant hosts.

Bee communities vary over time; while some bee groups will consistently show up during every sample round, early season bees such as blue metallic hairy belly bees will be abundant only at certain times in the year. Also, some bee species are only active at certain times of the day. You should plan on recording observational data for your field site once per month throughout the field season (approximately April through October/early November) and at approximately regular intervals (e.g. the first Saturday, the 15th day, etc.). Observations should occur in the morning and be repeated in the afternoon/early evening, as some bees are active for only a short portion of the day.

It is a good idea to be aware of the weather conditions before trying to make your observations. Bees do not like cool temperatures (below 55°F), wind (average wind speed over 5 miles per hour), or overcast skies (you should be able to see your shadow). Collect on an alternate day if conditions are not favorable, but try to remain consistent – always collect within a few days of your normal collecting date.

Included on the data sheets (pages 31-33) are places to record the habitat description, date, time and weather conditions. In addition to these habitat and environmental observations, you will also be keeping track of the bees visiting the plants in your garden. This

will help us to determine the abundance and diversity of floral visitors in your managed habitat. You will be provided with datasheets to fill out for every collection period.



When done consistently and regularly, observational data can yield much valuable information about the habits of pollinators and their use of floral resources.

Materials Required:

- Identification guides (*Citizen Science Pollinator Monitoring Guide* and the companion *Pocket Guide*)
- Clipboard
- Pencil
- Observational Datasheet(s)
- First aid kit (including an EpiPen or other appropriate medicine, if you are unsure of a bee allergy)

Timeline

- **Duration:** April through October or early November (ends after first hard frost).
- **Frequency of Observations:** Once per month, at consistent intervals – for example, the first Saturday or the 15th day of the month.
- **Report Submission:** Data sheets should be mailed to the PA Department of Agriculture once per month in the pre-addressed envelopes provided.

General Sampling-Day Procedure

Initial Observations

1. For the first observational period of the year, describe: age of site (if a garden, how long it has been present), general habitat description (trees, distance to water, setting/landscape, floral and nesting resources available), etc. Drawing a crude map of the site and immediate surroundings would also be helpful. List all potential floral resources at your site (including those in bloom, those that have completed bloom and those that have yet to bloom). (See “Site Information and Initial Observations Data Sheet”, page 31)
2. For the remaining observational periods, describe changes since the last visit, including the weather between observation periods (precipitation, major temperature shifts, etc.) and modifications to the landscape/habitat. Add additional floral resources missed on the initial list. (See top of “Pollinator Monitoring Data Sheet”, page 32)
3. Identify and list the floral resources of your site that are currently in bloom – you will make your observations from this list. For every plant that is flowering, count the number of each that are present in the garden.

Observational Periods

2. Perform this operation twice per day: once in the morning, between 9:00 AM and noon, the other in the afternoon/early evening, between 1:00 and 5:00 PM. (see “Pollinator Monitoring Data Sheets”, pages 32-33)
3. Note the time and relative temperature, windiness, and cloud cover (clear, partly cloudy, mostly cloudy with some sun and shadows, or overcast).
4. Observations:
 - Choose eight (8) plants that are in bloom. Record the number of each present in the garden.
 - Begin with the eight Master Gardener Pollinator Garden required plants: Oregano, Thyme, Asters, *Monarda*, *Echinacea*, *Asclepias*, *Agastache*, and *Helianthus*.
 - Include additional blooming plants in your garden to bring the total to at least 8 blooming plants, unless there are no other plants in bloom.
 - Be sure to spend 10 minutes per blooming plant species/cultivar recording the number of bees in each species/group utilizing the flowers.

- Using the bee guides (Section 4, A Guide to the Different Groups of Bees, pages 18-28), identify all bee species groups that arrive on the blooms. If you can't identify the bee group for sure, use the “other” category on the data sheet to record the bee's presence and list in the notes what you know (i.e., “not a honey or bumble bee”).
 - This could take some time if there are many blooming flowers; multiple two-man crews could speed the process.
 - Feel free to continue observing and recording from other blooming plants in your garden – remember that we want to know how effective each floral resource is at attracting pollinators.
 - Record how many of each plant species you made your observations from (i.e. 9 out of 10).
1. At the end of the observational period, record any additional observations: behaviors of note, interactions between bees, time spent at a flower, etc.

