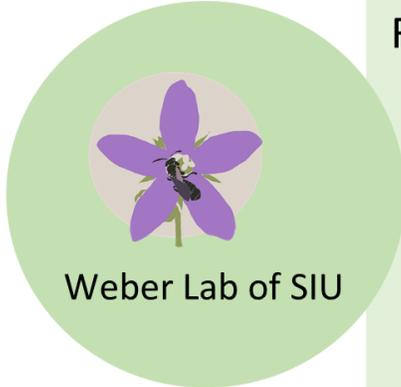


## Supplementary File 2. Pollinator Training Module Slides

SIU  
CARBONDALE

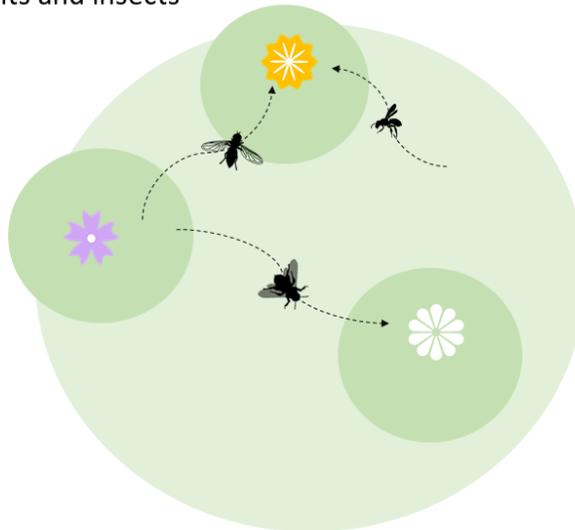


### Identifying Floral Visitors and Pollinators and Utilizing the Citizen Science Platform *iNaturalist*

Training for Citizen Scientists  
for pollinator observation and identification  
a curriculum by  
Kate Tillotson, Dr. Jenn Weber and Kim  
Sasan

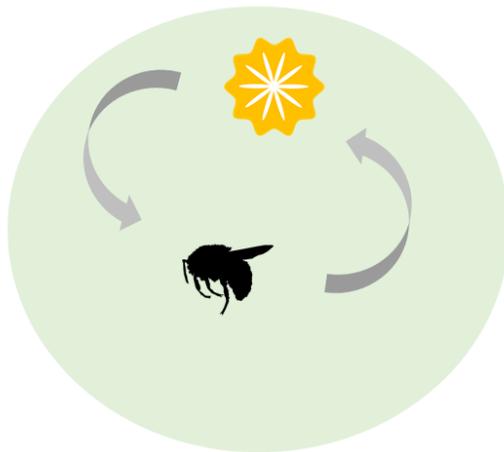
*All photos courtesy of Kim Sasan of  
Texas Master Naturalists*

To successfully identify pollinators and other floral visitors it's important to understand the interactions of flowering plants and insects



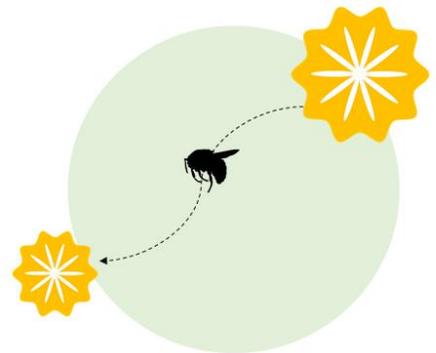
Most flowering plants are dependent on **mutualisms** with insects to move their pollen from one flower to another, these insects are called **pollinators**

These mutualisms are often complex and can be studied from the perspective of either participant in the mutualism- the plant or the pollinator



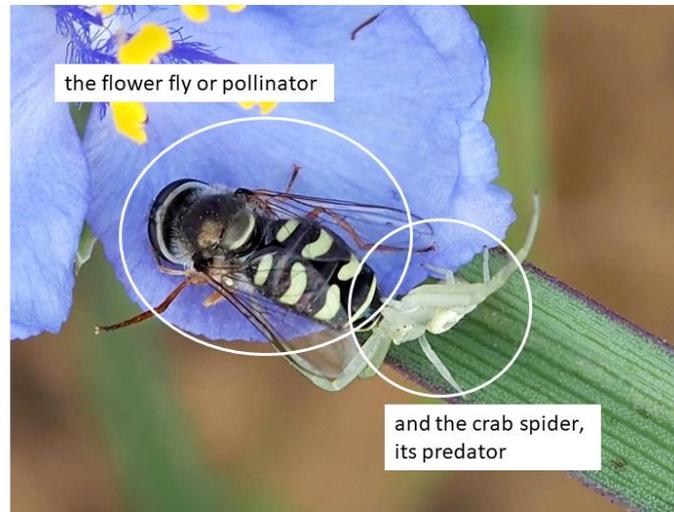
Categorizing both parts of the mutualism contributes observations that give researchers a better sense of these unique relationships

Pollinators are insects that, in visiting flowers, are **capable** and **efficient** at moving pollen from the flower of one plant to another, as you can see below this bee is covered in hairs that collect pollen as it forages for nectar and pollen. These hairs are located all over a bee's body and ferry pollen from one flower to another.