IMPORTANT!

- Only record pollinators that land on flowers!
- Avoid sudden movements so that you do not disturb insects visiting flowers before you get a chance to observe them well!
- Bee species can be difficult to tell apart – if you are unsure, record what you know. At the very least, we want to know if it is not a honey bee or bumble bee!

Submitting Data Sheets

PA Native Bee Survey Citizen Scientist Pollinator Monitoring Project Data Sheets should be sent to the Pennsylvania Department of Agriculture for processing on a routine basis, generally once per month or as part of the shipment of specimens collected from other surveys. Please call with any questions or for additional information regarding the PA Native Bee Survey.

Native Bee Survey
Pennsylvania Department of Agriculture
Bureau of Plant Industry – Apiary Section
2301 North Cameron Street
Harrisburg, PA 17110
(717) 787-4843 x278

2009 Citizen Science Pollinator Monitoring Program Site Information and Initial Observations Data Sheet

INSTRUCTIONS: Fill the following data sheet in completely. For the site information, be as exact as possible with the address (no PO Boxes or RR numbers); use a GPS unit to gather coordinates, if possible. We will use the site information to assign location names. List the participants involved in the data collection. Be as exhaustive as possible when describing the initial observations.

SITE INFORMATION

Site Name: Department of Agriculture
Site Location: 2301 N. Cameron St.
 Harrisburg, PA, 17110
County: Dauphin
Coordinates: N40.287010, W76.881508

Site Contact: Mary Thompson (Coordinator/Educator)
Contact Address: 422 E. Main Street
 Harrisburg, PA 17110
 (717) 215-5555

PARTICIPANTS

Tom Smith

Karen Smith

John Thompson

Sally Firth

Erin Young

Sara Engel

Mike Williams

Sharon Thomas

Wanda Engel

INITIAL OBSERVATIONS

Site History (i.e. age, former use of land, and any additional information):

Garden is 2 years old. It had formerly been a lawn area next to a detention basin for parking lot runoff. It already contained some of the plants we have planted (Asclepias and Asters). It is surrounded by lawn that is mowed approximately twice per month

Describe the landscape, including nesting sites (bare ground, cane or hollow stems, wood piles, etc), water resources, setting (Urban/rural/ag, yard/garden/field, managed/unmanaged surroundings):

The sides of the detention pond have some bare area and stems are allowed to remain after frost. There is often very shallow standing water in one end, with a rocky bottom. There is also some bare ground along the edge of the parking lot. The setting is along the edge of a detention pond, on the edge of an urban area (Harrisburg).

List floral resources (former, current or potential) in garden/around site:

Demo plants (Oregano, Thyme, Asclepias, Asters, Monarda, Echinacea, Helianthus, Agastache); Coreopsis, Dogwood, Redbud...

POLLINATOR MONITORING DATA SHEET

Date: 6 / 15 /2009

MORNING OBSERVATION PERIOD

INSTRUCTIONS: Fill in the date and requested times, and circle the relevant weather-related information. For the “Habitat changes...” section, fill in all of the habitat changes and weather anomalies (i.e. heavy precipitation, high winds, temperature extremes, etc.) since the last time you observed bees at this site. In the table, fill in the “Floral Resource” column with the flower species you are observing (i.e. type, cultivar, etc.); for each species, count the total number of plants (“# Plants”) and count the number of bees visiting each floral resource for ten (10) minutes per species; record the number of plants you actually made your bee counts from (“# Obs.”). If you cannot determine which group a bee belongs to, record the bee in the “Other” column and note whether you could tell it was not a honey bee or bumble bee in the “Observational Notes” section at the bottom of the page, along with any additional comments. Please record additional blooming species at the bottom of the other side of this datasheet, under “Additional Blooming Plants”.

Site Name: Department of Agriculture

Observation Start Time: 9 : 00

End Time: 11 : 30

Weather: Temp: 50 / 60s / 70s / 80s / 90s / 100+

Wind: Still / Light Breeze / Windy / Gusty

Sky: Clear / Partly Cloudy / Mostly Cloudy / Overcast

Habitat changes since the last observation/collection date:
There was a lot of rain at the end of May (about 2.25 inches) - the plants really perked up. The first week of June it was very warm (highs in the low 90s), but it has cooled off this week. A lawn tractor cut down a few of the plants on one end of the garden...