Pollinators act as unwitting vectors for the movement of pollen

Many insects visit flowers and may utilize flowers beyond collecting nectar or pollen. Scientists often want to understand and characterize all the **visitors** that come to a flower, not just the pollinators.



Here you can see two floral visitors- They're both utilizing this flower, but for different ends.

Here we see some of the floral visitors that may use flowers for ends other than pollination

Spiders are common **predators** on flowers. They often wait to ambush their prey by hiding beneath flowers and leaves.



Wasps are predatory meat eaters and use flowers to find prey. They also sometimes use flower nectar as a supplement to their diets.

Ants and beetles are a common sight on flowers. Generally, they are very poor pollinators and are only on or in flowers to steal nectar, that is why we consider them **nectarivores**.



Both groups have bodies mostly without hairs that would pick-up pollen (like bees have) as they feed on the flower's nectar

This limits the ability of these groups to facilitate pollen movement between flowers

Additionally, most ants are wingless and their ability to disperse pollen is even more limited



**Herbivores** may feed on flowers or other parts of the flowering plant, which can affect the resources a plant can utilize for flowering and reproduction.



Some of the most interesting herbivore interactions are those of pollinating species that depend on the same plants for feeding their larvae, such as the butterfly larvae pictured here

These herbivores often eat more than leaves and will bore their way into flowers, causing damage to the floral structures and stealing floral resources



Herbivores may be very tiny like these scale insects

## A bee or not a bee?

Even when we're just observing pollinators, it may not be clear who is who. Some insects that visit or pollinate flowers may imitate or mimic bees in their coloration, such as flower flies, beetles, and predators such as wasps, which share similar coloration.

Similarly, some bees may look like one another but have different roles as pollinators.

Many pollinators are very small, and it can be hard to distinguish the difference between flies and bees without careful observation.

Some bee mimics are hairy and similar in size to bees.

This is a fly



This is also a fly



## Honeybees (Apis)

Unlike Bumble Bees, Honeybees are a non-native species that was naturalized from Europe

Honeybees have stripes that are orange-yellow and black which distinguishes them from native bumblebee and bee species which have yellow or light-yellow coloration



## Bumblebees (Bombus)

Bumblebee stripes which are black and vivid yellow

Generally furrier and larger





## Carpenter Bees (Xylocopa)

Carpenter Bees have a shiny abdomen and much larger heads



Bumblebees (Bombus)

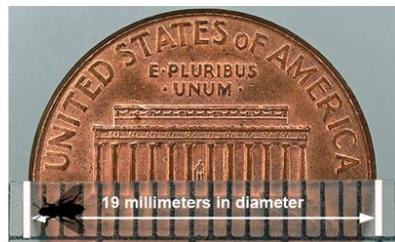
Bumblebees have a hairy abdomen



## Small Bees



Small bees do not belong to the same genus as Bumblebees (Bombus) and can be the size of Honeybees or smaller. These are native bees that are locally adapted and can be very diverse.



While some small bees are larger and easily seen some of the species in the genus Lasioglossum (Sweat Bees) can be as small as 3-4 mm



It's important to keep your eyes peeled and try to differentiate these from small flies!



They can be an important part of a pollinator community for different species of flowers



Flies have no pollen collecting hairs on their back legs like bees do



Fly species can have very similar markings to bees, but their flight is distinct from bees in that they can hover

Flies have much shorter antennae than bees



With large forward-facing eyes that often touch the top of their head

Antennae of bees vary from other insects in that they have elbowed antennae



Bees have eyes on the side of their head



## Wasps

As a general rule, wasps are predators and eat other organisms but may come to flowers to feed on pollen or nectar to aid their development. However, they're considered poor pollinators because of their hairlessness.