Floral Resource (Genus species)	# Plants/ # Obs.	Honey Bees	Bumble Bees	Large Carpenter Bees	Hairy Leg Bees	Dark Bees	Green Sweat Bees	Metallic Hairy Belly Bees	Dark Hairy Belly Bees	Cuckoo Bees	Other - Describe in Notes
<i>Oreganum X</i>	3 / 3	1	2	1		9	4		3		
<i>Thymus X</i>	4 / 3		4			13	8			1	
<i>Monarda 'Fireball'</i>	8 / 5	2	8			3	3				
<i>Echinacea sp.</i>	5 / 5		3		1	4	11			1	
<i>Asclepias tuberosa</i>	10 / 4	2	6	1		2	6		1		
<i>Agastache X</i>	20 / 11		1			11	3	1			
<i>Helianthus annuus</i>	6 / 3	4	4			9	8				
<i>Symphotrichum novae-angliae</i>	12 / 9	1	2		1	8	7		1	1	

Observational Notes:
Activity increased as temperature increased.

Some of the bees were already loaded with pollen before we started. The dandelions in the grass surround *ite*
attractive.

Feel free to use tally marks or write the final number. If you use tallies, please write the final total for each bee species on each plant species and circle it.

POLLINATOR MONITORING DATA SHEET

Date: 6 / 15 /2009

AFTERNOON OBSERVATION PERIOD

INSTRUCTIONS: Repeat the procedures from the morning observation period (reverse side of page), being sure to fill in the date and requested times and circling the relevant weather-related information. Use the same floral resources as those in the morning observation period. Again, be sure to record all bees, using the “Other” column for those that you cannot determine beyond that it is not a honey or bumble bee. At the bottom of the page, record all additional blooming plants that were not utilized during the observation periods.

Site Name: Department of Agriculture

Observation Start Time: 1 : 00

End Time: 2 : 45

Weather: Temp: 50s / 60s / 70s / 80s / 90s / 100+

Wind: Still / Light Breeze / Windy / Gusty

Sky: Clear / Partly Cloudy / Mostly Cloudy / Overcast

Floral Resource (Genus species)	Area Covered/ % Obs.	Honey Bees	Bumble Bees	Carpenter Bees	Hairy Leg Bees	Green Sweat Bees	Dark Bees	Metallic Hairy Belly Bees	Dark Hairy Belly Bees	Cuckoo Bees	Other – Describe in Notes
<i>Oreganum X</i>	3 / 3	2	3		1	4	3		2		
<i>Thymus X</i>	4 / 4	1	1	1		2	9				1
<i>Monarda 'Fireball'</i>	8 / 4	1				3	11	1		1	
<i>Echinacea sp.</i>	5 / 3		4			2	3		2		
<i>Asclepias tuberosa</i>	10 / 6				1	3	13	1		1	
<i>Agastache X</i>	20 / 9	2		1		11	17				
<i>Helianthus annuus</i>	6 / 6	1	2			1	1	1	2	1	
<i>Symphotrichum novae-angliae</i>	12 / 7		1			4	9		1		

Observational Notes:

One insect landed on Thyme - I think it was a bee, but not a bumble bee or honey bee, and it wasn't metallic, either

There were a lot of bees flying around, but not that many landed. Some of the bees seemed to be chasing others off the flowers. The carpenter bee on the thyme was chewing through the side of the flower.

Be sure to briefly describe any “other” bees (even if all you know is that it is not a honey or bumble bee).

Additional Blooming Plants:

Dandelions, Centaurea (Knapweed), Coreopsis, Sweet William, Dianthus, some Hydrangeas.

Include ALL plants that are blooming (if you can identify them), even the non-native plants.