Wasps have skinny bodies with a narrow waist and are generally hairless with long, thin legs

Wasps resemble bees in color and may be plentiful in flowering areas



We have discussed the differences between pollinators and floral visitors such as predators. We are also familiar with different groups of bees that could be observed visiting flowers as well as some of the ways other insects' mimic bees to protect themselves while they visit flowers.

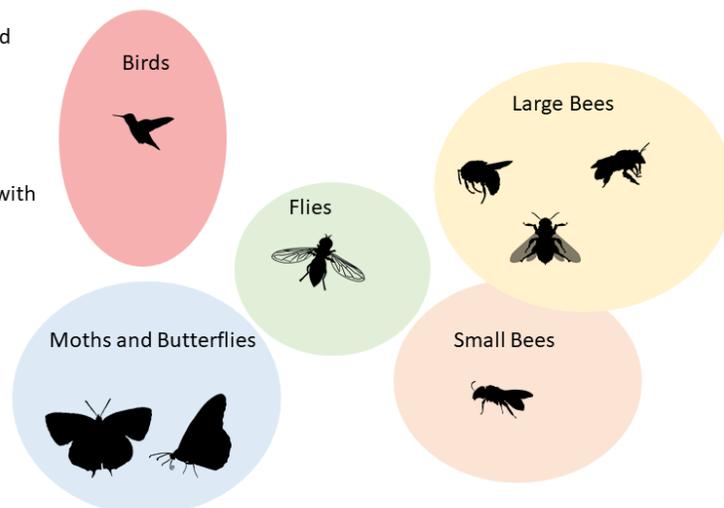
Building on this knowledge, we'll learn about functional groups and the relationships between flowers and pollinators that we could characterize.



## What is a functional group?

Pollinators can be subdivided into "functional groups"

Each group tends to interact with plant species differently



# Flower Shape and Form

Often reflects whether a flowering species is a specialist



Radial Symmetry

Radial symmetry and an open shape indicate a flower that may be visited by generalist pollinators

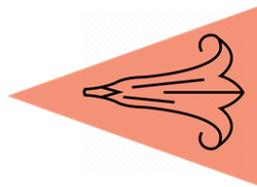


Dish Shaped

Shapes or forms such as bilateral symmetry or an enclosed or tubular form may indicate more specialized pollinators or different **pollinator syndromes**.

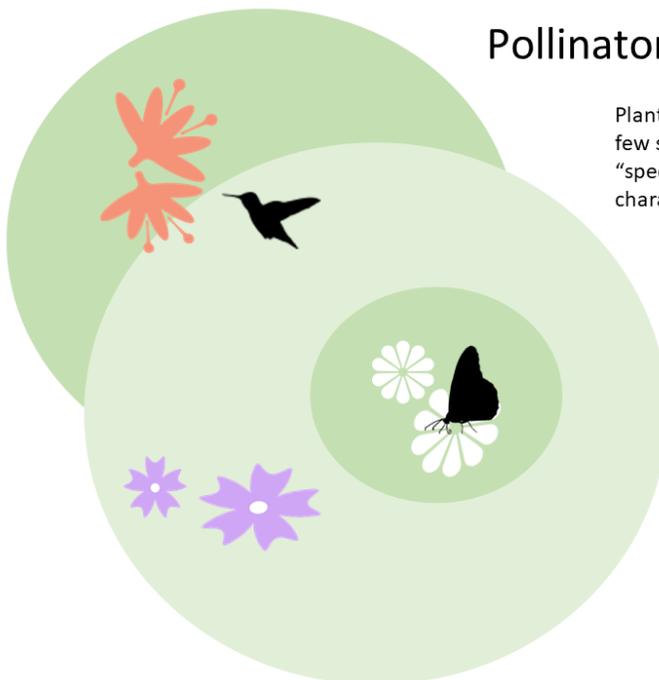


Bilateral Symmetry



Tubular Form

Pollination syndromes are a set of traits that generally indicate certain functional groups of pollinators and have been selected for over time.



## Pollinator and Floral Specialization

Plants that are reliant on one functional group or very few species for reliable pollination are said to be “specialized”. These flowering species have evolved certain characteristics that attract specific pollinators

Defining pollinator specialism is a little trickier...

Often scientists define specialization through behavior (interaction with a flowering plant) and range of a certain pollinator

Floral constancy is a type of “specialization”. During a foraging trip insects may visit flowers from only one species of plant. This behavior is easily observed.