Appendix A

THE BEES OF PENNSYLVANIA

“Honey Bees” (p. 18)

Apis mellifera (European Honey Bee)

“Bumble Bees” (p. 19)

**Bombus* spp. (Bumble Bees; 17 species)

“Large Carpenter Bees” (p. 20)

Xylocopa virginica (Carpenter Bee)

“Hairy Leg Bees” (p. 21)

Anthophora spp. (4 species)

Eucera spp. (2 species)

Habropoda laboriosa (Southeastern Blueberry Bee)

Melissodes spp. (11 species)

Peponapis pruinosa (Squash Bee)

Ptilothrix bombiformis (Hibiscus Bee)

Svastra compta

“Large Dark Bees” (p. 22)

Colletes spp. (Plasterer and Cellophane Bees, 13 species)

Andrena spp. (Mining Bees, 92 species)

Dieunomia heteropoda

Nomia nortoni

Macropis spp. (3 species)

Melitta mellitoides

“Small Dark Bees” (pp. 23-24)

“Yellow-faced Bees”

Hylaeus spp. (Yellow-masked Bees, 7 species)

Calliopsis andreniformis

Perdita octomaculata

Protandrena abdominalis

Pseudopanurgus spp. (3 species)

“Dark Sweat Bees”

Halictus spp. (6 species)

**Lasioglossum* spp. (52 species)

“Small Carpenter Bees”

Ceratina spp. (Small or Dwarf Carpenter Bees, 3 species)

“Green Sweat Bees” (p. 25)

Agapostemon spp. (4 species)

Augochlora pura

Augochlorella spp. (3 species)

Augochloropsis spp. (2 species)

“Dark Hairy Belly Bees” (p. 26)

Lithurgus chrysurus (Mediterranean Wood-boring Bee)

Anthidiellum notatum

Anthidium spp. (Wool Carder Bees, 2 species)

Heriades carinatus

Chelostoma philadelpi

Hoplitis spp. (4 species)

Paranthidium jugatorum

Megachile spp. (Resin and Leaf-cutting Bees, 25 species)

“Metallic Hairy Belly Bees” (p. 27)

Osmia spp. (Orchard and Mason Bees; 18 species)

“Cuckoo Bees” (p. 28)

Sphecodes spp. (10 species)

Coelioxys spp. (11 species)

Stelis spp. (5 species)

Nomada spp. (37 species)

Epeolus spp. (6 species)

Tripeolus spp. (10 species)

Holcopasites spp. (2 species)

Epeoloides pilosula

***Note:** There are a number of genera that also have cleptoparasitic, or cuckoo, bees that are not included in this list of genera. *Bombus* and *Lasioglossum* have both cleptoparasitic and non-cleptoparasitic species. Do not worry about cleptoparasitic members of these groups when counting – you are not likely going to encounter them and you are not expected to know the difference if you do see them.

Pennsylvania Native Bee Survey Citizen Scientist Pollinator Monitoring Guide

Pollinators are a key component of ensuring proper ecosystem health, linking natural environments with man-made and managed lands, such as parks, agricultural landscapes, and suburban and urban gardens. Although their primary objective is to feed themselves and their offspring, the work of bees, flies, beetles, butterflies and a host of other pollinators ensure that there is adequate pollination for a constant supply of fruits, vegetables, nuts and seeds. Of these, bees are generally considered to be the most important group of pollinators in North America.

Despite the great importance of these tiny organisms to our everyday lives – for, as much as one-third of our diet is the direct result of bee pollination! – surprisingly little is known about bees, outside of the honey bee, of course. We still have much to learn about the diversity and abundance of species on a local, or even regional, scale, about their nesting and foraging preferences, or about the diseases, pests and parasites that affect their health.

Since 2005, the Pennsylvania Native Bee Survey (PANBS) has been monitoring native bee diversity and abundance across the Commonwealth. To date, we have identified nearly 400 species of bees in Pennsylvania, but much remains to be discovered. In 2009, the PANBS, in cooperation with the Penn State Master Gardeners program, unveils the Citizen Scientist Monitoring Program, designed to equip citizen scientists with the monitoring tools necessary to identify and observe pollinators at work in our gardens. Through this effort, we hope to continue to expand our knowledge of how best to preserve, restore and protect these valuable ecological resources.



There are 17 species of bumble bees (*Bombus* spp.) identified from Pennsylvania, and one of them, *Bombus affinis*, may be extinct in the state. Photograph by Rajwinder Singh (2008).



Funding was made possible by the Häagen-Dazs Loves Honey Bees® program. For more information on this project, visit www.helpthehoneybees.com.



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