## Plant Communities and Markets

Communities are groups of species that commonly occur together. We can define this on several levels: the flowering plant community, the pollinators and visitors, or all together

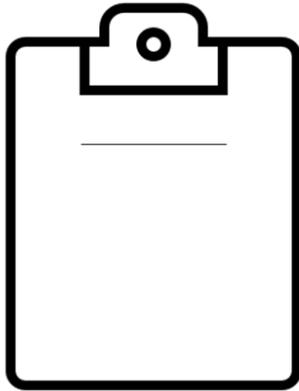
Plant communities are defined by the species present and their density and abundance

If one species is particularly dense, we may expect to see a different pollinator make-up or insects only visiting these flowers. These can be seen as "markets"

## Pollination Syndromes

				
Colors	Red, Orange	Red, Orange, Yellow	White, Yellow	Pink, Purple, Blue, White, Yellow
Shape	Bilateral or Radial Tube	Small or Long Tube	Radial, Flat	Bilateral or Radial
Time Open	Daytime	Daytime	Daytime	Dawn and Daytime
Scent	No scent	Strong scent	No strong scent	Some scent
Occurrence		En mass		

# Introduction to Observational Research and Citizen Science



You may have never personally participated in an observational study of pollinators BUT you've probably reported data

Now, more than ever, citizen observations can impact scientific research by contributing scientific data that can be collected in a repeatable method.

Through apps like iNaturalist Citizen Scientists can share their results directly with researchers.

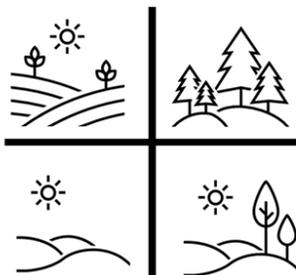


## Observational Research

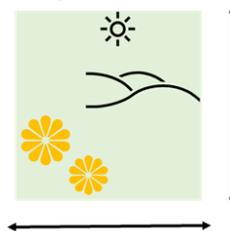
Taking data in a repeatable method is the backbone of scientific experimentation. This allows you, the researcher, to understand under what circumstances the data was taken and to account for discrepancies and anomalies

To take repeatable observational data on pollinators and floral visitors follow the steps below

Start by picking a spot that is "uniform" meaning that it has one type of habitat



You'll measure and observe an area the same distance as your arms outstretched, forming a square, about 1 meter by 1 meter



Record your observations for 30 minutes



# What to record?

1. Record data about where you're observing



Record the habitat features  
 -grassland?  
 -woodland?  
 -one large bush with many blooms?



2. Record the time, date and geographic location



This information you can gather from your phone



3. Record plant characteristics or species present



You may even want to identify plant species using the Seek app by iNaturalist

# What to record?

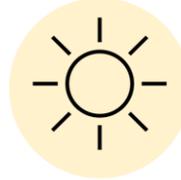
Record the functional groups of pollinators that are present and how many. If species look distinct you can record how many different species you think are present. Make notes of their habit- are they visiting many flowers or just a few?



Functional Groups	Tally	Distinct Species	Habit
Honeybees			
Bumblebees			
Small Bees			
Flower Flies			
Butterflies and Moths			
Birds			

# When?

Bees and other pollinators dislike cloudy, windy or cold and cool days



Take observations when it's nice and sunny out

Spring



Early Fall

Ensure that flowers are open and not closed due to time of day or weather



Take observations in mid-morning or afternoon depending on the heat of the day

# iNaturalist



iNaturalist is a powerful tool that connects people around the world in characterizing and collecting data on biodiversity



Just by uploading photos you can give scientists a chance to understand the species you're observing through metadata



iNaturalist is an open forum where people can discuss what species is present in your observations



# Other Records



You can leave your observations as is or take it a step further...



Record visitors that aren't pollinators, such as predators or herbivores

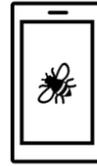


Maybe you want to ID insects you see but you don't know what species?

You can also use Seek by iNaturalist-it uses image recognition technology to identify natural life around you. No registration is needed and it doesn't collect user data.



You can upload a clear, close-up photo of your pollinator/visitor to iNaturalist



This allows other citizen scientists the ability to check and see what you may have found and ID it!



# Where your observation goes after it's uploaded

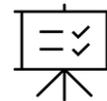
If enough people agree on the identification of your organism on iNaturalist then your observation can be used for research!



RESEARCH GRADE



Academic researchers can then use all this data to understand natural history questions in many fields



# You're a Citizen Scientist!

By participating, you can be an important part of increasing our knowledge and awareness of pollinators and other aspects of the natural world



These natural interactions are also ones that are crucial to humans and our food sources



Characterizing functional groups and pollinator species in an area deepens our understanding of the ecological services those insects play a part in

